The Influence of Regional and Local Accessibility on Logistic Firm Location

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Abstract: This paper describes a model of logistic firm location choice decision which includes two levels such as the regional choice and zone choice process. In which, the main contributions of this study are an analyzing the influence of regional accessibility and zonal accessibility on the logistic firm location choice decision by using the discrete choice model. The results indicate that the distance to the nearest station keeps a key role in the location choice decision of miscellaneous light manufacturers. In addition, the distance to the nearest IC highway is also very important factor for these manufactures and product wholesalers. These accessibility variables, however, are less important for the retailers. Finally, the spatial effects strongly affect the zone choice decision-making process of all firms.

Key Words: Regional accessibility, local accessibility, discrete choice model

1. INTRODUCTION

Transportation accessibility in general and accessibility of location in particular play a key role in the business location choice process (Leitham et al. 2000; De Bok and Sanders 2005; Targa et al. 2006; Ozmen Ertekin et al. 2007; Leitham et al. 2000). Hence, understanding how accessibility influence on the logistic firm location choice decision is very important task. Numerous studies have been focused to investigate the influence of transportation infrastructure’s accessibility, location’s accessibility and agglomeration on the firm location decision (Holl 2003; Garcia Mila and Garcia Montalvo 2007; Pardo and Arauzo Carod 2009; Kawamura 2004; De Bok et al. 2003; Waddell and Ulfarsson 2003). However, there are a few recent contributions on the relationship between regional accessibility, zonal accessibility and individual choices (Cerda and Ahmed 2009; Targa et al. 2006). In addition, the other
researches focus on the influence of regional accessibility and local accessibility on residential location choice (Waddell and Nourzad 2002; Srour et al. 2002). Therefore, how the influence of regional accessibility and zonal accessibility on an individual firm location choice decision should be considered in the research process. The contribution of this study, furthermore, is in the development and estimation of a model that integrates the treatment of several related firm location choices in a framework which can be used to estimating the influence of accessibility on logistic firm location choice decision.

The rest of this paper is organized as follows. The next section presents an overview of the previous studies of location choice and accessibility in the literature. Section 3 draws the structure of proposed model that consists of two levels: the first level is the region choice probability and the second level is the zone choice probability. In which, how the influence of accessibility on this location choice decision process is mentioned based on the accessibility variables of the proposed model. Section 4 presents a case study based on the data set of Tokyo Metropolitan area. Discussion of the results is presented in Section 5, and Section 6 presents the conclusions, recommendations and offers some future researches.

2. LITERATURE REVIEW

Numerous progresses have been made and applied to derive the determining factors of the residential choice behavior of households (Blijie 2005). The accessibility is one of the most important factors which influence on the location choice decision (Waddell et al 2003; Blijie 2005). In particular, regional accessibility is very important in employment location choice decision (Waddell et al 2003). They estimated the influence of regional accessibility on employment location choice based on the measure of the travel time to central business district and travel time to airport. The other two measures of regional accessibility also are used in their research are the accessibility to population and the accessibility to employment. Blijie (2005) also analyzed the impact of accessibility on residential choice based on multinomial logit model. He divided the accessibility measures into two groups such as: travel times and the accessibility of locations. In which, travel time group includes commuting distance to new location and the other group includes the distance to railway station, highway on-ramps and the quality of public transport. His results show that the two accessibility groups have a significant influence on the residential choice behavior of most of the household types. In addition, several researches have focused on the relationship between location and the accessibility of location (Zondag et al 2005; De Bok et al 2005). Zondag et al (2005) considered accessibility in term of a logsum variable which is an aggregated variable summarizing the accessibility for all purposes and all households at that location. They found that the role of accessibility is significant but smaller than that of demographic factors, neighborhood amenities and dwelling attributes in explaining residential location choices. The two sets of accessibility, furthermore, are suggested in term of push factors by De Bok et al (2005). The first set of accessibility includes the distance to the nearest highway on-ramps and the distance to nearest train station. The other set includes the accessibility to labor and the accessibility to customers or suppliers. Their results show that the accessibility of residential location has a modest importance and the distance to transportation infrastructure have the most significant influence on the residential location choice.

