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Research Article

Joint Residence-Workplace Location Choice Model Based on Household Decision Behavior

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Residence location and workplace are the two most important urban land-use types, and there exist strong interdependences between them. Existing researches often assume that one choice dimension is correlated to the other. Using the mixed logit framework, three groups of choice models are developed to illustrate such choice dependencies. First, for all households, this paper presents a basic methodology of the residence location and workplace choice without decision sequence based on the assumption that the two choice behaviors are independent of each other. Second, the paper clusters all households into two groups, choosing residence or workplace first, and formulates the residence location and workplace choice models under the constraint of decision sequence. Third, this paper combines the residence location and workplace together as the choice alternative and puts forward the joint choice model. A questionnaire survey is implemented in Beijing city to collect the data of 1994 households. Estimation results indicate that the joint choice model fits the data significantly better, and the elasticity effects analyses show that the joint choice model reflects the influences of relevant factors to the choice probability well and leads to the job-housing balance.

1. Introduction

Integrated land-use and transportation models are most important for both urban planning and transportation planning, and many researches have explored the interdependences between land-use and transportation systems. In the urban land-use pattern, one most important type is residence location, as well as the workplace. These two land-use types influence households' trip pattern greatly. Based on the personal trip survey (PT survey) data of more than 10 Chinese cities, such as Beijing, Shanghai, and Dalian, more than eighty percent of household daily trips are commute trips; that is, these trips depart from residence location and are directed to workplace, or vice versa. Therefore, it is very important to reveal the inherent mechanism of residence location and workplace choice behavior, especially for fast developing Chinese cities.

As an important behavior analysis approach, discrete choice model has been extensively used in the location choice researches. Lerman [1] and McFadden [2] have formulated residential location choice models using discrete choice method more than 30 years ago. Based on the above pioneering researches, Timmermans et al. [3], Waddell [4], Waddell [5], Ben-Akiva and Bowman [6], Sermons and Koppelman [7], Sermons [8], and Sermons and Koppelman [9] have further developed many models to describe households' residence location choices using discrete choice approaches too.

In more recent years, Bhat and Guo [10], Miyamoto et al. [11], Bhat and Guo [12], Guo and Bhat [13], and Jiao and Harata [14] have also proposed several residential location choice models using different discrete choice methods. Bhat and Guo [10] put forward a mixed logit model to analyze the residential location choice behavior and considered random taste variations in their model, as well as the spatial correlations among different residential locations. Miyamoto et al. [11] also proposed a residential location choice model using mixed logit method and used a stochastic process to formulate the spatial correlation. Bhat and Guo [12] formulated a joint mixed multinomial logit-ordered model to present the residential sorting effects and applied it to comprehensively examine the impact of

the built environment, transportation network attributes, and demographic characteristics on residential choice and car ownership decisions. Guo and Bhat [13] explored different conceptualizations to represent neighborhoods in residential location choice models and described three alternative ways to construct operational units to represent neighborhoods. Jiao and Harata [14] presented a mixed logit framework to identify residential location choice behavior in different households and integrated a "direct parametric representation" approach to capture the correlation between spatial units, as well as a comprehensive structure of zonal accessibility to reflect the effects of employment, school, shopping, and recreational opportunities. Most recently, Li et al. [15] formulated a multiobjective optimization model to distribute residential spatial units integrating three objectives. All the above models obtained rather significant results.

As for workplace choice, it has also been extensively studied using similar methods in the framework of disaggregated travel models, for example, Abraham and Hunt [16] and Levine [17].

Most above models of residence location or workplace choice often assume that one choice dimension is exogenous to the other; that is, residence location choice is conditional on predetermined workplace, or vice versa. However, there exist strong interdependences between residence and workplace locations, and such kinds of interdependences have been studied in several existing researches. Waddell [4] questioned it through an empirical study using data of the metropolitan area of Dallas-Fort Worth (Texas, USA). Waddell et al. [18] developed a discrete choice model of joint residence location and workplace choice using methods of latent market segmentation for one-worker households and put forward a methodology for accommodating different sequential decision-making processes. Li et al. [19] also formulated a joint decision model of residence location and workplace using nested logit method and applied it to Beijing city. Ibeas et al. [20] specified a nested logit model and a cross-nested logit model to investigate the existence of spatial correlation between residence and workplace locations and found out that the inclusion of spatial correlations in the model fits the data significantly better.

