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Analysis of residential choice behavior at community scale

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Abstract:

The complex problems shared by many cities throughout Japan are evidence of the impacts of land use plans that have been poorly designed and managed. Most of the existing plans in Japan have focused on the metropolitan areas but nowadays the physical layout or land use of communities is fundamental to sustainability. Community sustainability requires a transition from poorly-managed large-scale plans to land use planning practices at the community scale that maintain efficient infrastructures, and ensure close-knit neighborhoods and a sense of community.

This paper provides a scheme for discussing the residential choice of people at the community scale in a local city in Japan in order to help local communities or local authorities concerned with suitable land use planning. First, this paper gives the key principles of residential choice behavior through the statistical analysis of the revealed preference of people who actually made the decision to choose the location of their new residence. Some interesting results are a bigger correlation than expected between the location of residence and the place of work, and a strong attachment of movers to their old communities. The latter half of this paper describes a modeling process for specifying the residential choice at the community scale. The discrete choice model adopted in the present study is a conventional disaggregate logit model that is capable of representing complicated individual choice behavior while they are changing their place of residence.

1. Introduction

The complex problems shared by many cities throughout Japan are evidence of the impacts of land use plans that have been poorly designed and managed (see Abe, 1995). Residential location problem is, among many land use problems, a very important subject to which top priority should be given to provide it with speedy solutions. Therefore many kinds of studies have been accumulated, most of which have been done, as a pivotal point for controversy, with a wide urban area having a megalopolis as its center to deal with a large zone as an objective (for example, see ASCE, 1986, Healey, 1989 and Kaiser, 1995). In other words, the existing studies mainly aim at providing an analytical method useful for an upper-ranking plan for land use at a macro-level.

However, in consideration of the fact that residential location is basically the action on a household basis, it is no exaggeration to say that analysis on a small zone that can be clearly discerned by people, that is, the analysis at a micro-level should be required. Especially in a local city where change in the land use in a small range has been observed, the analysis on a small zone or community from a point of view of quality is

very important. Besides, the physical layout or land use of communities is fundamental to sustainability in local cities. Community sustainability requires a transition from poorly-managed large-scale plans to land use planning practices at the community scale that maintain efficient infrastructures, and ensure close-knit neighborhoods and a sense of community.

Accompanied with the innovations of cities such as change of social economic situations, expansion of the cities, etc., it is necessary to comprehend how change of the residential location can be noticed. Namely, it is necessary to explain under what kind of action principle residential location is secured. Standing on the conception referred to above, this study has investigated a local residential location model, whose purpose is to analyze the residential location taking up a small zone, i.e. community as an objective, focusing the matter on a local city in Japan.

Several reports have been released with land use analysis dealing with small zones, but only aggregate handling has been made in any of the reports. Keeping in mind the fact that the residential location is dealt with fundamentally on a basis of a household, a method where choice behavior based on a household's attribute can be described should be introduced for the analysis (for example, see Ben-Akiva, 1983 and Miyamoto, 1986a, 1986b).

In the point of view of city development, it is most efficient and most logical to take a measure of promoting development that gives priority to a zone starting from the ones having high preference as residential locations. In this sense, a method should be discussed which can evaluate aggressively the zone preference or the possibility for zonal development.

This study is aimed at introducing a disaggregate behavioral model describing choice behavior stochastically in order to satisfy simultaneously the two viewpoints stated above. That is, the residential location in this study is grasped as disaggregate residential choice behavior.

Saga City, which is a typical local city in Japan, is the study area that is composed of many communities. The area of a community is as small as the primary school district and sometimes the community is called a zone for simplicity.

2. Analysis of residential choice behavior

2.1 Questionnaire

A questionnaire was designed and done for the purpose of comprehension of behavioral principle to explain on what people should base their decision when they choose their place of residence and for the sake of collection of knowledge to make clear how much time people take for commuting or how much convenience is gained with the commuting method. The questionnaire was basically conducted with the revealed preference survey.

2.1.1 Zoning and setting up choosable zones

Saga City has 16 primary school districts. One primary school zone is further divided into two or three pieces, and the study area has 30 zones in all (see Figure 1). However the whole zones are not necessarily chosen as place of residence, but choosable zones are as a reality restricted by any of the conditions. Therefore, this study first did the setting-up of the choosable zones, based upon the conditions shown below.

(a) The first condition: Residential location shall be possible exclusively within the urbanization promotion area.

(b) The second condition: The city center zone where residential location and

commercial location are in competition shall be excluded from the choosable zones.

According to the national census and the business office statistical survey, the zone where residential location and commercial location are in competition and situations are greatly different from the other zones can be judged as zone 1, zone 2 and zone 3 in Figure 1. Thus these three zones shall be the zones out of objective. In this study, the zones 1 to 3 shall be the city center zone or the urban zone, whereas the other zones shall hereunder be the surrounding zone. In the end, all among the 30 zones in the city, the zones as objectives for choice of place of residence number 19. To put it concretely, the target zones are 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 28 and 30 in Figure 1.