Most of the empirical efforts developed in this business location area rely on incorporating accessibility to transportation facilities as a key factor in location decisions (Leitham et al 2000; Holl 2003; Holguin-Veras et al 2005; Targa et al 2006; Ozmen-Ertekin et al 2007). Leitham et al (2000) suggested and applied the stated preference experiments to estimate the influence of
transport on firm location choice. They considered accessibility factors in term of the road link which can be seen as a proxy of location accessibility. Further, the econometric model has been used to analyzing the role of transportation accessibility in the firm location by Holguin-Veras et al (2005). They found that the accessibility still has a major influence on firm location decision while many companies are trying to find location with lower land price and lower taxes. In particular, regional accessibility and local accessibility characteristics are included and identified in the factors categories that may have influenced the initial business location decision (Targa et al 2006). The results of their research confirmed that the association between the accessibility of highway facility and firms’ location decisions are positive and significant. The significant role of transportation accessibility on business location choice also is confirmed by Ozmen-Ertekin et al (2007). They used the generalized linear model approach to develop a regression model that represents regional attractiveness as a function of many factors such as land prices, safety, land availability, market size, economic stability, and transportation accessibility.

Recent relevant researches on the relationship between regional accessibility, local accessibility and location have focused on residential location choice (Cerda and Ahmed 2009; Michael Iacono and David Levinson 2010). In which, Michael Iacono 2010 used the cross-section data to estimate the value of accessibility to employment and resident works. Their results indicate that households highly value employment access, while access to other resident workers is considered a disamenity. In addition, the influence of accessibility of local highway is positive with sale price in his conclusion. The effect of regional accessibility on household choices is also analyzed by Cerda and Ahmed 2009 to underscore the importance of using regional accessibility for land use and transportation planning. The positive effect of accessibility on home sale values is found in his results. Most of these researches focus on the influence of regional accessibility and local accessibility on residential location choice.

Up to now, however, the influence of regional accessibility and local accessibility on logistic firms’ location decisions has received less attention. Therefore, the objective of this paper is to present a discrete choice model to analyze location decision behavior in order to better understand the regional and local accessibility factors that influence on the logistic firm location choice decision.

3. STUDY METHODOLOGY

Based on the data that was collected from the Establishment and Enterprise Census 2004, it is straight forward to see that the numbers of firms by industry type are differential among regions and zones. The reason for this is that each region has differential attributes and various attractiveness levels. For example, the numbers of construction and the heavy product manufacturers are very high in the areas which are far from the center of the cities of Tokyo metropolitan area. In addition, the number of agriculture, forestry and mining industries is also high in these zones of metropolitan area. However, electricity, gas, and water suppliers appear over all the metropolitan area. Therefore, each individual firm n, region choice and zone choice are assumed to be two related stages of the firm location choice process that consists of two levels: 1) region choice probability and 2) zone choice probability. Firstly, the region choice probability of each alternative \( P_r(n) \) is calculated with a spatial preference model in the form of the multinomial logit (MNL) model. Secondly, the probability of a zone being selected, \( P_i(r/n) \), is a location choice process which modeled by a spatial mixed logit model with the assumption that an utility function for zone attractiveness represented by a
firm’s spatial distribution and attractiveness indicators, such as the land price of zone, the accessibility of location... A firm is assumed to select the location with the maximum utility among location alternatives. The joint decision of firm \( n \) chooses zone \( i \) is the product of the probability that firm \( n \) chooses region \( r \) and then locates at zone \( i \) from a subset of alternatives belonging to the given region:

\[
P_n(i) = P_n(r) \times P_n(i/r)
\]