To revise the residence location and workplace choice models with the assumption that residential location and workplace are chosen independently of each other, that is, without decision sequence, one key feature of this paper is to cluster the households into two groups, choosing residence location first and choosing workplace first, and to formulate the residence location and workplace choice models under the constraint of decision sequence. Another key feature is to further combine the residence location and workplace together and to present the joint choice model.

The rest of this paper is organized as follows. The basic models for all households without decision sequence are proposed in Section 2. Clustering households into two groups, the revised models with decision sequence are presented in Section 3. The joint residence-workplace location choice model is put forward in Section 4 based on the combined choice alternatives. A questionnaire survey is implemented, and the data is illustrated in Section 5. The estimation results of three groups of models are reported and compared in Section 6, as well as the elasticity effects analyses. Conclusions and further researches are summarized in the last section.

2. Residence Location and Workplace Choices without Decision Sequence

In this section, the residence location and workplace choices are assumed to be independent of each other.

2.1. Residence Location Choice without Decision Sequence. Essentially, the household decision behavior influences the residential location choice greatly. Using the discrete choice method, the random utility theory is employed to describe such decision behavior. The following equation is formulated to indicate whether a household will choose a location as the residence place or not:

$$I_{hi} = \begin{cases} \text{one} & \text{if } U_{hi} \geq U_{hj} \text{ for } j = 1, \ldots, K \\ \text{zero} & \text{otherwise,} \end{cases} \tag{1}$$

where I_{hi} is an indicator to denote whether household h selects spatial unit i to reside or not; U_{hi} is the utility for household h to select spatial unit i; K is the total number of spatial units in the choice set.

Usually, the utility function U_{hi} may be divided into two items: the systematic item V_{hi} and the random item ε_{hi}:

$$U_{hi} = V_{hi} + \varepsilon_{hi}. \tag{2}$$

In a mixed logit formulation, the deterministic term V_{hi} can be further represented as below:

$$V_{hi} = \sum_{m=1}^{M} \alpha_m z_{him} + \sum_{n=1}^{N} \theta_n x_{hin}, \tag{3}$$

where α_m and θ_n are parameters to be estimated, α_m is the fixed parameter, θ_n is the unfixed parameter subject to a logarithmic normal distribution; z_{him} and x_{hin} are explanatory variables, for example, spatial unit information, household information, travel related information, and so forth; M is the number of explanatory variables corresponding to the fixed parameters; N is the number of explanatory variables corresponding to the unfixed parameters.

Based on the above formulations, the choice probability for household h to choose spatial unit i is presented as a mixed logit formulation:

$$\begin{aligned} L_{hi} &= \frac{\exp\left(V_{hi}\right)}{\sum_{j=1}^{K} \exp\left(V_{hj}\right)} \\ &= \frac{\exp\left(\sum_{m=1}^{M} \alpha_m z_{him} + \sum_{n=1}^{N} \theta_n x_{hin}\right)}{\sum_{j=1}^{K} \exp\left(\sum_{m=1}^{M} \alpha_m z_{hjm} + \sum_{n=1}^{N} \theta_n x_{hjn}\right)}. \end{aligned} \tag{4}$$

Using $f(\cdot)$ to represent the density function of the logarithmic normal distribution, the unconditional choice

probability for household h to choose spatial unit i is therefore the integral of L_{hi} over all possible variables of θ_n:

$$P_{hi} = \int_{-\infty}^{\infty} \left[\frac{\exp\left(\sum_{m=1}^{M} \alpha_m z_{him} + \sum_{n=1}^{N} \theta_n x_{hin}\right)}{\sum_{j=1}^{K} \exp\left(\sum_{m=1}^{M} \alpha_m z_{hjm} + \sum_{n=1}^{N} \theta_n x_{hjn}\right)} \right] \cdot f(\theta)\, d\theta. \quad (5)$$

According to the factors households pay most attention to when they make the residence location choice, the explanatory variables include the following:

TT_i: household travel time between residence location and workplace;

TD_i: household travel distance between residence location and workplace;

TC_i: household travel cost between residence location and workplace;

HP_i: regional housing price around residence location;

PO_i: regional population around residence location;

ZD_i: number of regional rail transit stations around residence location;

FAR_i: regional floor area ratio (FAR) around residence location.