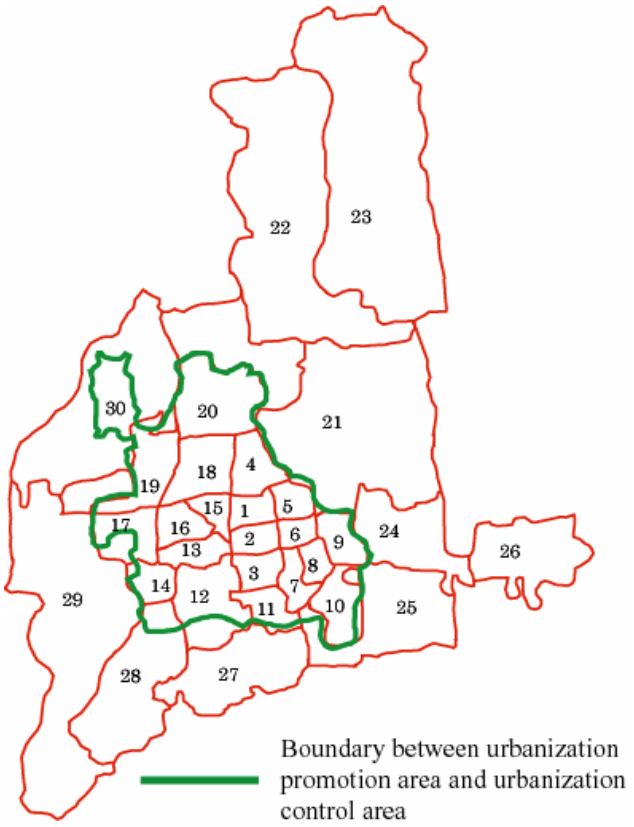

Figure 1 Zoning in Saga City

2.1.2 Items of the questionnaire

The items are classified into three parts; (1) the attribute of the decision-maker, which stands for the personal attribute of the person who made the real decision while changing their place of residence, (2) the characteristics of the place of residence, and (3) the situation surrounding the choice of place of residence. Listed in Table 1 are the items in question.

The questionnaire was performed in accordance with the visit and detention method in the middle of October, 2003. The respondents were randomly chosen from among the residents who have lived in the 19 zones stated above. The total number of the questionnaire notes distributed amounted to 1,306. The recovery ratio was 81.1% and the effective response ratio was 75.6%.

Table 1 Items of the questionnaire

A. Attribute of decision-maker in household or family
1. Zone number of residential zone where decision-maker lives 2. Age of decision-maker 3. Occupation of decision-maker 4. Working place of decision-maker 5. Commuting mode of decision-maker 6. Commuting time of decision-maker 7. Total number of family members 8. Car-ownership of household 9. Duration of living (residing years)
B. Characteristics of residential zone
1. Convenience to come to city center 2. Convenience of using bus 3. Convenience of daily shopping 4. Convenience of commuting to office 5. Convenience of coming to kindergarten 6. Convenience of coming to elementary school 7. Convenience of coming to public facility 8. Convenience of coming to financial institution 9. Convenience of coming to hospital 10. Convenience of coming to park 11. Level of satisfaction of roads near house 12. Level of satisfaction of public facilities near house 13. Comfortableness as place of residence 14. Time required to come to public transport terminal 15. Time required to come to city center
C. Choice of place of residence
1. Zone number of zone where decision-maker lived formerly 2. Type of former house 3. Reason for changing the place of residence 4. Existence of choosable zone 5. Commonality of choosable zone 6. Reason for choosing residential zone

2.2 Analysis of residential choice behavior based on the questionnaire

Descriptive statistics were discussed, with frequency analysis (simple aggregation) and crosstable analysis (crosstabulation), on the data obtained from the questionnaire in order to explain the choice behavior of the place of residence. With the crosstable analysis, relevancy among the items was discussed using Cramer's measure of association (hereafter referred to as v).

First, Figure 2 was obtained after classifying zones using the ratio of the households living in the zone for less than 10 years to the total number of households. Since a zone group where the ratio of the household living in the zone for less than 10 years is old enough as a residential zone and is located in close enough to the city center, a new location is hard to be made. On the other hand, another zone group where the said ratio is large enough is separated from the city center and is located closely to the urbanization control area. Thus the group is said to be the area where development will be made aggressively. Meanwhile the crosstable analysis also showed that the relevancy between the number of residing years and the residential area was high enough (v=0.36). The above description means that the degree of maturity of the residential zones differs from the type of zone to the type of zone. This might have resulted from the fact that the urbanization control by the administration was a success. Accordingly, it can be imagined that people follow the same tendency of changing their place of residence, reflecting the change of policies depending on the decade.