\( P_n(i) \) = probability that firm \( n \) will choose zone \( i \); \( P_n(r) \) = probability that firm \( n \) chooses region \( r \); \( P_n(i/r) \) = probability that firm \( n \) chooses zone \( i \), given region \( r \);

### 3.1. The influence of regional accessibility

This section focuses to discuss the influence of region’s attractiveness and regional accessibility on an individual firm location decision. The attractiveness measure is intended to capture the utility provided to the business choosing the region associated with the attributes of the region (Shukla and Waddell 1991; Hansen 1987). The accessibility of the region is measured by an accessibility index which was suggested by Allen et al.(1993). Therefore, the accessibility index is used in this analysis as follows.

\[
Acc^r = \frac{1}{R-1} \sum_{j=1}^{R} d_{rj}
\]

\( R = \) total number of region (17 regions); \( d_{rj} \) = is the distance between region \( r \) and region \( j \) [km]. \( Acc^r \) represents the average distance from a given region \( r \) to all other regions in the study area.

Mc Fadden (1974) used the multinomial logit model to investigate the location choice decision of each firm based on random utility theory. This study, therefore, applied a multinomial logit model to identify the region choice behavior from the regional attractiveness variables and regional accessibility. The multinomial logit model describes the probability that a firm \( n \) chooses region \( r \) with \( r^\prime \) alternatives as follows.

\[
P_n(r) = \frac{\exp(V^n_r)}{\sum_{r' \in R} \exp(V^n_{r'})}
\]

The error component of the utility function is assumed Gumbel distributed so this part can be eliminated from the utility function (Mc Fadden 1974). The observed utility that has been applied in the proposed model can be expressed as the following form of a linear additive utility function.

\[
V^n_r = \beta_1 \times X_1 + \beta_2 \times X_2 + \beta_3 \times X_3 + \beta_4 \times X_4 + \beta_5 \times X_5 + \beta_6 \times X_6 + \beta_7 \times X_7
\]

\( X_1 \) is the number of company of each region; \( X_2 \) is the number of employee of each region; \( X_3 \) is the accessibility index of each region; \( X_4 \) is the area of each region; \( X_5 \) is the population density of each region; \( X_6 \) is the road density of each region; \( X_7 \) is the average land price of each region;
3.2. The influence of local accessibility

The influence of local accessibility and spatial effect on the individual firm location decision is discussed in this section. In which, the local accessibility characteristics include the distance between zone and IC highway, the distance between zone and the nearest rail station. In addition, the accessibility to labor is computed with the number of employees of zone and the number of population at each destination. Furthermore, the addition of a generalized autoregressive term to the disturbance term of a mixed logit is suggested by Ben-Akiva et al. (2001). The \( \varepsilon_{ni} \) random utility term is made up of two components: a probit-like component with a multivariate distribution and an i.i.d Gumbel random variable. This paper, therefore, utilizes the generalized autoregressive term to explain the spatial correlation among zones.

\[
U_{ni} = V_{ni} + (I - \rho W)^{-1} T \varepsilon_{ni} + v_{ni} \tag{5}
\]

\( I \) = an identity matrix; \( \rho \) = a scalar unknown parameter; \( W \) = a weight matrix; \( T \) = a lower triangular matrix of unknown parameters; \( \varepsilon_{ni} \) = a vector of i.i.d random variables. The probability of the choice of alternative \( i \) in the proposed model may be written as follows:

\[
P_n(i/r) = \left[ \frac{\exp[X_{ni}^\beta + (I - \rho W)^{-1} T \varepsilon_{ni}]}{\sum_{j=J_n} \exp[X_{nj}^\beta + (I - \rho W)^{-1} T \varepsilon_{nj}]} \right] \ast f(\varepsilon / I_j) d(\varepsilon) \tag{6}
\]