According to several estimation experiments, TT_i and TD_i are assumed to be corresponding to the unfixed parameters θ_n.

Therefore, (5) can be further represented as

$$\begin{aligned} P_{hi} = \int_{-\infty}^{\infty} \Bigg[& \left(\exp\left(\theta_1 \mathrm{TT}_i + \theta_2 \mathrm{TD}_i + \alpha_1 \mathrm{TC}_i + \alpha_2 \mathrm{HP}_i \right.\right. \\ & \left.\left. + \alpha_3 \mathrm{PO}_i + \alpha_4 \mathrm{ZD}_i + \alpha_5 \mathrm{FAR}_i\right)\right) \\ & \times \left(\sum_{j=1}^{K} \exp\left(\theta_1 \mathrm{TT}_j + \theta_2 \mathrm{TD}_j + \alpha_1 \mathrm{TC}_j \right.\right. \\ & + \alpha_2 \mathrm{HP}_j + \alpha_3 \mathrm{PO}_j \\ & \left.\left. + \alpha_4 \mathrm{ZD}_j + \alpha_5 \mathrm{FAR}_j\right) \right)^{-1} \Bigg] \\ & \cdot f(\theta)\, d\theta. \end{aligned} \quad (6)$$

In this model, the unfixed parameter θ_n is assumed to follow the following logarithmic normal distribution:

$$\theta_n(s_k, \xi_n, \eta_n) = \frac{1}{2\sqrt{\pi}\eta_n} \exp\left[-\left(\frac{\ln(s_k) - \xi_n}{\eta_n} \right)^2 \right], \quad (7)$$

where s_k is the random variable, and ξ_n and η_n are the expectation and variance of $\ln(s_k)$, respectively.

2.2. Workplace Choice without Decision Sequence. Similar to the residence location choice model, the mixed logit method is employed to model the workplace choice.

According to the factors households pay most attention to when they make the workplace choice, the explanatory variables include household travel time TT_i, household travel distance TD_i, household travel cost TC_i, and

INC_i: household annual income;

EMP_i: number of regional employment opportunities around workplace;

GS_i: regional gross sale of consumer goods around workplace.

Based on several estimation experiments, TT_i and TD_i are also assumed to be corresponding to the unfixed parameters θ_n.

Therefore, the workplace choice model without decision sequence is represented as

$$\begin{aligned} P_{hi} = \int_{-\infty}^{\infty} \Bigg[& \left(\exp\left(\theta_1 \mathrm{TT}_i + \theta_2 \mathrm{TD}_i + \alpha_1 \mathrm{TC}_i \right.\right. \\ & \left.\left. + \alpha_2 \mathrm{INC}_i + \alpha_3 \mathrm{EMP}_i + \alpha_4 \mathrm{GS}_i\right)\right) \\ & \times \left(\sum_{j=1}^{K} \exp\left(\theta_1 \mathrm{TT}_j + \theta_2 \mathrm{TD}_j + \alpha_1 \mathrm{TC}_j + \alpha_2 \mathrm{INC}_j \right.\right. \\ & \left.\left. + \alpha_3 \mathrm{EMP}_j + \alpha_4 \mathrm{GS}_j\right) \right)^{-1} \Bigg] \\ & \cdot f(\theta)\, d\theta. \end{aligned} \quad (8)$$

In this model, the unfixed parameters θ_1 and θ_2 are also assumed to follow the logarithmic normal distribution as shown in (7).

3. Residence Location and Workplace Choices with Decision Sequence

In the above two models, we assume that residence location choice and workplace choice are independent of each other; that is, people choose locations without decision sequence. However, some households tend to choose workplace first and then choose residence location according to the constraint of workplace, or vice versa. Both of these sequential choice processes are present in the population in a proportion that is unknown to the analyst. Fortunately, the cluster analysis provides an effective method to differentiate them. In this section, we relieve the strong assumption, cluster all households into two groups, and formulate the residence location and workplace choice models with decision sequence.

