MODELING LOGISTIC ENTERPRISE RE-LOCATION DECISION BY A NESTED LOGIT MODEL

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Abstract

This paper develops a model to analyze decisions regarding the relocation process for logistics enterprise by using discrete choice models. In this framework, two decision points in the relocation process are assumed and maintained in the micro-simulation modeling. The first decision, move or non move, is modeled by using a binary logit form with outcome the probability of moving. The second decision, choosing the destination location, is modeled by a mixed logit model incorporating spatial effects with the outcome of the conditional probability of choosing a zone. This study also applied the relocation decision structure of each logistics enterprise by nested logit model to find out the best model.

In case study, the logistics enterprise relocation decision model has acceptable performance by the nested logit model. However, the nested logit model has to follow the IID Gumbel distribution holds within each nest. Therefore, nested logit model cannot take into account the various tastes among alternatives in the random part of utility function to improve the implementation of the model.

The proposed model also confirm again the important role of spatial interactions among individual logistics enterprise and among zones in the logistics enterprise relocation decision process. The results indicate that big logistics enterprises have a lower probability of relocating and the migrating enterprises are more attractive in the zone which has a high accessibility. Finally, the population density, number of employees and the average land prices of zone strongly affect on the relocation decision making process of individual logistics enterprises.

Keywords: Mixed Logit Model, Logistics Firm, Re-location Decision Model, Nested Logit Model

JEL classification:

1. Introduction

Most logistics enterprises must constantly adjust themselves to new and changing circumstances to survive in a competitive business environment. Relocation of an individual logistics enterprise can be considered as a form of the adaptation (Brouwer et al. 2004). Pellenbarg *et al.* (2002) defined enterprise relocation as a change of address of an individual enterprise from this location to the other location. The factors influencing a logistics enterprise's propensity for moving are internal factors such as number of employee, floor area, transportation costs, and so on; external factors including the number of companies in market, population density..; and location factors such as average land price of location, distance between location and the IC highway. (see more, e.g. Van Dijk and Pellenbarg, 2000; Brouwer et al. 2002). This research, therefore, analyzes the influence of these factors on relocation decision behavior of logistics enterprise in order to better understand the key factors.

There have been a number of studies concerning the issue of relocation decision making behaviors of an individual firm, which is also discussed in these papers (see, e.g. Charles, 1979; Van Dijk et al. 2000; Leitham et al. 2000; Wissen, 2000; Brouwer et al. 2004; Holguín-Veras et al. 2005; Clifton et al. 2006; Ozmen-Ertekin et al. 2007). However, very little research has been done concerning a model for individual logistics enterprise' relocation decision by means of a discrete choice model with spatial effects. Therefore, the objective of this paper is to present a nested logit model and discrete choice model to analyze logistics enterprise's relocation decision making behaviors considering spatial effects in order to better understand the key factors that influence the decisions made by logistics enterprises as to where they relocate in metropolitan areas.

2. LITERATURE REVIEW

2.1. Nested Logit Models

Waddell (1996) considered the interaction of workplace, residential mobility, tenure and location choices. In his research, the model is on the basis of the description of a household's location choice as a bundle of choices which consist of the decision to move, and the subsequent selection of a housing tenure and location. One motivation for the treatment of mobility and location choice as separate but linked choices is that he intends to model marginal changes in residential location as a function of changes over time in household characteristics and location characteristics, including such policy-relevant factors as accessibility and housing prices. His model is conceived as a dynamic adjustment to changing conditions, rather than as a cross-sectional static or equilibrium solution.

Zondag et al. (2005) analyzed the importance of accessibility in explaining residential relocation choice. They proposed the detailed structure of the housing market module which illustrated the various steps at the demand side of the housing market. First, a household makes a decision to move or to stay. Once, a household has a decision to move this household to enter the residential location choice module. The residential location choice module consists of a nested structure which includes the first level is a household chooses a region and the second level is a specific zone within a region. Their research results suggested that the significant role of accessibility but rather small compared to the effect of demographic factors, neighborhood amenities and dwelling attributes, in explaining residential location choices.

Holguín-Veras et al. (2005) placed their concentration on studying the problem of the business relocation and applied both the aggregate and disaggregate approaches taking account of the fundamental geographic models of business relocations, and an econometric investigation of the role of the transportation accessibility in the process of the business relocation. The disaggregate approach applied in their study is involved in the development of the multinomial logit (MNL) models representing the decision to choose an alternative among a set of the aggregated alternatives.

In the research process, however, less attention has been given to the use of a mixed logit model in particular, and discrete choice models in general, in the analysis of spatial effects for the location choices of logistic companies.