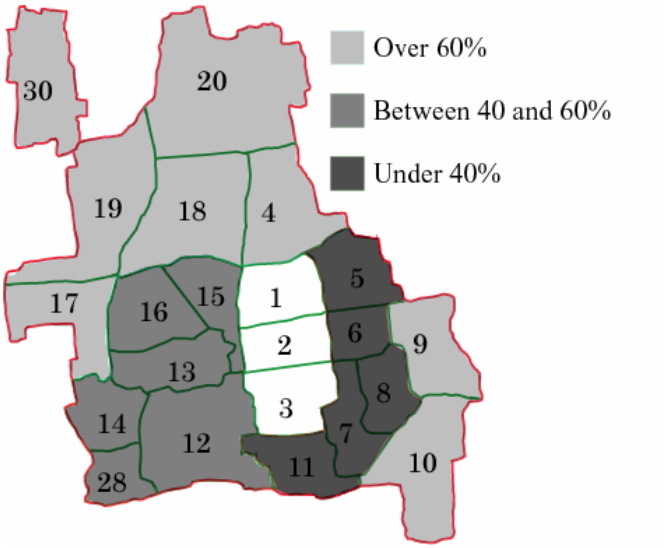

Figure 2 Percentage of households living in the zone for less than 10 years

In general, determination of the residential zones has been done with plural reasons entangled with each other. Frequency analysis of the number of reasons for changing their place of residence replying that this is the most important revealed the following results. That is, the greatest reason for the choice of residential zone is that the land price is low (22.1%). The second greatest reason is that for commuters, the distance to their offices is short enough (11.9%). Furthermore that the residents happened to possess land (11.4%) and that the land sellers are reliable (10.1%) are the reasons to be followed in this order. In addition, at the same level as the reasons for natural conditions and the convenience of transportation, the following are also reasons to be kept in mind. The residents live in the places close to their relatives or kinsmen (9.2%) and they live in the community with which they have long been familiar (8.9%). From this it may be said that regional or kinship-inclined relations are not ignorable factors.

At the next stage in scrutinizing the relation between the residential zones and the sites where residents are engaged in their work, nothing remarkable is noticed with a way of living of the so-called “separation of office from residence,” i.e. a lifestyle of the people who reside in the surroundings of a city so as to work in the pivotal spot of the city, as seen in megalopolises. Furthermore this features highness of the ratio of the residents who find their working places in the zone where they reside. Hence it might be permissible to conclude that the relation between the working site and the residential place is classified into the following two types:

(a) Type 1: The working site is a zone among the city center zones, whereas the residential place is a zone among the surrounding zones.

(b) Type 2: The working site is a zone among the surrounding zones, whereas the residential place is a zone identical with the zone in question or a zone adjacent to the said zone.

Figure 3 demonstrates the frequency distribution of the number of households concerning the adjacency index between the residential zone and the working zone. It followed from the figure that the difference in the working zone brings about the difference in the choice of a residential zone. However, in the point that as the adjacency index becomes greater, the number of households is rapidly decreased, the two types are common to each other. This fact means that there is a close relation between the land where the working zone is located and the candidate land of the residential zone and then that a set of choice candidate land with the working site as a

kernel is formed. Here, the adjacency index was originally introduced by the authors to know the topological distance between two different zones by the number of intermediate zones existing between them (see Chishaki, 1988).

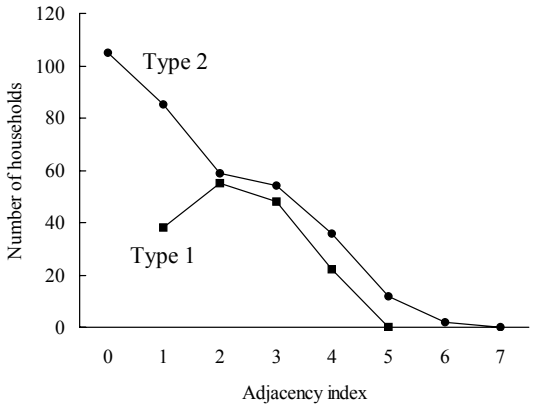

Figure 3 Frequency distribution of number of households on the adjacency index between the residential zone and working zone.

Figure 4 similarly shows the frequency distribution for discussing the relation between the former residential zone and the residential zone at present, by classifying the households into two groups:

(a) Type A: household whose former residential zone was in the city center zones.
(b) Type B: household whose former residential zone was in the surrounding zones.

This figure indicates that the patterns of changing the place of residence are different from each other with both types. The tendency of Type A is good to know how the residential place has changed from the city-center state to the suburban state by being shifted to the surrounding area. Furthermore when attention is paid to the fact that the difference between the number of households with 1 in the adjacency index and the numbers of households with 2 in the adjacency index is considerably greater with Type B, a tendency is noted, in the case when the former residential zone is among the surrounding zones, that changing the place of residence will be done to a place near enough to the zone itself or to the adjacent zone. This can be deduced also from one of the questionnaire's results that land ownership and attachment to the old community were the key reasons for choosing a residential zone.