In this research, a large amount of information about the households is collected through a questionnaire survey, and seven groups of preference data are extracted to represent

the households' preferences when they choose residence and workplace locations, including the following:

(1) residence location is adjacent to workplace;

(2) traffic is convenient;

(3) commute is convenient;

(4) housing price is acceptable;

(5) there are good schools nearby;

(6) geographic position is good;

(7) residential community environment is excellent.

Based on the above 7 groups of preference data, cluster analysis is then implemented to cluster all households into two categories, choosing workplace first, and then choosing residence location conditional on workplace, or vice versa. The detailed data and clustering results are described in Section 5.

Using survey data of clustered households, we can formulate the residence location and workplace choice models with decision sequence, respectively. For the convenience of comparison between different models, we use the same explanatory variables here as models without decision sequence. Therefore, the residence location choice model with decision sequence is the same as (6), while the workplace choice model with decision sequence is the same as (8). Here the unfixed parameters θ_1 and θ_2 are also assumed to follow the logarithmic normal distribution as shown in (7).

4. Joint Residence-Workplace Location Choice

As stated above, there exist strong interdependences between residence and workplace locations, and in most time they influence each other, and households tend to consider these two choice problems together. It is often unreasonable to simply assume that households choose residence location or workplace first. Therefore, we assume that both residence location and workplace choices are made simultaneously as an instantaneous bundle and then model the interdependence based on such assumption.

In this model, we take the residence-workplace location pairs as new choice alternatives. To model the joint location choice behavior, all explanatory variables influencing residence location and workplace choices are incorporated within the joint choice model

$$\begin{aligned} P_{hi} = \int_{-\infty}^{\infty} \Bigg[\Big(& \exp\big(\theta_1 \mathrm{TT}_i + \theta_2 \mathrm{TD}_i + \alpha_1 \mathrm{TC}_i + \alpha_2 \mathrm{HP}_i \\ & + \alpha_3 \mathrm{PO}_i + \alpha_4 \mathrm{ZD}_i \\ & + \alpha_5 \mathrm{FAR}_i + \alpha_6 \mathrm{INC}_i + \alpha_7 \mathrm{EMP}_i + \alpha_8 \mathrm{GS}_i \big)\Big) \\ & \times \Bigg(\sum_{j=1}^{K} \exp\big(\theta_1 \mathrm{TT}_j + \theta_2 \mathrm{TD}_j + \alpha_1 \mathrm{TC}_j + \alpha_2 \mathrm{HP}_j \\ & + \alpha_3 \mathrm{PO}_j + \alpha_4 \mathrm{ZD}_j \\ & + \alpha_5 \mathrm{FAR}_j + \alpha_6 \mathrm{INC}_j \\ & + \alpha_7 \mathrm{EMP}_j + \alpha_8 \mathrm{GS}_j \big)\Bigg)^{-1} \Bigg] \\ & \cdot f(\theta)\, d\theta. \end{aligned} \tag{9}$$

The definitions of all variables in (9) are the same as the above, and the unfixed parameters θ_1 and θ_2 are also assumed to follow the logarithmic normal distribution as shown in (7). Since the residence-workplace location pairs are taken as the choice alternatives, the number of alternatives increases dramatically.

5. Data

To testify the above three groups of models, we collected the field data of 1994 households in Beijing city through a questionnaire survey. The residence and workplace locations in the data cover all districts of Beijing city, including 6 urban districts and 10 suburban districts.

Table 1 provides a summary of household characteristics in the survey data used, and the distributions of household structure, household income, car ownership, and commuting mode are included. The clustered result of households choosing residence or workplace first is also shown in the table.

From Table 1 we can find out that now more than 60% of Chinese households in Beijing own one or more cars. The rail transit and bus modes are clearly the superior modes of transport structure in this case study.

Furthermore, for estimation of models with decision sequence, all 1994 households were clustered into two groups using the cluster analysis method based on 7 kinds of preferences in Section 3. The clustering results are also shown at the bottom of Table 1.

In addition to the questionnaire survey data, three other data sets associated with Beijing city were used: land use data, demographic data, and census data. The land use data was obtained from Beijing Municipal Commission of Urban Planning and was used to get the acreage of each residence and workplace location. The demographic data and census data came from Beijing Municipal Bureau of Statistics and were used to compute the regional housing price, regional population, number of regional rail transit stations, regional floor area ratio (FAR), household income, number of regional employment opportunities, and regional gross sale of consumer goods for each residence location or workplace.