2.2. Discrete Choice Models with Structuralized Spatial Effects

Boots and Kanaroglou (1988) incorporated the effect of spatial structure in discrete choice models of migration. Dubin (1995) developed a spatial binary logit model to predict the diffusion of a technological innovation. In Dubin's model, the probability of the adoption of a new technology varies depending upon a firm's own characteristics and its interactions with those who have previously adopted its technology. Paez and Suzuki (2001) tested the application of a spatial binary logit model to a land use problem related to the effects of transportation on changes in land use. Mohammadian and Kanaroglou (2003) expanded the binary choice model into a more general form to derive a spatial multinomial logit model, and tested it on a problem related to the choice of housing type.

Bhat (2004) proposed a mixed spatially correlated logit (MSCL) model for location-related choices. The MSCL model is a powerful approach that can capture both random variations in taste and spatial correlation in location choice analysis. The empirical results underscore the need to account for these variations and this spatial correlation, both to obtain an improved data fit and to realistically assess the effect of socio-demographic, transportation system, and land use changes on residential location choices. In addition, Miyamoto (2004) presented a discrete choice model with a systematic specification of the spatial influences upon the choice process. The utility function of this model is specified with autoregressive expressions for the deterministic and error component, and the model is evaluated with reference to three alternative models: the standard logit model, a logit model with an autoregressive deterministic term, and a mixed logit model with autoregressive error terms. Furthermore, Mohammadian and Kanaroglou (2005) attempted to incorporate spatial dependencies in random parameter discrete choice models. They formulated a mixed spatial multinomial logit model that incorporates spatial dependencies to predict the choice of type for new housing projects. Their results suggest that the choices in a housing project are influenced by factors related to other projects in adjacent zones, resulting in correlated choice behavior over space.

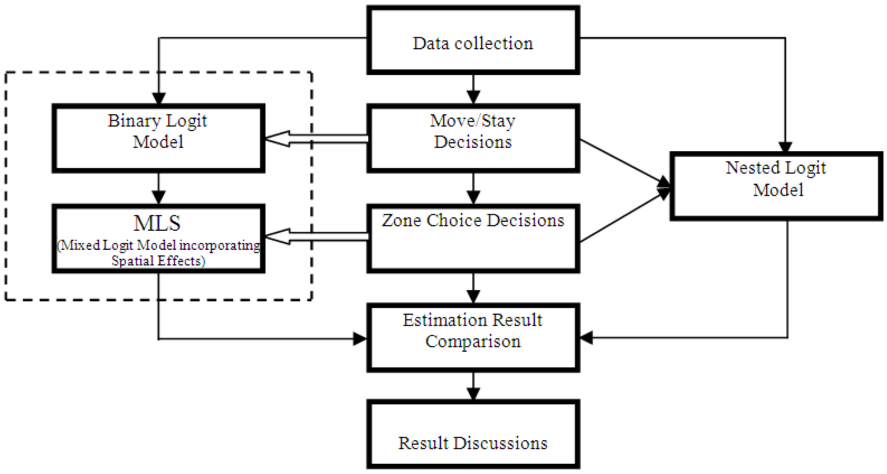
As described above, in previous research efforts, the debate focused on a model for residential location choice in urban areas. Very little research, however, has been conducted regarding a model for relocation choice for logistic firms using a discrete choice model with spatial effects. Therefore, the objective of this paper is to present a mixed logit model for the analysis of relocation choice behavior in order to better understand the key factors that influence the decisions made by logistic firms as to where they relocate in metropolitan areas.

3. STUDY METHODOLOGY

3.1. Conceptual Framework of Re-location Choice Models

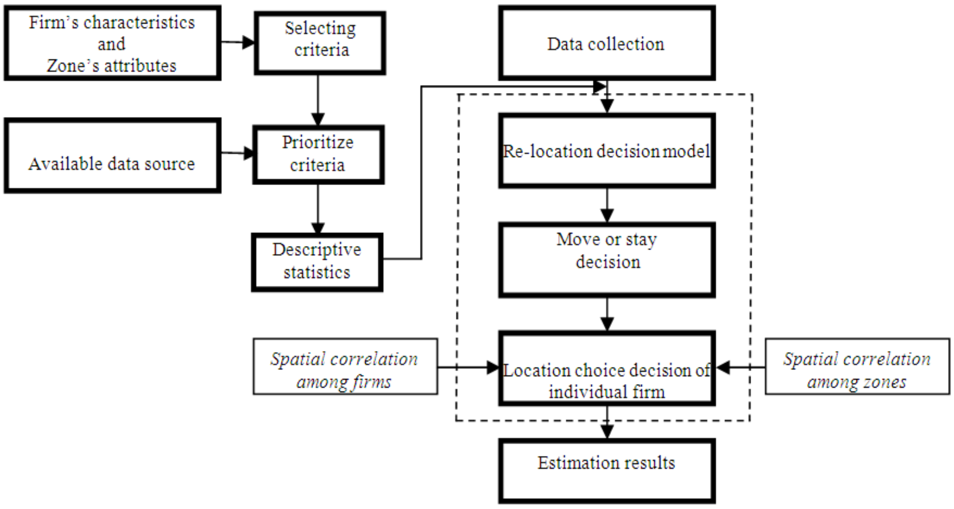
The methodology framework focuses on the logistics enterprise relocation model of individual logistics enterprise incorporating spatial interactions to analyze how the current conditions of location or logistics enterprises' characteristics have influence on the logistics enterprise relocation decision process.