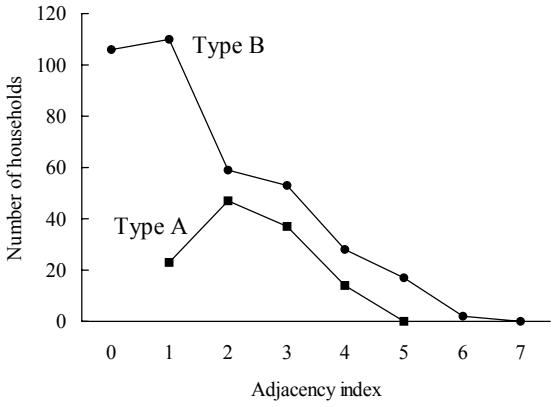

Figure 4 Frequency distribution of number of households on the adjacency index between the present residential zone and former residential zone.

The crosstable analysis succeeds in showing that the relevancy between the residential zone and the former residential zone (v=0.25) and the relevancy between the residential zone and the commonality of the candidate land (v=0.25) are both strong enough. The commonality of the candidate land means in this study that the individuals of the candidate land are similar to each other when the residential environment is referred to. This study supposes that the same situation can also be seen with the residential zones at present. Thus, it can be concluded that people make the decision of residential choice under a behavioral principle that a new residential zone is finally chosen among individuals of the candidate land having common characteristics to the former residential zone in consideration of the distance from the former residential zone.

Other factors showing relatively large relevancy are the relevancy between residing years and former residential zone (v=0.26), the relevancy between residing years and reason for choice of residential zone (v=0.24), and the relevancy between residing years and former type of residence (v=0.25). Summarizing these facts resulted in a new finding that changing the place of residence has been done for identical tendencies depending on the year of changing the place of residence. In other words, this suggests that there is a possibility of changing the place of residence being induced by city transition, such as the concentration onto the city center and the following extension of the city, and administrative transition such as the change of zoning policy.

3. Mathematical modeling of residential choice behavior

3.1 Setting up of the choice set

Needless to say, it is important to determine the choice set that is equal to the set of choosable alternatives or candidates while developing the disaggregate logit model. This study has a target area that consists of 19 zones with community scale as stated earlier. Provided that the said zones are left untouched, it is permissible to state that modeling comes to be planned on the supposition that people chose one among all the 19 alternatives by making comparisons between all of them. However, in reality, people make comparisons of very few alternatives with which their actual judgment is possible. Because the choice set is not common to all people but different from person to person, it is necessary to set up the choice set for every person in order to find alternatives of which people can actually be aware or of which they are supposedly aware. Setting up the choice set is also required for further enhancement of the model validation and for reducing workload in the model calibration. This study introduced two different methods for setting up the choice set. Their explanation will be fully given hereafter.

3.1.1 Setting up of the choice set using the adjacency index

Figures 3 and 4 suggest that a method is possible to regard the zone group adjacent to people's working zone or former residential zone as a choice set when their working zone or former residential zone is in the surrounding zones. A controversial problem at that time is to what extent the upper limit of the adjacency index should be taken. In general, the greater the adjacency index is, the more the number of zones becomes. This stands for that the probability that the zones actually perceived is included in it becomes greater and therefore the method gives more logical setting-up. However, existence of too many zones reduces the effectiveness of setting up the choice set. This study has decided that in consideration of the balance of both, the zone group included in a range of the first-degree adjacency, which is equal to the zone group whose adjacency index is

1, is to be used as the choice set.

The setting up of the choice set using the adjacency index on the people's working place should be first done based upon the well-known facts that people give priority to the distance from their working place over the distance from the former residential place and that the distance from the people's working place is more important when moving in from the outside of the city. First of all, let it be judged whether the people's working zone is included in the surrounding zones or not. If so, let the first-degree adjacent zone be a temporary choice set. If the present residential zone is included in the temporary choice set, let the temporary choice set be the final choice set and let the procedure be finalized. If the present residential zone is not included in the temporary choice set and the people's working zone is included in the city center zones, the method using the adjacency index becomes impossible to use to set up the choice set and thus an alternative method should be applied. Figure 5 illustrates the flowchart of the method using the adjacency index described above. Actually, the setting-up was able to be done with 76% of the households.