All the above data provide a rich set of variables for consideration in model specification.

Table 1: Household characteristics of the survey sample.

Characteristic	Number of samples	Sample shares
Sample size	1994	100%
Household structure		
Single	393	19.7%
Single living with parents	359	18.0%
Couple	578	29.0%
Couple living with children	586	29.4%
Three generations living under one roof	78	3.9%
Household income (Chinese Yuan)		
<50,000	586	29.4%
50,000–100,000	923	46.3%
100,000–150,000	303	15.2%
150,000–200,000	118	5.9%
>200,000	64	3.2%
Car ownership		
0	774	38.8%
1	1025	51.4%
≥2	195	9.8%
Commuting mode		
Car	253	12.7%
Rail transit	879	44.1%
Bus	626	31.4%
Taxi	66	3.3%
Walk/bicycle	150	7.5%
Others	20	1.0%
Clustered decision sequence		
Residence first	1242	62.2%
Workplace first	752	37.8%

6. Estimation Results and Elasticity Effects Analyses

6.1. Estimation Results. Estimations of the above models were implemented with maximum simulated likelihood (MSL) method proposed by Bhat and Guo [10]. Randomly scrambled Halton method in Bhat [21] was used to achieve the random draws for MSL estimation.

The MSL estimations in this paper were carried out based on the GAUSS platform. Since the scrambled Halton sequence has been coded using GAUSS language and proved very efficient in Bhat [21], we simply borrowed the code and integrated it into the MSL estimation.

The estimated mean values of all the coefficients of five models are reported in Table 2, respectively.

In Table 2, the t-statistics are also presented in parentheses to show the significance of all explanatory variables. For unfixed parameters, mean values and standard deviations are both reported.

The residence location and workplace choice models without decision sequence are estimated as though all households in the sample choose location independently, based on all sample data. The residence location and workplace choice models with decision sequence are estimated as though some households in the sample choose residence conditional on a prior choice of workplace, while other households choose workplace conditional on a prior choice of residence, based on the clustered two groups of data, respectively. The joint residence-workplace location choice model is estimated as though residence and workplace influence each other, and all households in the sample consider the choice of two locations simultaneously.

From Table 2 we can find out that the signs and significances of all estimated parameters are generally consistent with prior expectations.

For common parameters in both residence and workplace choice models, the travel time, travel distance, and travel cost between residence location and workplace have expected negative signs, indicating that proximity to employment location is an important factor in residential location choice, and proximity to residence location is also an important factor in workplace choice.

For specific parameters in residence location choice models, the housing price has the expected negative sign, indicating that households tend to reside in area with low housing price under other fixed conditions. The positive sign of zonal population shows that households are more likely to locate in zones with high population, which reflects the population clustering effect. The number of rail transit stations has the expected positive sign; that is, households tend to live in zones with good accessibility to activity opportunities. The negative sign of FAR shows that households are also more likely to locate in zones with low residential density and comfortable community environment.

For particular parameters in workplace choice models, the household income has the expected positive sign; that is, households tend to choose the workplace which brings high income to them. The positive sign of employment opportunities shows that the number of available jobs is a rather important factor influencing the workplace choice. The gross sale of consumer goods also has the expected positive sigh, indicating that households are more likely to work in those zones with good shopping environment.

To further observe the parameters of single choice models, one can find out that, for all models, the magnitudes of travel distance and number of rail transit stations are both much bigger than other parameters. It shows that these two factors are much more important for household location choices. Further comparison between choices with and without decision sequence indicates that there is a modest improvement in the log-likelihood of the model with decision sequence, which underlines the significance of identifying the sequence of choosing residence and workplace locations.

For the joint residence-workplace location choice model, the basic pattern of results is consistent with the residence location choice models without and with decision sequence, and the estimated parameters are also rather significant from t-statistics. The travel distance and number of rail transit

Table 2: Estimation results of five models.