Figure 1.1 Conceptual Framework of Re-Location Models



In reality, the logistic enterprise or household relocation behavior decision process is very complex. This process has been separated into many steps from one more step up to seven steps in the many previous researches. Nevertheless, the most common relocation choice process has been chosen for this research. Therefore, the logistic enterprise relocation model of the proposed model is assumed to include two steps such as move/stay decision and location choice decision in this research.

Figure 1.2 Proposed Re-location Model Structure Incorporating Spatial Effects



Firstly, the moving decision of each individual logistic enterprise often is influenced by internal factors. Besides, the moving decision of each individual logistic enterprise also is affected by the characteristics of each firm and the level of attractiveness of the destination. Hence, the moving decision of each logistics firm of this research has been considered within the influence of all aspects which include the condition of current location, the characteristics of each individual logistic enterprise and the attribute of the destination based on the moving plan of each individual firm. The individual firm relocation model has been analyzed by the binary logit model in this research.

Secondly, the zone choice decision of each individual logistic enterprise is considered by the firms which have been decided by means of moving from the current location to another. The zone choice preference is mainly influenced by the attribute of each destination zone and special industrial characteristics of individual logistic enterprises. Mixed logit model incorporating spatial effects has been proved that it is the best model to explain the actual decision of an individual logistic enterprise for an alternative location from a choice set. This part of the study, therefore, applies a mixed logit model to identifying the zone choice behavior from the zonal attractiveness variables.

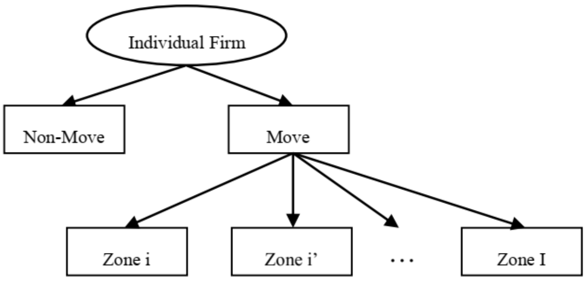
The relocation decision process also is considered by the nested logit model. Firstly, the individual logistic enterprise makes a decision to move or to stay. One, an individual logistic enterprise has a decision to move this individual logistic enterprise to enter the zone choice decision. In addition, the similar input of variables for proposed model has been applied in the nested logit model.

3.2. Proposed Re-location Models Structure

This paper proposes the firm relocation process that consists of two levels, namely, (1) moving probability, and (2) location choice probability.

The proposed model structure can be drawn as the following chart which shows clearly in Figure 1.3. For each individual firm *n*, the relocation process is assumed to consist of two levels, namely (1) move/stay, and (2) zone choice decision.

Figure 1.3 Re-location Models Structure



The joint decision of firm *n* to move and to relocate to zone *i* is assumed to the product of the probability firm *n* that will move and the conditional probability that firm *n* chooses location *i*. The probability of relocation decision of individual firm can be expressed as follows:

$$P_n(i) = P_n(m) \times P_n(i/m)$$

Where,

$P_n(i)$ = probability firm *n* will relocate and choose zone i;

$P_n(m)$ = probability firm *n* will move;

$P_n(i/m)$ = probability that firm *n* chooses zone *i* after deciding to move;

n =1,…, N with N= the total number of firms.

3.2.1. Move/stay Decision Process

The probability of firm *n* $P_n(m)$ is determined by the firm characteristics and the attributes of the current location.

$$P_n(m) = \frac{1}{1 + \exp(-\beta x_{mn})}$$

Where,

$P_n(m)$ = the moving probability of firm *n;*

x_{mn} = characteristics of an individual firm and attributes of the current location;

β = utility coefficient.

3.2.2. Zone Choice Decision Process

This section discusses the estimation of the zone's attractiveness for the moving logistic enterprise. The attractiveness measure is intended to capture the utility provided to the business relocating to the zone associated with the attributes of the zone. Mixed logit model incorporating spatial effects has been proved the best model to explaining the location choice decision making behavior (Train, 2003). Therefore, the methodology of an individual logistic enterprise location choice model using mixed logit model is utilized to explain in the process of relocation model of an individual firm. The average value of these probabilities yields the following simulated probability:

$$\hat{P}_{ni}(\theta) = \frac{1}{R}\sum_{r=1}^{R} L_{ni}(\beta^r)$$

Where,

R = a total number of draws;

$\hat{P}_{ni}$ = an unbiased estimator of P_{ni} by construction.