Spatial dependences are incorporated in a mixed logit model to predict the type choice for new housing projects by Mohammadian et al. (2005). It was assumed that the systematic component of the utility function (\( V_{ni} \)) consists of two terms. The first term is a linear parameter function that captures the observed attributes of decision-maker \( n \) and alternative \( i \), while the second term captures spatial dependences across decision-makers. This research, therefore, applies this concept in order to explain the interaction among logistic firms. After adding the interactions, the systematic utility function of alternative \( i \) for firm \( n \) is given as follows:

\[
V_{ni} = \sum_{k=1}^{K} \beta_{ik} x_{nik} + \lambda \sum_{s=1}^{S} y_{is} \frac{1}{d_{ns}} \tag{7}
\]

\( \lambda \) = a scalar unknown parameter; \( y_{is} \) = a consumption fraction of alternative \( i \) of firm \( s \); \( \delta \) = a scalar unknown parameter; \( d_{ns} \) = a distance between firm \( n \) and another firm \( s \); \( S \) = a total number of firms.

A mixed logit model allows the use of simulation methods for estimation. Therefore, the simulated probabilities of a model that incorporates spatial correlation among firms in the deterministic term, and incorporates spatial correlation among zones in the error term, can be expressed as follows:

\[
\hat{P}_n(i/r) = \frac{1}{R} \sum_{r=1}^{R} \sum_{j \neq J_n} \text{exp}[X_{nj}^\beta + \phi_{nj} + (I - \rho W)^{-1} T \varepsilon_{nj}] \tag{8}
\]
4. DATA COLLECTION FOR CASE STUDY

The case study’s area of this research is Tokyo Metropolitan Area which is divided into 17 regions and 335 zones based on 2 digits code and 3 digits code of cities, respectively. In addition, the data sets used in this case study were compiled from numerous sources such as the 2005 Population Census of Japan (PCJ), the Establishment and Enterprise Census (EEC), the Road Traffic Census (RTC) survey, and the Tokyo Metropolitan Goods Movement Survey (TMGMS). These surveys are summarized as follows.

The TMGMS was conducted for the goods movement and trucks movement in the Tokyo Metropolitan Area by the City and Regional Development Bureau of the Ministry of Land, Infrastructure and Transport in the Japanese Government. The survey was conducted in 2004. In which, the survey data consists of four surveys: Survey A on Firm’s Characteristics, Survey B on Truck Behavior, Survey C on Goods Carried in and out, and Survey D on Firms’ Location. The characteristics of firms include type of industry, location, number of employees, weight of shipments, and other related information. The EEC is conducted by the Statistics Bureau in the Ministry of Public Management, Home Affairs, Posts and Telecommunications of the Japanese government. General information about firms obtained from the EEC consists of type of industry, location, number of employees, head or branch office, capital, and other related factors. The total number of establishments for each industry type in each zone is collected from this data. The survey is conducted every five years, and the data utilized in this study is from the year 2004. The RTC survey is conducted for all of Japan by the Road Bureau of the Ministry of Land, Infrastructure and Transport of the Japanese government. The survey aims to characterize the usage of automobiles and quantify the volumes of traffic in Japan. The data consists of two parts, namely the link traffic volume and OD survey data. The OD survey data includes vehicle trips OD (passenger cars, buses, and trucks), commodity OD by commodity type, and other related criteria. The survey is usually conducted every five years, and the survey data utilized in this research is from the year 2004.

5. RESULTS AND DISCUSSIONS OF CASE STUDY

The study is based upon miscellaneous light manufacturers, retailers and product wholesalers. The results of the estimated region choice models and zone choice models for logistic companies are presented in Table 4 and Table 5, respectively. The summary of descriptive statistic of each industry type is expressed in the following sections.