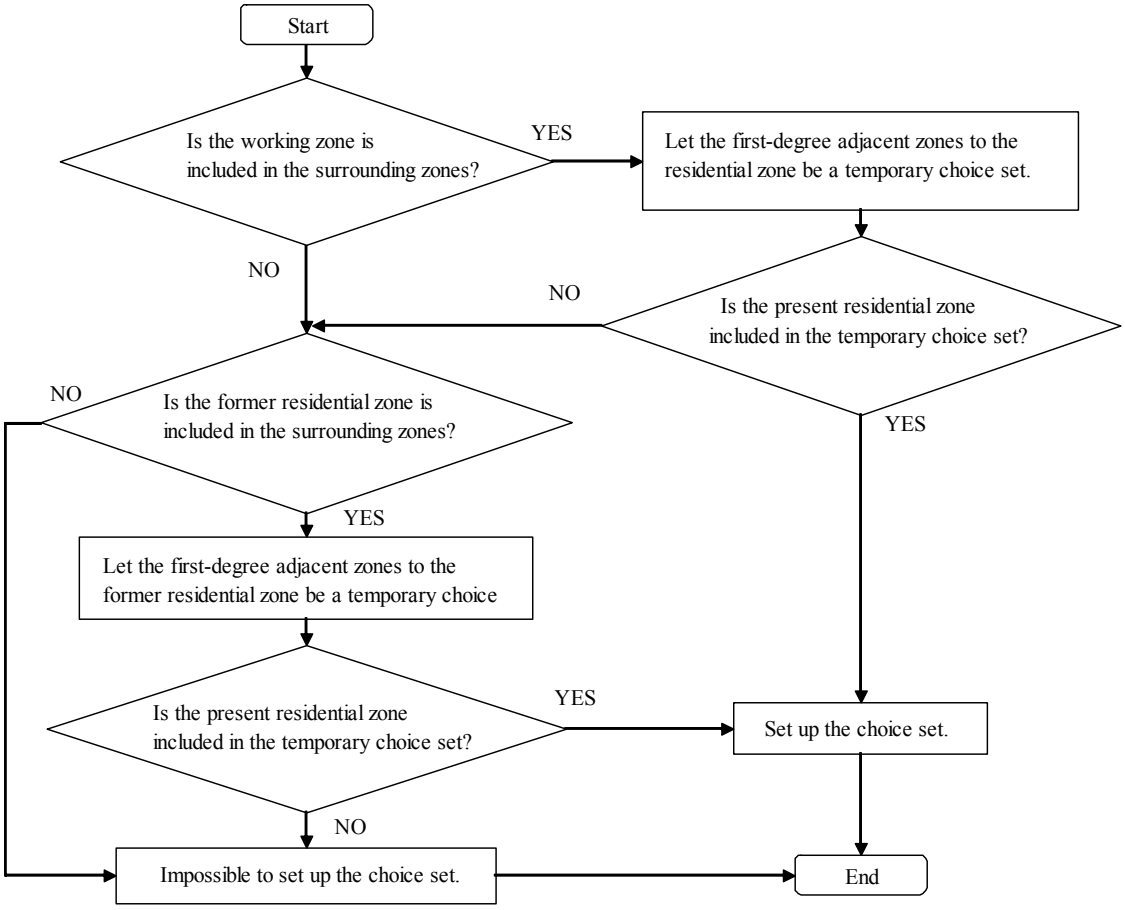

Figure 5 Flowchart of setting up choice set using the adjacency index

3.1.2 Setting up of the choice set by means of the principal component analysis

The real behavioral analysis done in the earlier section showed that people have perceived a few zones having common or similar characteristics while thinking of candidate zones. Based upon the idea, a method could be developed to allow the zone group that is similar to the actually chosen zone in the characteristics to be a choice set. The first step of this method is to classify all zones into several groups corresponding to

its regional characteristics. This study employed the principal component analysis (called PCA hereafter) since it can provide a very meaningful classification of zones reflecting the regional comprehensive characteristics with the many socio-economic variables. The PCA finally gave several principal components, the first two of which were used to depict the schematic diagram of the zone distribution. Namely, it gave the two-dimensional distribution diagram, with the first principal component score as the horizontal axis and with the second principal component score as the vertical axis, to classify many zones to a few groups. Let it be judged that the zones included in the same group have the same zonal characteristics and let all zones in the group in which the actually chosen zone is included be the choice set. When the PCA was performed using the socio-economic variables listed in Table 2, the distribution diagram was able to classify 19 zones into four zone groups by the plus and minus combination of the individual axes. Figure 6 illustrates the final classification of zones.

