ANALYSIS OF LOCATION OF LAND MARKET AGENTS WITH DIFFERENT CHARACTERISTICS CONSIDERING THEIR ACCESSIBILITY EVALUATION

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1. Introduction

(1) Research Background and Objectives

Land Market might be affected in several levels by changes on Transportation System, and vice-versa. This dynamic interaction arises because systems' agents (i.e. households and firms) need to improve benefits, choosing the best routes or modes to reach their destinations, or, in long term, changing the location to develop their activities. This is the interaction between Transportation System and Land Market (Figure 1).

Regarding the construction of a new road, it might firstly affect the trip patterns of users (i.e. Transportation System), rising changes from their travel time to mode choices. Then, these changes might affect the location of Land Market's agents (i.e. households and firms) through changes in Accessibility and Attractiveness, which are measures of trip utility based on Transportation System patterns. Furthermore, these utility indices might affect location choice by two ways: Direct and Indirect Effects. The first one affects location according to distinctions in agents' characteristics, and the second one is considered through Land-price.

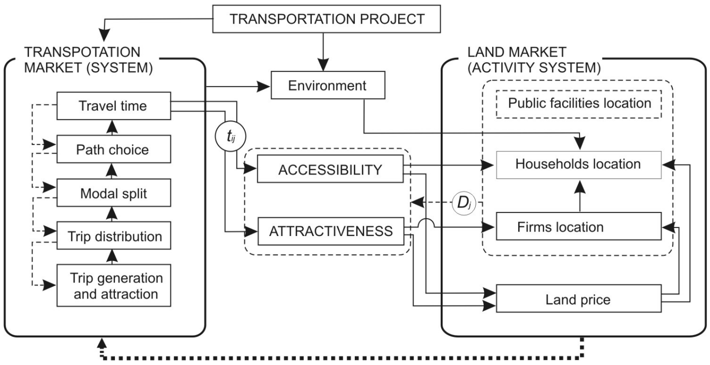

Fig.1 – Transportation System and Land Market Interaction flow

Therefore, the objective of this research is to analyze the direct effects' evaluation for agents with different characteristics, by observing their location choice and utility indices (e.g. accessibility and attractiveness).

(2) Research Characteristics

Previous researches have generally considered agents' characteristics as uniform. However, in the real world, the difference among households' attributes is an important factor that affects location choice. For instance, the age of household's head or income level might influence the utility's perception of a residence location. They make different choices, depending of their hopes, trying to get as higher benefits as possible. Likewise, firms with different characteristics, such as economy sector that they belong, have different location choices hoping to improve their profits (e.g. diminishing transportation costs). On the other hand, Indices of Accessibility and Attractiveness are estimated based on the physical data (e.g. travel time and measures of trip attraction weight), besides they are components of land price. Therefore, the question is how households and firms of different types evaluate accessibility or attractiveness respectively and land price. To analyze this kind of differences in so detailed level, a disaggregate database should be used. Therefore, data available in aggregate format such as zones were broken down in 100m mesh.

2. Research Methodology

(1) Basic Assumptions

The basic assumption of this research is that people are located in the best place to perform their activities (i.e. to reside, to work, to shop, etc.) based on the present's road network, facilities location, and land supply situations. In this paper, the model calibration is conducted using population data by age-rank, instead of households' location. In the case of Transportation System, travel times are calculated without consider the congestion effects. Differences in population's location choice are defined through observation in variations of estimated parameters and its statistical indices.

Keywords: Location choice, Accessibility, Land-price

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(2) Description of the Location Model

a) Model Structure

Considering the case of households' location choice, the probability of a household *h* chooses a site *i* with utility V_i^h will be calculated using the Logit model (Equation 1):

$$p_i^h = \frac{\exp\left(V_i^h\right)}{\sum_{i'} \exp\left(V_{i'}^h\right)} \qquad (1)$$

where: $p[L_i^h]$ is the location probability, and V_i^h is the perceived utility of a household *h* in the location *i*. The perceived utility V_i^h is defined by a linear equation (Equation 2):

$$V_i^h = a_0 + a_1.X_1 + a_2.X_2 + ... + a_n.X_n \qquad (2)$$

where: a are estimated parameters, and X are variables such land-price, distance to CBD (Central Business District), distance to school, accessibility to workplaces and stores, and so on.