5.1 Descriptive Statistics

Table 1 All results based on nonmissing observations of miscellaneous light manufactures

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std.Dev</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of company of a region</td>
<td>100284.9</td>
<td>140893.1</td>
<td>778.0</td>
<td>321539.0</td>
<td>1122</td>
</tr>
<tr>
<td>Number of employee of a region</td>
<td>1268239.5</td>
<td>1813685.5</td>
<td>5188.0</td>
<td>4117330.0</td>
<td>1122</td>
</tr>
<tr>
<td>ACC of a region</td>
<td>322.4</td>
<td>113.4</td>
<td>102.0</td>
<td>946.0</td>
<td>1122</td>
</tr>
<tr>
<td>Area of a region</td>
<td>2753.7</td>
<td>7312.7</td>
<td>63.9</td>
<td>25830.0</td>
<td>1122</td>
</tr>
<tr>
<td>Population density of a region</td>
<td>10.4</td>
<td>3.8</td>
<td>0.7</td>
<td>15.4</td>
<td>1122</td>
</tr>
<tr>
<td>Road density of a region</td>
<td>0.1</td>
<td>0.303E-1</td>
<td>0.516E-1</td>
<td>0.1</td>
<td>1122</td>
</tr>
<tr>
<td>Average land price of a region</td>
<td>492.3</td>
<td>266.9</td>
<td>34.0</td>
<td>861.0</td>
<td>1122</td>
</tr>
</tbody>
</table>
Table 2 All results based on nonmissing observations of product wholesalers

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std.Dev</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of company of a region</td>
<td>152360.5</td>
<td>154290.3</td>
<td>778.0</td>
<td>321539.0</td>
<td>999</td>
</tr>
<tr>
<td>Number of employee of a region</td>
<td>1937521.1</td>
<td>1987532.2</td>
<td>5188.0</td>
<td>4117330.0</td>
<td>999</td>
</tr>
<tr>
<td>ACC of a region</td>
<td>345.1</td>
<td>105.1</td>
<td>102.0</td>
<td>946.0</td>
<td>999</td>
</tr>
<tr>
<td>Area of a region</td>
<td>553.3</td>
<td>2001.0</td>
<td>63.9</td>
<td>25830.0</td>
<td>999</td>
</tr>
<tr>
<td>Population density of a region</td>
<td>10.9</td>
<td>3.4</td>
<td>0.7</td>
<td>15.4</td>
<td>999</td>
</tr>
<tr>
<td>Road density of a region</td>
<td>0.1</td>
<td>0.25E-1</td>
<td>0.516E-1</td>
<td>0.1</td>
<td>999</td>
</tr>
<tr>
<td>Average land price of a region</td>
<td>548.6</td>
<td>236.4</td>
<td>34.0</td>
<td>861.0</td>
<td>999</td>
</tr>
</tbody>
</table>

Table 3 All results based on nonmissing observations of retailers

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std.Dev</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of company of a region</td>
<td>50968.6</td>
<td>111365.5</td>
<td>778.0</td>
<td>321539.0</td>
<td>548</td>
</tr>
<tr>
<td>Number of employee of a region</td>
<td>641847.9</td>
<td>1430145.6</td>
<td>5188.0</td>
<td>4117330.0</td>
<td>548</td>
</tr>
<tr>
<td>ACC of a region</td>
<td>411.8</td>
<td>259.6</td>
<td>102.0</td>
<td>946.0</td>
<td>548</td>
</tr>
<tr>
<td>Area of a region</td>
<td>2336.3</td>
<td>5545.3</td>
<td>63.9</td>
<td>25830.0</td>
<td>548</td>
</tr>
<tr>
<td>Population density of a region</td>
<td>6.1</td>
<td>4.3</td>
<td>0.7</td>
<td>15.4</td>
<td>548</td>
</tr>
<tr>
<td>Road density of a region</td>
<td>0.1</td>
<td>0.4</td>
<td>0.516E-1</td>
<td>0.1</td>
<td>548</td>
</tr>
<tr>
<td>Average land price of a region</td>
<td>272.7</td>
<td>236.1</td>
<td>34.0</td>
<td>861.0</td>
<td>548</td>
</tr>
</tbody>
</table>

5.2. The Estimation Results of Region Choice Decision

Table 4 describes the estimation results of the multinomial logit model for regional choice decision. As the obtained results indicate, the coefficients for the total number of population and the total number of employee of region have a statistically significant and positive effect on the preference of the miscellaneous light manufacturers, product wholesalers and retailers. This means that all logistic firms are more likely to choose the regions that have a high population density and a large employee pool. Next, the result also shows that the total number of company of each region has a negative and significant effect on the region choice decision for all logistic firms. An explanation is that any firm always prefers the region which has a large market and this market is not divided by a lot of companies.

