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An Analysis of the Factors Affecting Preferences for Rental Houses in Istanbul Using Mixed Logit Model: A Comparison of European and Asian Side

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Abstract: This study aims to analyze the factors affecting households' preferences to select houses for rent in Asian and European side of Istanbul with Mixed Logit model. Analysis showed that earthquake resistance, luxury, proximity to hospital, presence of green areas, luxury-comfort level positively affected the preferences for houses for rent of households residing in European side, while monthly rent when compared to the present house negatively affected their preferences. As for the Asian side, monthly rent and tiring effect of working time negatively affected house preferences, while proximity to city center, size of the house, presence of green areas and proximity to educational facilities positively affected the preferences for houses for rent.

Keywords: Housing preferences, Mixed logit model, Rental housing, Revealed Preference, Stated Preference.

JEL Classification Number: C25, C35, C91, D12, R21

1. Introduction

Housing need that increases due to population growth or migration from rural areas causes housing problem in large cities. Projects to eliminate increasing housing need result in rapid development of the housing sector. Housing projects with different characteristics and structures began to be preferred both for residing and for investment purposes. Housing projects offering appealing investment opportunities with their increasing characteristics affect the house preferences of people who seek houses for rent, in addition to those who will purchase houses. Individuals, who have the chance to choose among a wide variety of housing projects that vary according to different income levels, select their houses with maximum benefits. At this stage, it is important to determine the factors

affecting house preferences of tenants and the dynamics that prevail in housing market. The study used mixed logit model that allow making detailed analyses of individuals and preferences to determine the factors affecting preferences of tenants in Istanbul for houses for rent.

2. Literature Review

A review of literature on house preferences reveals that qualitative preference models are widely used in practice. Kim (1991) is the first study in this field, in which the researcher used nested logit models to examine house location selection of households. Ben Akiva and Bowman (1998) used both demographic and environmental characteristics to analyze house location selection. Bayer et al., (2013) examined the characteristics of house and environment using discrete choice models and hedonic regression. Carliner and Ahluwalia (2004) used logit models to examine the factors that affect house preferences of immigrants. Bhat and Guo (2004) used mixed spatial correlated logit model and Tillema et al., (2006) used multinomial logit and mixed logit model to examine house location selection behaviors. Walker and Li (2006) studied house preferences using discrete choice models in which latent classes participated in the model. Zhou and Kolkerman (2008) analyzed the factors affecting house preferences using mixed logit model. Kitrinou et al., (2009) used ICLV (Integrated choice and latent variable) model to examine the factors that affect house preferences.

3. Methodology

Mixed Logit model is a qualitative dependent variable. It is used when preference probability depends on the characteristics of the individual and the quality of the preference. Mixed logit models include unobservable factors into the model and take into account the information that parameter value, to which the characteristics of individual and the alternative are reflected, has different random distribution. Mixed logit was first used by Boyd and Mellman (1980) and Cardell and Dunbar (1980). The model was later developed by Bhat (1998), Brownstone and Train (1996) (Glasgow 2000). Mixed logit model is generally expressed as:

$$U_{ni} = \mu' z_{ni} + \beta_n' x_{ni} + \varepsilon_{ni} \quad (1)$$

where ε error term is an IID error term with Gumbel distribution (Revelt and Train 1998). In mixed logit model, β_n random coefficient has different distribution selected according to the character of research and data. Probability based on β_n random coefficient condition is obtained as follows:

$$P(j/\beta) = \frac{e^{x_j\beta + z_j\mu}}{\sum_{k \in J} e^{x_k\beta + z_k\mu}} \quad (2)$$

Unconditional probability, on the other hand, is obtained by taking weighted integral of β' with its distribution**:**

$$P(j) = \int_{\beta} \left[\frac{e^{z_j \mu + x_j \beta}}{\sum_{k \in J} e^{z_k \mu + x_k \beta}} \right] g(\beta / \Omega) \partial_{\beta} \tag{3}$$

As personal preferences cannot be definitely determined, probability should be determined based on the intensity function of β:

$$P_{ni} = \int L_{ni}(\beta) f(\beta) d\beta \tag{4}$$

$L_{ni}(\beta)$ is logit probability of the parameter. Taking integral in calculation of P_{ni} probability is found by approximation by simulations unlike the classical integral taking operation. This process is repeated for a number of times and selection probability by taking the mean of the results of $L_{ni}(\beta)$ is calculated using the following formula (Train 2009):

$$SL_i = \left(\frac{1}{R} \right) \sum_{r=1,\ldots,R} L_{ni}(\beta)^r \tag{5}$$

In mixed logit model, probability is estimated as the weighted average of logit probabilities that is obtained based on the distribution of parameters. The weights used in calculation are intensity function of parameters (Train 2000). Therefore, parameters are not constant and take different random values in each unit in mixed logit model. The property of IIA in qualitative preference models means the independency of irrelevant alternatives. Since approximation with simulations is used to find probabilities in mixed logit model, the property of IIA does not appear (Ben-Akiva and Bierlaire 1999). McFadden R^2 value is used more than other values of Pseudo R^2 are defined as goodness of fit measure of discrete choice in analysis of mixed logit model. As the coefficients cannot be directly interpreted in mixed logit models, the value defined as WTP is calculated. This value is defined as "willingness to pay" and the coefficients are interpreted according to this value.