Table 2 List of socio-economic variables used in the PCA

1. Nighttime population
2. Rate of change of nighttime population
3. Population density (=nighttime population / zonal area)
4. Working rate (= working population / zonal area)
5. Working population in all industries
6. Working population in the secondary industry
7. Working population in the tertiary industry

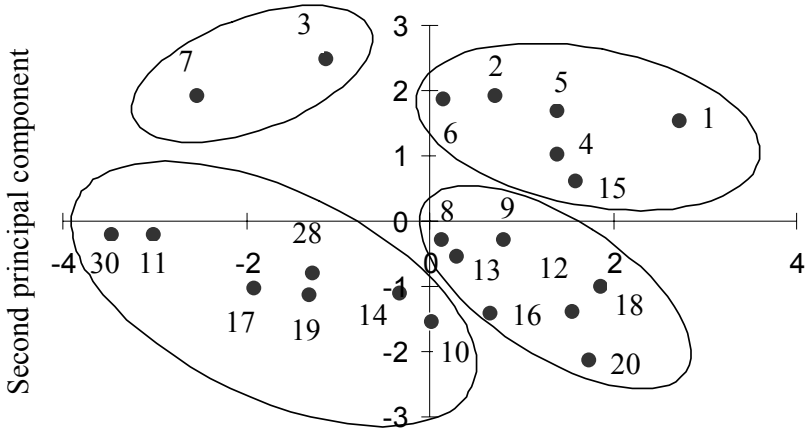

Figure 6 Classification of zones with the PCA

The setting-up method with the adjacency index is said to be based on the spatial distance since it utilizes the commuting distance or the distance from the former residential zone, while the setting-up method with the PCA is said to be based on the zonal environments since it includes many zonal characteristics reflecting the socio-economic situations. Viewing from another direction, the adjacency index method will be person-based, whereas the PCA method will be zone-based. Therefore, the joint use of both methods makes it possible to set up the choice set simultaneously in consideration of the two different factors in the residential choice. In this study, with the households where the choice set was unable to be set up by the adjacency index method, the choice set was set up using the PCA method. Meanwhile with the households where

the two setting-up methods were available, the intersection of two sets obtained by two different methods was used as the final choice set. Finally, the number of zones of the choice set was 2 as the minimum and 6 as the maximum. Its flow is given in Figure 7.

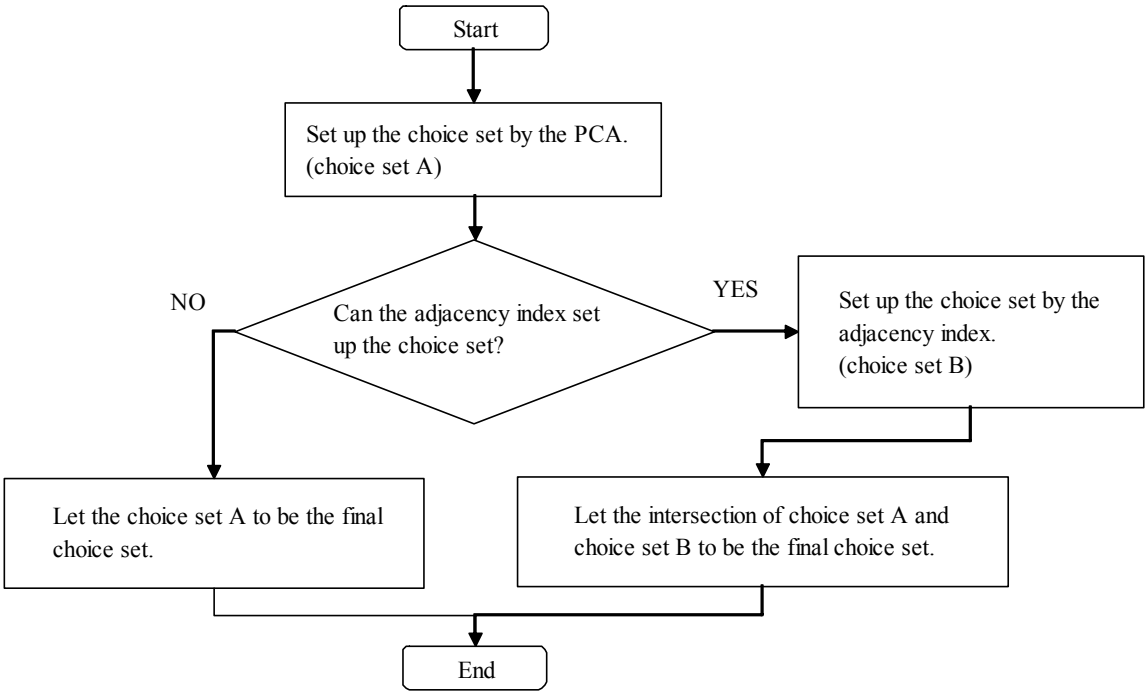

Figure 7 Flowchart of setting up the final choice set

3.2 Calibration of the residential choice model

3.2.1 Model form

As stated earlier, this study adopted the disaggregate logit model for explaining the residential choice behavior at the community scale. The model form is as follows:

$$P_{in} = \frac{e^{V_{in}}}{\sum_{j \in C_n} e^{V_{jn}}} \tag{1}$$

Notations are:

i, j = alternative (is zone in this study),
n = person or decision-maker,
k = parameter index,
P_{in} = probability of any zone i being chosen by person n from his/her choice set,
C_n = choice set for person n, and how to set up the choice set was already stated in the previous section,
V_{in} = systematic component of utility, supposed to be linear as:

$$V_{in} = \sum_{k=1}^{K} \beta_k X_{ink} \tag{2}$$

X_{ink} = k-th independent variable with person n and zone i, and its selection will be given in the next section,
β_k = k-th unknown parameter, to be estimated by some method, and
K = number of independent variables.