The estimated coefficient value of the area of each region has the expected sign as positive sign for all firms in this research. The positive sign implies that the larger the market carrying capacity, the much more likely the firm is to locate. Finally, it is straight forward to see that the coefficient for the variable ACC has a negative sign due to the nature of the accessibility index used here, which is directly proportional to the travel distance. The negative sign suggests a region that has a short distance move is more attractive to migrating logistic firms. The coefficient of ACC, furthermore, has a significant t value in the preference structure of all logistic firms.
Table 4 Estimation results of the multinomial logit model for regional choice decision

<table>
<thead>
<tr>
<th>Variables</th>
<th>Miscellaneous light manufacturers</th>
<th>Product wholesalers</th>
<th>Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff. (t-stat.)</td>
<td>Coeff. (t-stat.)</td>
<td>Coeff. (t-stat.)</td>
</tr>
<tr>
<td>Number of company of each region</td>
<td>-1.1725 (-1.59)</td>
<td>-0.6122 (-2.01)</td>
<td>-0.6814 (-2.75)</td>
</tr>
<tr>
<td>Number of employee of each region</td>
<td>0.0917 (1.57)</td>
<td>0.0531 (2.27)</td>
<td>0.0523 (2.73)</td>
</tr>
<tr>
<td>ACC of each region</td>
<td>-0.0021 (-1.74)</td>
<td>-0.004 (-3.18)</td>
<td>-0.0026 (-4.21)</td>
</tr>
<tr>
<td>Area of each region</td>
<td>0.0001 (1.37)</td>
<td>0.0007 (1.62)</td>
<td>0.0004 (0.31)</td>
</tr>
<tr>
<td>Population density of each region</td>
<td>0.0981 (1.94)</td>
<td>0.8252 (1.63)</td>
<td>0.1621 (2.31)</td>
</tr>
<tr>
<td>Road density of each region</td>
<td>1.9152 (5.44)</td>
<td>1.6114 (2.75)</td>
<td>1.1125 (2.06)</td>
</tr>
<tr>
<td>Average land price of each region</td>
<td>-0.0048 (-4.12)</td>
<td>-0.0046 (-5.18)</td>
<td>-0.0026 (-1.61)</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-2482.3 -2147.1</td>
<td>-1632.6</td>
<td></td>
</tr>
<tr>
<td>Rho square</td>
<td>0.22 0.19 0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of samples</td>
<td>1122 999 548</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of regions</td>
<td>17 17 17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.3. The Estimation Results of Zone Choice Decision

Since the survey data is limited and the distance among firms in all regions is not available. The present model, therefore, cannot be calibrated for all given regions and all types of industries but will be considered in the future improvement. Hence, each industry type is tested with only one given region in this research.

Table 5 describes the estimation results of the mixed logit model for zone choice decision. The obtained result of this table indicates that the land price coefficients have statistically significant and negative signs for all firms which belong to all types of industries in this research. This means that the land price has a significantly negative effect on a firm’s decision to select a particular location in the case of the miscellaneous light manufacturers, product wholesalers and retailers. The reason for this is that firms like to locate in zones that have a lower land price in order to realize their maximum profit.