Variables	Residence location choice		Workplace choice		Joint choice
	Without d-s	With d-s	Without d-s	With d-s	
Travel time (M)	−0.2869 (−7.89)	−0.2962 (−7.92)	−0.1352 (−21.55)	−0.1134 (−17.03)	−0.3011 (−6.88)
Travel time (S.D.)	0.3752 (7.41)	0.3921 (8.09)	0.0517 (6.29)	0.0604 (7.36)	0.2744 (8.11)
Travel distance (M)	−0.8255 (−8.76)	−0.8403 (−8.92)	−0.4948 (−23.88)	−0.4706 (−19.85)	−0.6602 (−8.95)
Travel distance (S.D.)	0.4385 (7.42)	0.5035 (7.95)	0.1071 (7.38)	0.2251 (5.66)	0.3849 (6.77)
Travel cost	−0.1233 (−5.04)	−0.1022 (−4.47)	−0.0323 (−11.55)	−0.0396 (−10.34)	−0.0371 (−4.61)
Housing price	−0.2363 (−3.22)	−0.4623 (−6.47)	\	\	−0.4437 (−4.78)
Population	0.0417 (3.25)	0.0217 (2.01)	\	\	0.0214 (2.14)
Number of rail transit stations	0.4449 (4.22)	0.5012 (5.66)	\	\	0.3706 (3.21)
FAR	−0.0388 (−1.99)	−0.0488 (−2.93)	\	\	−0.0841 (−2.07)
Household income	\	\	0.2624 (3.88)	0.4607 (5.25)	0.3329 (4.16)
Employment opportunities	\	\	0.0224 (5.24)	0.0274 (6.44)	0.0271 (4.21)
Gross sale	\	\	0.1122 (2.01)	0.2101 (3.11)	0.0866 (3.71)
Number of observations	1994	752	1994	1242	1994
log-likelihood at convergence	−1304	−1263	−1279	−1154	−1089

Here d-s means "decision sequence"; M means "mean value"; S.D. means "standard deviation."

stations are again significant and in the expected direction, with the same pattern of relatively larger magnitude than other parameters. The negative sign of the travel distance indicates that the shorter the travel distance between residence location and workplace, the more the likelihood of the zone being chosen as the residence location.

Again, the pattern of estimation results of the joint choice model is generally consistent with the workplace choice models without and with decision sequence, and also the estimated parameters are rather significant from t-statistics. The largest magnitude of travel distance again shows its importance for the workplace choice.

From the log-likelihood at convergence, we can further find out that the index of the joint choice model is the largest among all five models. It means that the joint choice of residence location and workplace is the most similar to household natural choice behavior mechanism.

6.2. Elasticity Effect Analyses. Since the coefficients in a complex choice models are not straightforward to understand, we further implement three groups of elasticity effects analyses for the joint choice model. To extract the different characteristics between urban and suburban households,the choice alternatives are classified into two groups: urban area and suburban area.

The following explanatory variables are used.

(1) Number of Rail Transit Stations. Seven scenarios are developed based on the number of rail transit stations: −50%, −30%, −10%, base 0%, +10%, +30%, and +50%. The choice probabilities of 7 scenarios are shown in Figure 1.

Figure 1 shows that, with the same number of rail transit stations, the choice probability in suburban area is higher than that in urban area. With the decrease of the number of rail transit stations, the choice probability of suburban area decreases more dramatically than that of urban area. All these show that suburban households pay more attention to rail transit than urban households.

(2) Housing Price. Seven scenarios are also developed based on the housing price: −50%, −30%, −10%, base 0%, +10%, +30%, and +50%. The choice probabilities of 7 scenarios are shown in Figure 2.

With the increase of housing price, the choice probability of suburban area drops more sharply than that of urban area. It means that suburban households are more sensitive to housing price.

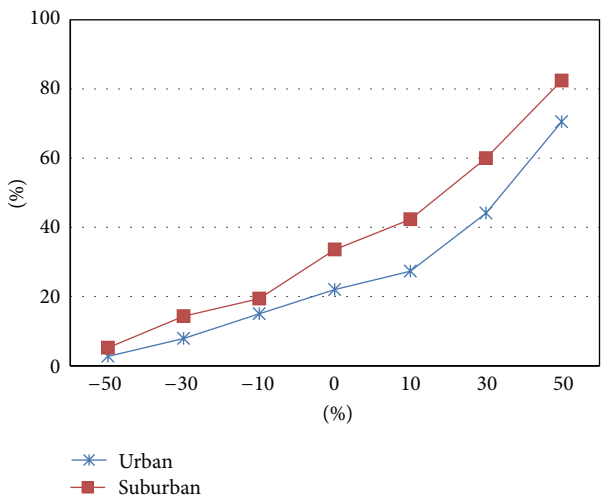

Figure 1: Elasticity effect based on number of rail transit stations.