The simulated probabilities of an individual firm location choice model that incorporates spatial correlation among firms in the deterministic term, and incorporates the spatial correlation among zones in the error term, can be expressed as follows:

$$\hat{P}_{ni} = \frac{1}{R}\sum_{r=1}^{R} \frac{\exp(\sum_{k=1}^{K}\beta_k X_{nik} + \sum_{s=1}^{S}(\lambda \exp(-d^{\delta}{}_{nsi}))y_{si}) + (I-\rho W)^{-1}{}_i T\zeta_{ni})}{\sum_{j\in Z}\exp(\sum_{k=1}^{K}\beta_k X_{njk} + \sum_{s=1}^{S}(\lambda \exp(-d^{\delta}{}_{nsj}))y_{sj}) + (I-\rho W)^{-1}{}_j T\zeta_{nj}}$$

Where,

R = a total number of draws;

$\hat{P}_{ni}$ = an unbiased estimator of P_{ni} by construction;

X_{nik} = a ($Z \times K$) matrix of explanatory variables;

β_k = a ($K \times 1$) vector of unknown parameters; λ, δ = unknown parameters;

ρ = the parameter indicating the spatial autocorrelation;

W = the spatial weight matrix;

I = the identity matrix;

T = a lower triangular matrix of unknown parameters σ ;

ζ_{ni} = a vector of i.i.d random variables with zero mean and unit variance.

3.3. Re-location Models by Nested Logit Model

In this study, the moving decision of each individual logistic enterprise and location choice are assumed to be two related steps of the individual firm relocation choice process that can be modeled jointly by using a nested logit (NL) structure. The two-tier nested structure of (Lee et al. 2010) for residential mobility and location choice has been utilized to explain the relocation decision of an individual logistic enterprise. Some notes are utilized in the structure of logistic enterprise relocation model by nested logit model.

The mathematical formulation of this model follows the utility maximizing NL model developed by McFadden (1974), as described by Koppelman and Wen (1998), but with an additional sampling correction procedure added to ensure consistent estimation of the model parameters using a subset of alternatives. The probability of an individual firm choosing zone *i* is defined as follows:

$$P^n{}_z = P^n{}_{z/m} P^n{}_m$$

Where,

$P^n{}_z$ = the probability of firm *n* will relocate and choose zone *z*;

$P^n{}_m$ = the marginal probability of an individual firm *n* choosing move;

$P^n{}_{z/m}$ = the conditional probability that firm *n* chooses zone *z* after decided to move;

n = 1,…, N with N= the total number of firms.

First level: the bottom level conditional choice probability is equivalent to the standard multinomial logit (MNL) equation (Lee et al. 2010) and has the form as follows:

$$P^n{}_{(z/m)} = \frac{\exp(\mu_z V^n{}_{z,m})}{\sum_{k=1}^{I}\exp(\mu_z V^n{}_{k,m})}$$

Where,

$V^n{}_{z,m}$ = the observable components of the utility function for each elemental alternative *z*;

μ_z = the associated scale parameter.

There is no correction that is needed here as it has been shown that the standard MNL form produces consistent estimates of the model parameters due to the IIA property when the simple random sampling strategy is used to draw a subset of zones (McFadden, 1978). In addition, the other researches also mentioned other sampling strategies which include independent importance sampling or stratified importance, different additional adjustment terms as described in Ben-Akiva and Lerman (1985) are needed to correct for sampling bias. The marginal choice probability of an individual firm for choosing move decision can be expressed as follows:

$$P^n{}_m = \frac{\exp(\mu_m V'_m)}{\sum_{m'}^{M} \exp(\mu_{m'} V'_{m'})}$$

4. DATA COLLECTION FOR CASE STUDY

The input, output, and data source in each of the models are summarized in Table 1.1 in the case study of the proposed model. With regard to the data source of the move/stay decision, the distance from the current location of individual firm to the nearest IC highway and the average land price of current location were collected from the survey A and D of TMGMS. The number of employees of the firm and the floor area also was collected from the survey D of TMGMS. For the data source of the zone choice decision, the number of employees of the firm was collected from the survey D of TMGMS. The number of the population of a zone was collected from the population census of Japan. The number of firms of zone and the number of employees of the zone was collected from the establishment and the enterprise census (EEC). In addition, the accessibility of each zone was calculated based on the accessibility formula of Allen *et al*. based on the average travel distance of each zone which can get from the RTC. The average land price of a zone can be computed from the land price survey of Japan. The average distance between zones obtained from the empirical data is used as the zonal impedance variables in this research.

Table 1.1 Input, Output, and Data Source in Logistics Firm's Relocation Model

Model		Input	Data source	Output
Re-location Model	**Move/stay Probability**	- The number of employees of each firm. - The floor area of each firm - The land price of the current location of each firm. - The distance from the current location of each firm to the nearest IC Highway	Survey A and D of TMGMS	Probability of moving decision.
		- Dummy variables of destination characteristics	Survey D of TMGMS	
		- The weight of commodity per day and the travel distance from firm to customers - Transportation cost	Survey B of TMGMS	
	Zone Choice Probability	- Average land price of zone	Land price survey	Probability of a zone being selected.
		- Number of firms of zone	EEC	
		- Population number of a zone	PCJ	
		- Total area of zone	GIS	
		- Employees number of firm - Floor area of each firm	TMGMS	
		- Accessibility of each zone - Distance	RTC	

5. RESULTS AND DISCUSSIONS

5.1. The Comparison of Estimation Results for Move/stay Decision

The estimation of this study is based upon chemical manufacturers, machinery manufacturers and retailers because of the limitation of available data sources. The total number of samples of each industry type which includes chemical manufacturers, machinery manufacturers and retailers is 571, 659 and 519 (firms), respectively. Moreover, Table 1.2 describes the comparison of estimation results of the binary logit model for move/ stay decision of individual firm among three types of industry.