The total number of employees of a firm keeps an important role in the location choice decision for the miscellaneous light manufacturers. This is because the number of employees is one of the most important input factors for the miscellaneous light manufacturers. These manufacturers usually require many employees, and their salaries represent a large part of their total expenses. The role of this characteristic, however, is less important for the product wholesalers and retailers.
Table 5 Estimation results of the mixed logit model for zone choice decision

<table>
<thead>
<tr>
<th>Variables</th>
<th>Miscellaneous light manufacturers</th>
<th>Product wholesalers</th>
<th>Retailers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coeff. (t-stat.)</td>
<td>Coeff. (t-stat.)</td>
<td>Coeff. (t-stat.)</td>
</tr>
<tr>
<td>Number of population of zones</td>
<td>0.0016 (2.42)</td>
<td>0.0014 (2.64)</td>
<td>0.0019 (1.84)</td>
</tr>
<tr>
<td>Number of employee of zones</td>
<td>0.0033 (2.54)</td>
<td>0.0012 (1.93)</td>
<td>0.0061 (3.27)</td>
</tr>
<tr>
<td>Land price of zones</td>
<td>-0.0541 (-3.85)</td>
<td>-0.091 (-3.09)</td>
<td>-0.032 (-2.39)</td>
</tr>
<tr>
<td>The distance between zone and the nearest IC highway</td>
<td>-0.0026 (-2.62)</td>
<td>-0.0063 (-1.78)</td>
<td>-</td>
</tr>
<tr>
<td>Number of employee of firms</td>
<td>0.0172 (3.07)</td>
<td>0.022 (4.51)</td>
<td>-</td>
</tr>
<tr>
<td>The distance between firm and the nearest station</td>
<td>-0.0023 (-3.98)</td>
<td>-0.0045 (-0.93)</td>
<td>-0.0097 (-1.04)</td>
</tr>
<tr>
<td>Standard deviation $\sigma$</td>
<td>2.0172 (1.12)</td>
<td>0.1833 (1.73)</td>
<td>0.329 (2.15)</td>
</tr>
<tr>
<td>Correlation among zones $\rho$</td>
<td>2.1634 (2.84)</td>
<td>1.9812 (1.77)</td>
<td>1.6741 (2.05)</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>2.0331 (3.27)</td>
<td>2.1194 (2.18)</td>
<td>3.0842 (1.78)</td>
</tr>
<tr>
<td>Correlation among firms $\lambda$</td>
<td>1.9487 (4.22)</td>
<td>1.0131 (4.36)</td>
<td>1.8621 (3.01)</td>
</tr>
<tr>
<td>$\delta$</td>
<td>3.0151 (3.32)</td>
<td>2.0722 (3.51)</td>
<td>3.1251 (4.18)</td>
</tr>
<tr>
<td>Log-likelihood at convergence</td>
<td>-528.7</td>
<td>-339.5</td>
<td>-225.8</td>
</tr>
<tr>
<td>Log-likelihood at zero</td>
<td>-701.4</td>
<td>-426.9</td>
<td>-288.1</td>
</tr>
<tr>
<td>Rho square</td>
<td>0.24</td>
<td>0.20</td>
<td>0.21</td>
</tr>
<tr>
<td>Number of samples</td>
<td>210</td>
<td>110</td>
<td>70</td>
</tr>
<tr>
<td>Code of given regions</td>
<td>50</td>
<td>80</td>
<td>11</td>
</tr>
<tr>
<td>Number of zones</td>
<td>33</td>
<td>62</td>
<td>13</td>
</tr>
</tbody>
</table>

As can be seen in Table 5, the accessibility to labor is computed with the number of employees of zone and the number of population at each destination. The accessibility variables have a statistically significant and positive effect on that zone being selected as a firm’s location for all logistic firms in this research. This means that manufacturers are more likely to locate in zones that have a high population density and a large employee pool. The reason for this is that the companies can reduce the cost of recruitment that is important cost for the manufacturers. Furthermore, these accessibility variables also are important factors for the retailers and product wholesalers based on the statistically significant and reasonable sign of the obtained coefficients in Table 5. This is likely to be important to get close to the consumers of the retailers.