3.2.2 Selection of independent variables

It is also important to know what independent variables are appropriate to be built in the model. Referring to the former study's result (see Aoki, 1995) and taking the following reasons into account, this study decided to utilize two socio-economic indices and three personal attributes as the independent variables of Eq.(1)

(1) Commuting time: The real behavioral analysis showed that people think commuting time is most important when thinking about the change of residence. Therefore, the commuting time (in minutes) was taken as the alternative-common variable.

(2) Time to the public transport terminal: In thinking about the choice of residential zones, people don't ignore the time it takes to reach a key terminal for public transport such as a railroad station or bus terminal. The real behavioral analysis also assures this matter. This study selected Saga Station of Kyushu Railway Company as the public transport terminal, and the time (in minutes) for people to reach it from their homes was employed as the alternative-common variable.

(3) Land ownership: The land ownership was determined to be an independent variable because it was designated as the third reason for the choice of residential zone in the real behavioral analysis. A dummy variable was actually introduced for the purpose of being shown 1 in the case of owning land and 0 in the case of owning no land.

(4) Age: It is widely known how choice of the residential places has been differently made dependent on the age bracket. Considering this fact, this study introduced a dummy variable that can reflect the age constitution of the decision-makers. With 50 years of age, a median, as the boundary, let the variable be 1 in the case that the decision-maker is more than or equal to 50 years old, and 0 in the case that he or she is less than 50 years old.

(5) Job: Whether the decision-maker is working or not exercises a considerable degree of influence on the choice of residential places. Therefore, a dummy variable was introduced; indicating 1 in the case that the decision-maker is jobless, while 0 in the case that he or she has a job.

With respect to (1) commuting time and (2) time to the public transport terminal, just exclusively a characteristic value of the alternative actually chosen could be taken. This means that another characteristic value concerning the other alternative should be estimated. This study did a simple estimation to set the mode in the distribution of the characteristic value taken in relation to the zone pair in question as an estimated value for another alternative that was not chosen.

There is also an important factor other than the variables referred to above. It is land price. The reason is that the land price constitutes so-called locational surplus together with such factors including commuting time. An attempt was made with the introduction of the land price in this study as well, but the introduction was this time placed out of consideration, taking account of the deficit in the land prices caused by smallness of the objective zone, and results of the t-Test on the parameters estimated. However, as was explained by the real behavioral analysis, the land price is a major factor in choosing residential places. Thus investigation is to be made with the method of the introduction in the future.

3.2.3 Estimation results

Estimation results by the method of maximum likelihood are summarized in Table 3, which assures that the proposed model achieves the high reproducibility of the actual data since two fitness-of-good measures are considerably good; the likelihood ratio is 0.598 and the percent correctly estimated is 88.6%. The t-value of the commuting time and the time to the public transport terminal is large, when consideration is made

excluding alternative-specific dummy variables. Especially, the commuting time showed the maximum value in all the variables, which resulted in coincidence with the real behavior in the residential choice.

Table 3 Estimation results of the residential choice model

Independent variable			Parameter	t-value
Characteristics on alternative	Alternative-specific dummy variable	Zone 4	-3.993	-4.702 **
		Zone 5	-1.477	-1.773
		Zone 6	-1.884	-2.062 **
		Zone 7	-5.536	-4.583 **
		Zone 8	-4.518	-3.943 **
		Zone 9	-2.549	-2.406 *
		Zone 10	0.291	0.284
		Zone 11	-4.698	-4.716 **
		Zone 12	-3.692	-3.746 **
		Zone 13	-6.217	-5.904 **
		Zone 14	-5.307	-5.638 **
		Zone 15	-3.065	-2.939 **
		Zone 16	-4.132	-5.030 **
		Zone 17	-0.231	-0.492
		Zone 18	-3.395	-4.617 **
		Zone 19	-2.946	-6.309 **
		Zone 20	-3.024	-4.351 **
		Zone 28	-4.714	-4.766 **
	Commuting time		-0.487	-10.442 **
	Time to the public transport terminal		-0.190	-3.884 **
Attribute of decision-maker	Land ownership		17.929	0.026
	Age		21.146	0.029
	Job		-0.025	-0.00002
Number of observations = 574 Number of cases = 1,264 Likelihood ratio = 0.598 Percent correctly estimated = 88.6%				

(Note) ** means significant at significant level of 0.01, and
* means significant at significant level of 0.05.

It can be found from interpretation of the alternative-common variable's parameter that the shorter the commuting time is and the shorter the time to the public transport terminal is, the higher the utility of the alternative is and therefore the higher the choice probability, which is identical to the probability in the case that the alternative is chosen, is. The positive sign of the parameter of land ownership indicates that the choice probability of the alternative becomes higher if people own their land in a specific alternative.