The results show the value of floor area, number of employees of each firm for three types of industry. The parameter for retailers has the lowest value which means that retailers often have a higher moving probability than that of chemical manufacturers or machinery manufacturers. The reason can be interpreted as the number of employee and floor area of retailers are smaller than that of chemical manufacturers and machinery manufacturers. In other words, the influence of floor area and number of employees of retailers on their moving decisions is lower than that of manufacturers with a large floor area and employees. The negative sign of the number of employees of chemical manufacturers, machinery manufacturers and retailers implies that large firms are less willing to move. The statistical significance of the estimated parameter shows that this factor maintains an important role in the moving decision for chemical and machinery manufacturers. An explanation is that the number of employees is high for the manufacturers companies. Therefore, the manufacturer companies usually require many employees. The results of Table 1.2 also show that the floor area of each individual firm has the influence and statistically significant with the number of employees of each individual firm on the move/ stay decision for each type of industry.

Table 1.21 Comparison of Estimation Results for Move or stay Decision

Variables	Chemical manufacturers	Machinery manufacturers	Retailers
	Coeff (*t-value*)	Coeff (*t-value*)	Coeff (*t-value*)
Constant	-5.9815 (-7.73)	-4.4000 (-6.41)	-4.5047 (-3.75)
Number of employee of each firm (persons)	-0.0243 (-3.35)	-0.0315 (-3.54)	-0.0904 (-4.01)
Floor area of each firm (1,000 m^2)	-0.0048 (-1.09)	-0.0075 (-3.66)	-0.0252 (-1.82)
Land price of current location of each firm (1,000 yen/m^2)	0.1885 (2.15)	0.9237 (2.30)	1.0661 (1.02)
Distance from current location of each firm to IC Highway (1,000 *m*)	0.0374 (1.95)	0.1121 (3.55)	Omitted*
Transportation Cost (10,000 yen)	0.0008 (1.67)	0.0006 (2.22)	0.0002 (2.17)
Firms need for large land (Yes =1, No =0)	1.2477 (3.29)	1.0955 (2.79)	1.0715 (1.98)
Firms need to be near to IC Highway (Yes =1, No =0)	0.6431 (1.97)	0.1181 (1.41)	Omitted*
Firms need to be near to major customers (Yes =1, No =0)	0.8723 (2.56)	0.5733 (1.82)	0.7242 (1.80)
Firms need to be near to customers (Yes =1, No =0)	1.1576 (3.51)	Omitted*	Omitted*
Firms need to be convenient for employees to commute (Yes=1, No = 0)	1.2215 (3.32)	1.6574 (3.86)	Omitted*
Firms need to be available for land to expand area (Yes =1, No =0)	0.3338 (0.94)	2.6348 (3.97)	0.9064 (2.28)
Firms have problems about loading and/or unloading at road in front of your firm (Yes =1, No =0)	1.0663 (2.89)	0.6909 (0.90)	1.7468 (2.17)
Firms have problems of parking space (Yes =1, No =0)	0.5120 (1.40)	0.8711 (1.33)	1.7373 (3.20)
Number of observation	571	659	519
Log-likelihood at convergence	-162.3	-173.8	-135.7
Log-likelihood at zero	-271.0	-345.9	-229.7
Log likelihood ratio	0.400	0.497	0.409
Hit ratio (%)	62.5	63.1	50.0

The results compare the value of land price of the current location of each firm, and distance from the current location to the nearest IC highway among three types of industry. The results show that the land price coefficients of the current location of each individual firm has statistically significant and positive signs for chemical manufacturers, machinery manufacturers and retailers. This result indicates that the land price of the current location has a significant positive effect on a firm's moving decision for all manufacturers companies and retailers. The reason for this is that individual firms which have a high land price of current location will have a high probability of moving. The land price of the current location factor, therefore, is an important factor that influences the relocation decision behavior of chemical manufacturer firms, machinery manufacturers and retailers. In addition, the result indicates that the parameter of land price for retailers has the highest value which means that retailers have a higher mobility than that of chemical manufacturers and machinery manufacturers. Because retailers prefer to locate in the central zone with high land price of the current location to closely to customers, therefore, the influence of land price of current location on the retailer's moving decision is higher than that of manufacturers.