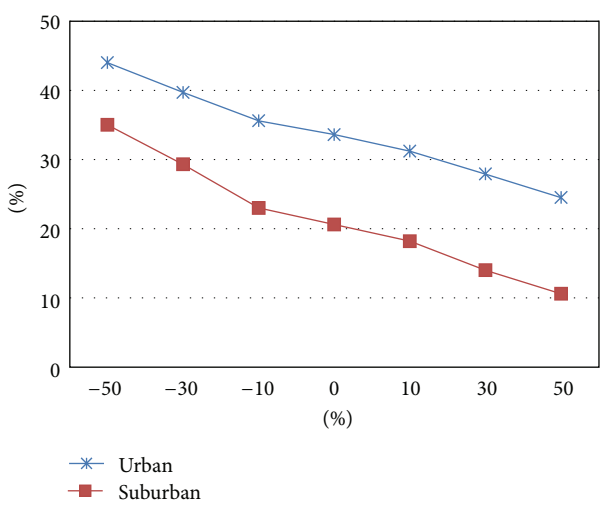

Figure 2: Elasticity effect based on housing price.

(3) Household Income. Seven scenarios are further developed based on the household income: −50%, −30%, −10%, base 0%, +10%, +30%, and +50%. The choice probabilities of 7 scenarios are shown in Figure 3.

Comparing with the above two variables, the household income is the most sensitive index. Obviously, with the increase of household income, the choice probability of urban area rises more dramatically than that of suburban area. It shows that households tend to live and work in urban area to improve their income.

7. Conclusions

This paper addresses five mixed logit models concerning location choices: residence location choice model without decision sequence, residence location choice model with decision sequence, workplace choice model without decision sequence, workplace choice model with decision sequence, and the joint residence-workplace location choice model. We first assume that residence and workplace choice behaviors are independent of each other and formulate two basic choice models without decision sequence. Then we cluster households into two groups, choosing residence or workplace first, and propose two choice models with decision sequence; that is, residence location choice is conditional on predetermined workplace, or vice versa. We further put forward a joint choice model to combine the residence location and workplace together. A questionnaire survey is implemented in Beijing city to collect the data of 1994 households. Estimated parameters show that the travel distance and number of rail transit stations are the most important two factors for household location choices. The log-likelihood at convergence indicates that choice models with decision sequence are much more significant than models without decision sequence, and the joint choice model is the most reasonable. Further elasticity effects analyses show that the joint choice model reflects the influences of relevant factors to the choice probability very well.

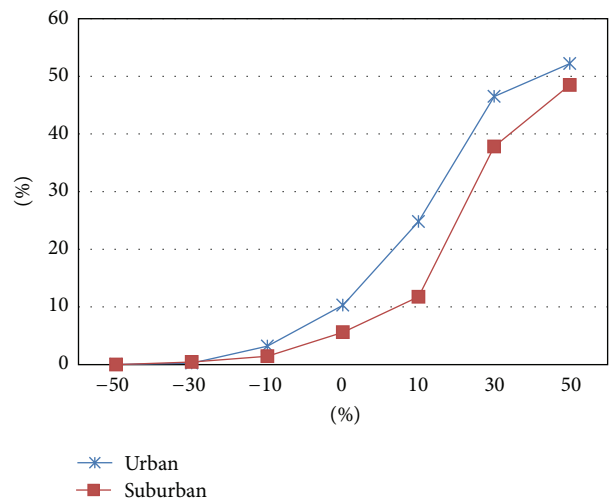

Figure 3: Elasticity effect based on household income.

This research is further directed towards two aspects. The first is to take into account the differences among male, female, and children and to model the choice behaviors of households with different family structures. The second is to capture the dynamics of household residence location and workplace changes using panel data.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

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