Indices of accessibility and attractiveness are used in utility's function, being estimated using the following model (Equation 3):

$$ACC_i^k = \sum_j \left(D_j^k\right)^{\beta_k} .\exp\left(\gamma_k.C_{ij}\right) \qquad (3)$$

where: ACC_i^k is the accessibility from a site *i* to trips with purpose *k*; D_j^k is a weight of trip attraction for destination *j* (e.g. shopping center floor area); C_{ij} is the generalized travel cost (travel time) from site *i* to destination *j*; β_k and γ_k are parameters.

b) Estimation Method of Parameter γ_k

In the case of this research, generalized travel cost C_{ij} will be stated as travel time *t*, which has different effects to the accessibility according to the trips' purposes *k* (i.e. work, shop, leisure, etc.). In the accessibility model, parameters γ_k are the weights defined by purpose *k*.

Assuming that D_j are uniformly distributed in the study area, and the probability of destination choice of purpose *k* is given by logit model, the parameter γ_k is estimated from the corresponding cumulative distribution of travel time of the area. Figure 2(c) shows the differences in travel times spent by proportion α of the trips according to the purpose *k*.

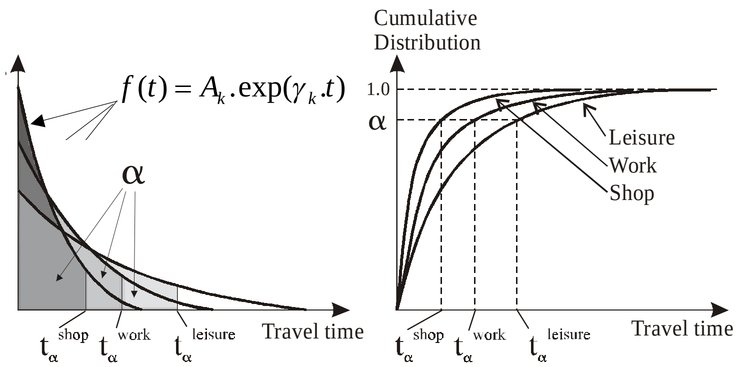

Fig.2 – Parameter γ_k estimation assumption

(3) Data Arrangement

Socio-economic data are usually available aggregated by zones. These kinds of data have some limitations to the research process. For instance, the location of households and firms can be handled one-by-one by broking down into a more detailed zones scale. In the case of this research, the data *d* (i.e. population, number of firms, number of employees, etc.) were broken down to 100 m mesh using the model represented in equation 4:

$$b_i^d = B_k^d . \frac{S_i^{u_d} .\lambda_{l_i}^d}{\sum_i S_i^{u_d} .\lambda_{l_i}^d} \qquad (4)$$

where: b_i^d is the broken down data *d* in mesh *i*; B_k^d is the available data *d* by zone *k* to which mesh *i* belongs; $S_i^{u_d}$ is the total floor area in mesh *i*, by building use u_d (i.e. residence or other use) defined according to the data *d* (i.e. in the case of population data, residences' total floor area is considered); and λ_{li}^d is the breakdown parameter defined according to the land use *l* of mesh *i* and data *d*.

The parameter λ_{li}^d was estimated by assuming that structures (buildings) in the study area are uniformly distributed according to their uses and to the land-use restrictions. However, the use of broken down data also has some limitations, due to the empirical estimation of parameters λ_{li}^d .

3. Location Model Estimation

(1) Study Area

The study area selected to calibrate location model is Toyohashi city, with a total population of 374,027 inhabitants; it's classified as a Regional Urban Area. The main data used in this research were: ① the Official Land-price 2002, with 72 surveyed points included in this analysis (Figure 3); and ② the commerce, industry and business statistics related to years 1998 and 2001, broke down to 100m mesh.

Concerning to population characteristics, more than 75% of the population is located within 10 minutes from Toyohashi station (Figure 4), which corresponds to the urban planned area. The population older than 75 years old represents 32% of the total inhabitants at 5 minutes from the station, the CBD (Figure 5). Furthermore, the proportion of young population increases proportionally to the distance to station (Figure 6).