This result also illustrates that the distance from each logistics firm to the nearest IC highway has a statistically significant and positive effect on the moving decision of chemical manufacturers and machinery manufacturers. This also means that manufacturers companies are more likely to locate in the locations that are near the IC highway. The reason for this is that the companies can reduce their cost of travel which is an important cost for the manufacturer firms. This factor, however, is less important for the retailers based on the value of statistic insignificance. Therefore, the value of this factor has been statistical omitted from the proposed model. Furthermore, the transportation cost of each individual firm is statistically significant with reasonable signs for retailers, machinery manufacturers, and chemical manufacturers. The parameter of transportation cost for retailers is the lowest value. This can be explained that commodity of retailers often distributed in the short distance with smaller weight than that of manufactures. However, the positive sign of transportation cost means that retailers and manufacturers prefer to move to the locations which have a lower transportation cost.

The results indicate that the need for large land of each individual firm is statistically significant with a reasonable sign for manufacturers and retailers. This means that the need for large land of each firm has a positive effect on the moving decision of that firm. With the high demand for large land, the probability of moving decision will increase for each individual firm. In regard to the need to be near to the IC highway of individual firms, these factors keep an important role for chemical manufacturers and machinery manufacturers but less important role with retailers. This can be interpreted that commodity of manufacturers often distributed in the long distance and the near distance to IC highway will reduce the average travel distance in order to reduce transportation cost for manufacturers. Similarly, with regard to the need to be convenient for employees to commute, this dummy is statistically significant for chemical manufacturers and machinery manufacturers. The reason for this is that number of employees of manufacturers often is large and manufacturer firms prefer to move to the location which has a high convenience for employee to commute.

The result also compares the value of dummy parameters for three industry types. The parameter of dummy for machinery manufacturers has the highest value which means that manufacturers often require a large floor area which is available. However, retailers often require the small floor area for available land.

Regarding the other dummy, the parameter of these dummy for retailers has the highest value. This can be interpreted that retailers often locate in the central zone which has limited parking space or limited space for loading or unloading of road in front of the retailer's firm. Whereas, chemical manufacturers and machinery manufacturers are often located in the zones which are outer of the central zones and the space for parking, loading or unloading may be large in these zones.

Finally, the results summarized the estimated results of the models for three industry types in the case study. The measures of fit of the models, represented by log-likelihood ratio and hit ratio, which are shown at the end of Table 1.2 are rather high for all industry types in this study. The results of log-likelihood ratio of chemical manufacturers, machinery manufacturers and retailers are 0.400, 0.497 and 0.409, respectively. Considering the results of log-likelihood ratio, it is straightforward to say that the proposed model for move/stay decision making behavior of an individual firm has a good model performance. In addition, the results of hit ratio of chemical manufactures, machinery manufacturers and retailers are 62.5%, 63.1% and 50.0%, respectively. The values of hit ratio indicate that the proposed model for move/stay decision of each individual firm is sufficient to predict the move/stay decision making behavior.

5.2. The Comparison of Estimation Results for Zone Choice Decision

Table 1.3 describes the comparison of estimation results of the mixed logit model incorporating spatial effects for the zone choice decision.

Firstly, the obtained results in this table indicate that the coefficients of population density and number of employees of each zone have a statistically significant and positive effect on the preference of the chemical manufacturers and machinery manufacturers. This means that all manufacturing firms are more likely to choose the zones that have a high population density and therefore a large employee pool. The manufacturers often require a lot of employees in the manufacturing process and the cost of employee recruitment is one important part in the total cost. Therefore, the cost of recruitment can reduce if an individual firm can organize the committee for recruitment in the same area or the same zone which employees live. It will contribute to maximizing the profit of each individual firm. Additionally, this factor is also the important factor for the retailers based on the statistically significant and reasonable signs of the estimated coefficients. This issue of retailers can be explained that retailers can increase the number of regular customers to maximize their profit purpose if they located in the zone with high population number. The retailers also can get other benefit from to get close to the customers in the zone.

Secondly, the estimated result also shows that the average land price of each zone has negative and significant effects on the zone choice decision for chemical manufacturers, machinery manufacturers and retailers. In the real situation, the manufacturers not only require a lot of employees but also require a large floor area. Therefore, the average land price of a large floor area is one of the most important costs of each manufacturer. From this reason, it is straightforward to see that any firm always prefers the zone which has a low land price and this market can help firm to maximum profit. The average land price of each zone is not only important for each manufactures but also very important for each retailer. In fact, the retailer requires a smaller floor area than that of each manufacture. However, the location of each retailer is normally located in the center of cities or located near the rail station to get close to the customers. In addition, the land price of these kinds of location is very high in the cities. Therefore, the average land price of each city keeps a key role for retailer in the competitive business environment.

Thirdly, the estimated coefficient value of the distance parameter (impedance variables) has the expected sign as a negative sign for the all industry types in this study. The values of coefficient of distance parameter for chemical manufacturers, machinery manufacturers and retailers are -0.0055, -0.0039 and -0.0115, respectively. In which, the parameter of retailers has the lowest value which means that retailers prefer to choose the zone in the shortest distance to lower the cost of transportation. The other reason for this is that the commodity originated from retailers will be distributed in the shortest distance to customers who are the final users of commodity.