The accessibility of zone is evaluated in terms of the distance between zone and the nearest IC highway. The estimated coefficients for accessibility have a statistically significant and negative sign for the miscellaneous light manufacturers and product wholesalers. In other words, firms of miscellaneous light manufacturers and product wholesaler prefer to be located
near highway onramps. This might be explained by the transportation cost and travel time can be reduced for logistic firms. The distance between alternatives and the nearest IC highway, however, is less important for the retailers.

The local accessibility is evaluated in terms of the distance between firm’s location and the nearest station. The significant accessibility coefficient is the negative coefficient for the miscellaneous light manufacturers. This means that these manufacturers like to locate in the location that near the station. The reason for this is that the number of employees of these manufactures is high and they usually commute to companies by train. The role of this accessibility is less important for the product wholesalers and retailers.

The spatial parameters are statistically significant in terms of the t-statistics with reasonable signs for all types of logistic firms in Table 5. This means that the significant role of the spatial interaction and spatial autocorrelation in the location choice decision behavior of firms is found in the Tokyo metropolitan area. The values of the correlation coefficients indicate the effectiveness of the firm location choice model when it incorporates the correlation among zones in the error term, and when it incorporates the correlation among firms in the deterministic terms, given the distribution of consumption between the firms and suppliers.

The significant role of the spatial interaction among logistics firms in the proposed model means that the location choice decision of an individual firm is often influenced strongly by the spatial interactions with other neighbor logistic firms or other firms which located nearby in the same zone. An explanation is that the related logistic firms which gather together will gain benefits such as lower cost of production and a greater market share that one firm can obtain in the field of urban economics. A firm, during making a choice decision, does not act in isolation; by way of contrast, firms are influenced by other firms such as the suppliers, manufacturers, and customers.

6. CONCLUSIONS AND RECOMMENDATIONS

This paper analyzed the influence of accessibility on the location choice decision of each individual logistic firm. Especially, the study has highlighted the influence of regional accessibility, local accessibility and spatial effects on an individual firm location choice decision by discrete choice model.

The accessibility to labor is computed with the number of inhabitants at each zone. The accessibility to customers or suppliers is computed with the number of employees and the number of population of each zone. Both variables were highly correlated so during the estimation of the location choice models for all logistic firms. The study found that the distance between firm’s location and the nearest station keeps a key role in the location choice decision of miscellaneous light manufacturers. In addition, the distance between zone and the nearest IC highway is also very important factor in choosing location for these manufacturers a. These accessibility variables, however, are less important for the retailers.

The incorporating spatial interaction among firms in the deterministic part and the spatial correlation among zones in the error term into the location pattern of firm make the proposed model that can effectively capture spatial effects even when additional explanatory variables are not available or cannot be easily obtained. These spatial interactions also keep a key role in the zone choice decision of all logistic firms. This study found that zone that has a short
distance move is more attractive to migrating firms for the miscellaneous light manufacturers, product wholesalers and retailers.

Future activities will focus on the policy evaluation that demonstrates the model’s capability of analyzing of the impact of policies or projects, and reflecting the realistic location choice behavior of the logistic firms in response to those policies or projects. In other words, the future work will demonstrate the application of the model to capture the location choice decision behavior regarding the assumed travel condition. The future study, therefore, will assume an implementation of scenario that is the construction of new ring roads in the centre of Tokyo metropolitan area. The reason for this is that the construction of new ring roads studies the interaction between road network in particular, the transport infrastructure in general and the location decision making of an individual firm.

Finally, the obtained results should be of interest to freight transportation and urban planners. Furthermore, it is understood that it is important to determine the effect of a spatial planning policy on a firm location. However, the significance of the obtained results still can be improved, since the study case of the present research is limited to small data sets for the model estimation. Therefore, it is expected that a better model performance could be achieved by using an improved, updated and larger sets of data. The present results, moreover, can be valuable for further research into simulation modules for the location decisions for firms in an integrated land use and freight-transport modeling environment.

REFERENCES