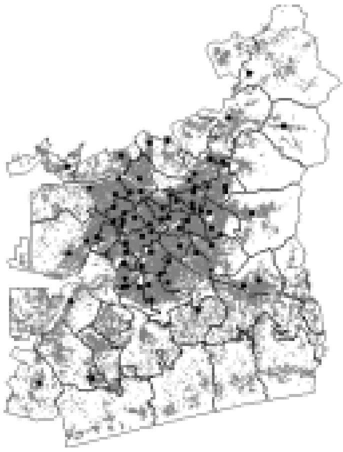

Fig.3- Land price surveyed points

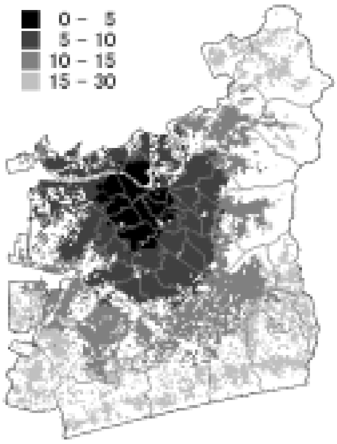

Fig.4- Travel time to Toyohashi sta.

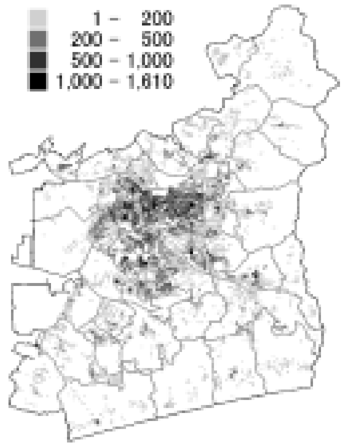

Fig.5- Older than 75y.old pop. distribution

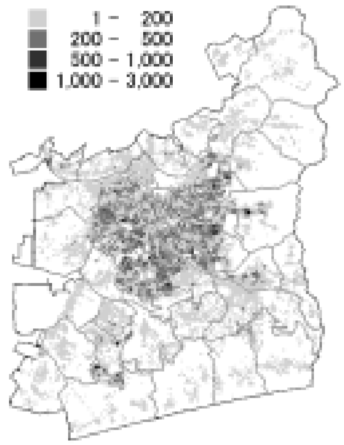

Fig.6- 25~39y.old pop.distribution

(2) Location Model Calibration

a) Linear Regression Analysis of the Population Distribution

Firstly, a linear regression analysis was held using the following model form:

$$\ln\left(\frac{POP_i^p}{\sum_i POP_i^p}\right) = \sum_k a_k^p .ACC_i^k + b^p .LP_i + c^p \qquad (5)$$

where: the dependent variable is the log of the population p' s proportion (by age-rank) in mesh i; ACC_i^k are indices of accessibility in mesh i by purpose k; LP_i is the land-price in a point within mesh i; and a, b, and c are estimated parameters.

Accessibility to Work and Accessibility to Shop presented strong correlation, causing a multicollinearity problem. Furthermore, the results obtained by linear regression can be considered poor if compared to Path Analysis' figures (Table 3).

b) Location Model using Path Analysis

This paper is presenting some results obtained in the previous tests using this methodology. One of its merits was the improvement of land price's relation with location. Likewise, Indices of accessibility have an important role on land price assessment and their indirect effects to location choice should be took into account. Path Analysis can handle this problem by drawing structure like one shown in Figure 7. This is a regression technique that considers the sequence of the variables and their relations' causes and effects. The dependent variable ln(POPk) is the location probability by age-rank population, and the explanatory variables are connected to the first one by arrows.

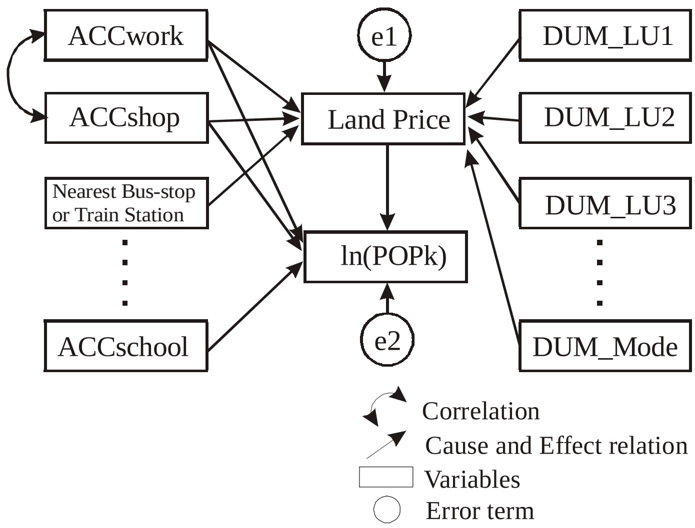

Fig.7 – Path Analysis Model Structure

Some variables, like distance to the nearest station or bus-stop and land-use dummy variables, are assumed to be related only to Land Price (i.e. their indirect effects to location choice. On the other hand, indices of Accessibility related to school and parks have been considered exclusively as direct effects (i.e. related only to Location itself). Accessibility to work, to shop, and to service have both direct and indirect effects to location choice. The parameters estimated to indirect effects' part are shown in Table 2.