Furthermore, the negative sign implies that the zone which located near the current zone will be more attractive for individual firms. In other words, the individual firm prefers to relocate at zone in short moving distance. The other reason for this is that the transportation cost is one of the main costs of each manufacturer. The manufacturers always want to reduce the transportation cost to maximize their profit.

Table 1.3 Comparison of Estimation Results for Zone Choice Decision

Variables	Chemical Manufacturers	Machinery Manufacturers	Retailers
	Coefficients (*t-value*)	Coefficients (*t-value*)	Coefficients (*t-value*)
Zonal Attributes Variables			
Average land price of zones (1,000 yen/ m^2)	-0.0034 (-2.87)	-0.0031 (-1.94)	-0.0003 (-1.29)
Population density of zones (in 1,000 persons/ km^2)	0.2031 (3.69)	0.0614 (1.03)	0.1510 (2.73)
Number of employee of zones (in 1,000 persons)	0.0031 (2.53)	0.0012 (1.05)	0.0010 (0.81)
Impedance Variables			
Distance (1,000 m)	-0.0035 (-5.60)	-0.0058 (-3.63)	-0.0020 (-1.33)

Variables	Chemical Manufacturers	Machinery Manufacturers	Retailers
	Coefficients (*t-value*)	Coefficients (*t-value*)	Coefficients (*t-value*)
Firm Characteristics Variables			
Number of employee of firms (in persons)	-0.0003 (-1.06)	-0.0036 (-1.37)	Omitted*
Floor area of firms (m^2)	-0.0087 (-1.82)	-0.0035 (-1.32)	Omitted*
Distance from firm to IC Highway (1,000 m)	0.2595 (2.00)	0.0111 (1.31)	0.0675 (2.32)
Correlation Variables			
Spatial correlation among firms			
δ	0.3953 (6.52)	0.4402 (6.15)	0.6577 (3.62)
λ	0.1835 (3.53)	0.2938 (3.37)	0.5802 (1.60)
Spatial correlation among zones			
ρ	0.5454 (9.30)	0.6923 (1.97)	0.0876 (1.98)
***Standard deviation of lower triangular matrix* T**			
σ	0.6427 (1.86)	1.3072 (2.83)	0.5917 (1.86)
Number of observation	60	92	53
Log-likelihood at convergence	-172.2	-221.4	-156.3
Log-likelihood at zero	-237.0	-363.5	-209.4
Log likelihood ratio	0.273	0.390	0.253
AIC test	6.14	5.09	6.27
Hit Ratio (%)	55.38	64.21	40.69

5.3. The Results of Firm Re-location Decision by Nested Logit Model

Table 1.4 shows the results of individual firm relocation decision by nested logit model. The nested logit model of individual firm mobility and location choice has a relatively parsimonious specification but it, nevertheless, includes the important exploratory variables that are expected to be an integral part of the individual firm relocation decision process. The model has an acceptable good fit based on the value of log-likelihood ratio and AIC test, which are shown at the end of Table 1.4 are 0.267, 0.176 and 0.149 for chemical manufacturers, machinery manufacturers and retailers, respectively. In addition, the model gives the same sign of the estimated parameters, each of which is as expected. For example, the average land price of each zone has a negative effect on the individual firm location choice decision as it's intuitive that an individual firm tends to locate in the zone with lower land price. Next, as we expected that the number of employees of each individual firm has negative sign. This means that the large firms or big firms have a lower mobility of re-locating.

Regarding with the logsum of nested logit model, the logsum value can be considered as the links between the two levels of the nested logit model by bringing information from the bottom level into the upper level. Therefore, the logsum coefficient reflects the degree of independence among the unobserved portions of utility for alternatives the moving nest. Note that the probability of choosing moving nest in the first level depends on the expected utility that the individual firm receives from choosing that nest. This expected utility is made up to the utility that an individual firm receives no matter which zone an individual firm chooses in the moving nest. The expected extra utility that an individual firm receives from being able to choose the best zone in the moving nest, which is the multiple between logsum value and logsum coefficient (see more, Wen, Chieh-Hua & Frank S. Koppelman.2001, Vovsha, Peter.1997, and Heiss, F. 2002, Matt Golder).

In this research, the log-sum coefficient showing a degree of independence in the unobserved parts of utility for alternatives in a nest, and the estimated logsum parameters of the move nest are 0.0455, 0.2592 and 0.3664 for chemical manufacturers, machinery manufacturers and retailers, respectively. Therefore, the low values of the log-sum coefficients mean that an increase would affect slightly on the probability of the move nest of being selected, as the expected maximum utility would affect slightly on the choice between move decision and non move decision.