3.3 Choice probability at zonal level

Eq. (1) gives the choice probability at the personal level or the personal choice probability. Indeed it is important but the zonal choice probability, which means the choice probability at the zonal level, is often required to evaluate the zone preference as a residential location. For example, when administrators who are in charge of land use discuss some related plans, they always have the zonal characteristics in mind but never

care about the personal matters. The zonal choice probability is obtained by aggregating all of the personal choice probabilities included in a certain zone.

This study attempted to apply the classification method among the several methods to aggregate the personal choice probability. Letting S_i be the choice probability, or the share, of zone i, S_i is expressed as follows:

$$S_i = \sum_g \frac{N_g}{N_T} S_{ig} = \sum_g \frac{N_g}{N_T} P(i \mid \overline{\boldsymbol{X}}_g, \boldsymbol{\beta}) \tag{3}$$

where

$S_{ig} = P(i \mid \overline{\boldsymbol{X}}_g, \boldsymbol{\beta})$ = share of zone i in segment g,

g = segment index,

$\overline{\boldsymbol{X}}_g$ = matrix of average independent variables in segment g,

$\boldsymbol{\beta}$ = vector of parameters that were already estimated

N_g = number of persons in segment g, and

N_T = total number of persons.

Let the segment in this study be a group of the individual persons who have the same pair of residential zone and working zone. The mean value of socio-economic variable is obtained by averaging the values including in the segment, while with the personal attribute in a certain segment, let the one that accounted for a larger proportion in the segment be adopted in consideration of the fact that the three personal attributes equally have either of two values, 0 and 1. Let the choice set of a certain segment to be the union of the choice sets of the persons included in the segment.

Table 4 Zonal choice probability (in percent)

Zone	Observed	Estimated
Zone 4	6.10	4.16
Zone 5	5.05	9.37
Zone 6	5.57	3.83
Zone 7	1.39	0.65
Zone 8	3.48	1.61
Zone 9	5.05	5.93
Zone 10	5.23	8.47
Zone 11	3.31	4.81
Zone 12	4.18	6.87
Zone 13	4.36	2.53
Zone 14	6.10	1.47
Zone 15	2.79	2.98
Zone 16	4.18	5.49
Zone 17	6.79	8.97
Zone 18	10.10	12.50
Zone 19	8.10	8.44
Zone 20	6.62	5.88
Zone 28	4.53	1.59
Zone 30	7.14	4.45

Table 4 shows the zonal choice probability estimated by the classification method. The correlation coefficient between the actual zonal choice probability and the estimated zonal choice probability for all zones is as great as 0.86. This means that the proposed model has also the high reproducibility of choice probability at the zonal level. It is shown from the figure that the zonal choice probability is relatively high in the

zones in the northwest while the probability is relatively low in the surrounding zones in the southwest. This fact is consistent with the real choice behavior where the zones 7 and 8 as old communities have not been chosen very often and contrarily the northwest zones where remarkable development is under way have been often chosen.

Table 4 also indicates that zones 5 and 8 are excessively estimated, whereas zones 14 and 28 are underestimated. This might be derived from the fact that the utility was highly estimated and then the choice probability was greatly estimated because the time to the public transport terminal is relatively short in zone 5 and other similar zones. It follows form the above discussion that the required time for people to reach the public transport terminal becomes a key factor at the aggregation-level.

The zonal preference means, judging from the point of view of city development, the potentialities that the zone has. Therefore the proposed model succeeded in bringing up an approach to how the zonal potentialities should be evaluated.

4. Concluding remarks

This study first investigated the residential choice behavior with actual data from the revealed preference survey on the individuals' residential choice in Saga City, a typical local city in Japan and then built a model for specifying the residential choice behavior using the disaggregate logit model. The following are the conclusions duly arrived at through the present study.

(1) It could be found that in the residential choice behavior at the community scale in a local city, people have strongly perceived a relation with working place or former residential place. There were several key reasons for choosing the place of residence, some of which were something particular to a local city such as regional or kinship-inclined relations and attachment to old communities.

(2) The effective way for setting up the choice set while developing the disaggregate residential choice model was successfully proposed to combine two methods. Namely, one is based on the commuting distance or distance from the former residential zone using the adjacency index, while another is based on the residential environments using the principal component analysis.

(3) Based upon the real choice behavior, the disaggregate logit model for explaining the people's residential choice behavior was built. The calibration proved the proposed model to have a reproducibility of the actual behavior. Thus validation of the proposed model was ensured.

(4) Finally, to estimate the zonal preference, the zonal choice probability was discussed by aggregation of personal choice probability. It was also confirmed that the proposed model can fit to the zonal probability, and therefore this study could propose one method for discussing the zonal potentialities from the view point of the zonal preference.

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