Table 3 shows the model estimation of direct effects' part, grouped by age-rank. By observing the coefficient of determination (R^2), we can conclude that the location models by age-rank groups have better performance than when it was applied to total population. Furthermore, Land-price improves its confidence (i.e. t-value) compare to regression one.

Table 2 – Land Price Model parameter estimation

	B	t
(Constant)	-45.09	-2.11
DUM_LU1 (Low-storied Residential Area Type 1)	38.41	10.12
DUM_LU2 (Low-storied Residential Area Type 2)	37.97	4.75
DUM_LU3 (Medium and High-storied Resid. Area Type 1)	33.65	10.89
DUM_LU4 (Medium and High-storied Resid. Area Type 2)	52.55	6.58
DUM_LU5 (Residential Area 1)	36.79	9.69
DUM_LU7 (Semi-residential area)	42.35	3.78
DUM_LU8 (Neighbor Commercial Area)	61.33	16.81
DUM_LU10 (Semi-industrial Area)	23.51	6.19
ACC to work (Dj:Number of workers in Production Sector)	0.04	17.00
ACC to shop (Dj:Number retail shops)	0.53	7.69
ACC to service (Dj:Number of worker in Seervice Sector)	-0.05	-7.96
Walk time to nearest station or bus-stop	-1.35	-3.96
Travel time to Toyohashi Sta.	1.93	5.05
DUMMY Bus-stop (1/0)	-14.24	-3.21
DUMMY Train station (1/0)	-37.86	-4.74
(Coefficient of Determination) **R^2 = 0.941**		

Table 3 – Location Model Estimation using Regression Analysis and Path Analysis

Method	**Regression**		**Path**													
Dependent Variable	Total population		Total population		25~39 y. pop		40~49 y. pop		50~64 y. pop		65~74 y. pop		75 or more y. pop	
Explanatory Variables	B	t	B	t	B	t	B	t	B	t	B	t	B	t
(Constant)	-11.5797	-6.31	-11.5797	-12.51	-11.7252	-12.16	-11.7649	-12.41	-11.9191	-12.87	-12.5586	-12.46	-11.7278	-10.04
ACC to shop (Dj:Number of retail shops)	-0.01125	-1.90	-0.01125	-4.64	-0.02002	-7.93	-0.01280	-5.16	-0.00888	-3.66	0.00925	3.51	0.01569	5.13
ACC to work (Dj:Number of workers in Prodution Sector)	-0.00036	-0.48	-0.00036	-3.71	-0.00063	-6.20	-0.00037	-3.73	-0.00037	-3.73	0.00079	7.43	0.00139	11.29
ACC to service (Dj:Number of workers in Service Sector firms)	0.00135	1.91	0.00135	6.52	0.00204	9.48	0.00148	7.01	0.00121	5.85	-0.00056	-2.47	-0.00144	-5.54
Land Price	0.00644	2.46	0.00644	5.48	0.00510	4.17	0.00662	5.50	0.00635	5.40	0.00654	5.11	0.00814	5.49
Accessibility to nearest park (Dj:Area)	0.00014	2.70	0.00014	3.94	0.00019	5.33	0.00013	3.70	0.00014	4.15	0.00007	1.77	0.00003	0.70
Distance to nearest school	0.08644	2.00	0.08644	2.98	0.11962	3.95	0.06979	2.34	0.09758	3.36	0.04041	1.28	0.01394	0.38
Travel time to Toyohashi St.	0.01881	0.30	0.01881	1.43	-0.03652	-2.66	0.02482	1.84	0.03584	2.72	0.11556	8.05	0.12006	7.21
(Coefficient of Determination) R^2	**0.625**		**0.630**		**0.707**		**0.643**		**0.664**		**0.798**		**0.855**	

4. Conclusion and Next Assignments

The analysis of population location should be done regarding when the household fixed in such location. Besides, the households' needs and characteristics might suffer changes along the time. The present state of the occupation in the urban space reflects the result of a process that spent several years. Therefore, in the activity system, location is a difficult part to be changed. That is to say, people might change more easily their life style than location. In this sense, the characteristics of activity's choices are another part to be analyzed in this process, which observation of trip destinations will be done using disaggregate households database.

Aknowledge

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