Table 1.4 The Estimation Results of Firm Re-location Decision by Nested Logit Model

Variables	Chemical Manu	Machinery Manu	Retailers
	Coefficients (*t-value*)	Coefficients (*t-value*)	Coefficients (*t-value*)
Zone choice			
Average land price of zones (1,000 yen/ m^2)	-0.0042(-3.37)	-0.0085(-3.23)	-0.0029(-4.94)
Population density of zones (in 1,000 persons/ km^2)	0.0079 (2.30)	0.0023 (1.52)	0.0016 (1.28)
Number of employee of zones (in 1,000 persons)	0.0731 (2.01)	0.0402 (3.12)	0.0230 (0.76)
Distance (1,000 m)	-0.0006 (-1.72)	-0.0002 (-1.11)	-0.0017 (-1.15)
Number of employee of firms (in 1,000 persons)	-0.0734 (-0.85)	-0.0212 (-0.47)	Omitted*
Distance from firm to IC Highway (1,000 m)	0.0111 (2.40)	0.0047 (1.43)	0.0012 (0.69)
Move/stay choice			
ASC_move	-0.0793 (-3.62)	-0.2704 (-1.71)	-0.3119 (-1.42)
Land price of current location of firm (1,000 yen/m^2)	0.0016 (0.96)	0.0022 (1.45)	0.0036 (0.98)
Transportation Cost (10,000 yen)	0.0015 (1.37)	0.0013 (1.35)	0.0004 (0.82)
Firms need for large land (Yes =1, No =0)	0.0378 (0.83)	0.0118 (0.69)	0.0148 (0.41)
Firms need to be near to major customers (Yes =1, No =0)	0.0455 (1.07)	0.0816 (1.21)	0.0211 (0.97)
Firms need to be convenient for employees to commute (Yes=1, No = 0)	-0.0109 (-2.35)	-0.0106 (-1.24)	Omitted*
Firms need to be available for land to expand area (Yes =1, No =0)	0.5854 (0.89)	0.7054 (1.86)	0.0499 (1.31)
Firms have problems about loading and/or unloading (Yes =1, No =0)	0.1714 (1.59)	0.0943 (0.78)	0.0116 (0.47)
Firms have problems of parking space (Yes =1, No =0)	-0.6417 (-0.65)	-0.8595 (-1.23)	-0.0710 (-1.45)
Move nest logsum μ_m	0.0455 (3.62)	0.2592 (3.91)	0.3664 (2.06)
Number of observation	571	659	519
Log-likelihood at convergence	-1652.5	-2144.2	-1743.7
Log-likelihood at zero	-2256.1	-2603.8	-2050.6
Log likelihood ratio	0.267	0.176	0.149
AIC test	5.85	6.55	6.77

The estimation results of the nested logit model arrange in a line with those found in previous empirical studies (Lee et.al 2010). Number of employee, floor area, distance between the current location to the nearest IC highway, transportation cost and land price of current location of each individual firm, the demand to get a large land, need to be near to customers or major customers, need to be near IC highway, and need to be convenient for employees to commute, the pressures of many problems such as loading and unloading at road in front of firms, parking space were determined to be important individual firms' characteristics which helped to explain the individual firm's mobility and zone choice decision making process with the important attractiveness of zones. In general, large firms or big companies are less likely to move and change location than the small firms with high land price of current location and transportation cost.

Even though, the individual firm relocation decision model has acceptable performance by the nested logit model. However, the nested logit model has to follow the IID Gumbel distribution holds within each nest (Ben-Akiva et al. 1985). Therefore, nested logit model cannot take into account or considering the various tastes among alternatives (zones) in the random part of utility function to improve the implementation of the model. It means that the nested logit model has some disadvantages to deal with the incorporating spatial interactions among zones in the error part of utility function in the individual firm zone choice decision model.

6. CONCLUSIONS AND RECOMMENDATIONS

The main contribution of this paper is to get insight in the process of the logistics firm relocation incorporating spatial interactions and the explanatory variables determining this decision. The proposed individual firm relocation model structure consists of two levels, namely (1) moving probability, and (2) location choice probability. In which, the model has analyzed the influences of the factors on the firm relocation decision process by using the discrete choice models which include binary logit model and mixed logit model incorporating spatial effects.

The zone choice decision level of the proposed model shows that the population density of the zone has a statistically significant and positive effect on the preference of the chemical manufacturers and machinery manufacturers. Besides, the average land price of each zone has a negative and significant effect on the zone choice decision for all manufacturers and retailers.

Finally, this research has analyzed the relocation decision structure by using nested logit model. In general, the results are not significant different between nested logit model and the proposed model. However, the proposed model of relocation decision process can get some advantages such as taking into account the correlation among zones and the correlation among firms to improve the implementation of the model. Meanwhile, the nested logit model has to follow the IID Gumbel holds within each nest (Ben-Akiva et al. 1985). Therefore, nested logit model cannot take into account the correlation among alternatives (zones) in the random part of utility function. In addition, the t statistic values of most variables are higher in the proposed model than that of the nested logit model.

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