4. Data

We attempted to collect data from households through a questionnaire to examine the preferences of the tenants residing in Istanbul for houses for rent. The questionnaire consisted of questions based on Revealed Preference (RP) and Stated Preference (SP). The questionnaire was administered to a total of 688 houses. RP based questions aimed to collect information on demographic structure of households and on the existing house. SP based questions, on the other hand, allow making house selections according to a scenario for 8 selection conditions, each of which are different and are developed using the defined levels for 14 characteristics affecting house selection of individuals.

Fractional factorial experiment design method was used to determine the levels of the characteristics defined for each selection. The individuals determined the most appropriate preferences for houses for rent by comparing their present houses and each of 8 different hypothetical situations. Analysis was conducted with 688x8x3=16512 observations since 688 participants will prefer 3 different options (detached house, apartment and residence) for 8 different selection situations. Definitions of variables are presented Table 1.

Table 1: Definitions of Variables

Variable	Definition
Monthlyrent	Monthly Rent
Worktime	Time spent to go to work
Hsize	Size of the House
Earthquake	Earthquake resistance
Lux	Luxury
Green	Green Areas
Cprox	Proximity to City Center
Eprox	Proximity to Educational Facilities
Hprox	Proximity to Hospital
Earthquake rent	Earthquake resistance of the house according to monthly rent
Luxury comfort	Luxury of the house according to comfort
Worktimetiring	Tiring effect of time to go to work on individual

5. Empirical Results

This study attempted to examine preferences for houses for rent of households residing in European and Asian side of Istanbul. The units were divided as those residing in Europe and those residing in Asia. House for rent selection models were estimated for both sides of Istanbul. Detached house was selected as reference level in mixed logit models estimated for European and Asian side. In our study, simulation method that will be used to estimate the probability of mixed logit models was determined using Halton sequences. Halton sequences simulation method provides estimation power for the model with less divergence than other random drawing (Bhat 1999).

It is important to identify the parameters that are assumed to be randomly distributed and to determine which distributions of these parameters have. In mixed logit models, asymptotic t test, LR, Wald and Score tests are used to determine whether the parameters are random. On the other hand, distribution type of the parameters which are found to be randomly distributed can be determined by the presence of a sign constraint in parameter values, mean and standard deviation values and the shape of the graphs and number of

sample units. The following hypotheses are used to determine whether the variables with random coefficients in the estimated mixed logit model should be in the model or not:

***Ho*:** Random parameter unavailable; and ***Ha*:** Random parameter available

LR, Wald and Score (LM) test were conducted based on restricted and unrestricted model. LR test statistics was calculated from restricted and unrestricted model. Wald test statistic was calculated from unrestricted model and Score test statistics was calculated based on restricted model. Test statistics and results are presented below.

Table 2: Test of the Presence of Random Parameters for European Side

	LR Test	Wald Test	Score Test
Test Statistics	2746.5***	436437.7***	588.402***

Note: ***,**,* indicate significance at the level 1%, 5% and 10%, respectively.

Null hypothesis is rejected according to the result of LR, Wald and Score (LM) tests. The model should contain earthquake rent random parameter. The distribution of earthquake rent random variable, which was found to be random for European side, is presented below. The parameter is normally distributed with a mean of 0.0020 and a standard deviation of 0.1003. 49% of households residing in European side are observed to have negative marginal benefit.

LR, Wald and Score tests were conducted to analyze whether luxury comfort and earthquakerent variables, which are random parameters in house preference model estimated for Asian side, should be included in the model or not. Test results are presented in Table 3.

Table 3: Test of the Presence of Random Parameters for Asian Side

	LR Test	Wald Test	Score Test
Test statistics	1096.1***	41796.52***	614.9481***

Note: ***, ** and * indicate significance at the level 1%, 5% and 10%, respectively.

Null hypothesis is rejected according to the result of LR, Wald and Score (LM) tests. The model should have luxury comfort and earthquake rent random parameters. The distribution of 2 random variables that were found to be random for the Asian side is presented below. Luxury comfort random parameter is normally distributed with a mean of 0.778 and a standard deviation of 0.122. According to Luxury comfort parameter, 47% of the households residing in Asian side have negative marginal benefit.

Earthquake rent parameter is normally distributed with a mean of 0.0388 and a standard deviation of 0.038. According to Earthquake rent random parameter, 15% of households residing in Asian side have negative marginal benefit. Two different models were

Figure 1. Distribution of Random parameter Earthquake rent for European Side

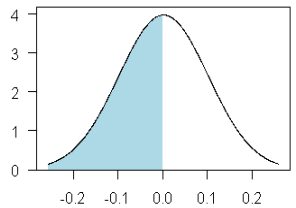


Figure 2. Distribution of Luxury comfort random parameter for Asian side

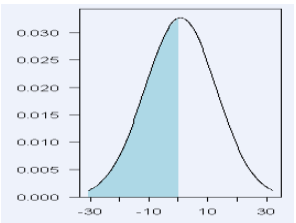
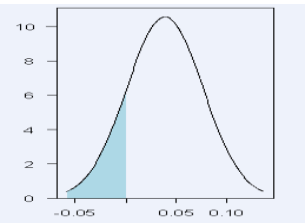


Figure 3. Distribution of Earthquake rent random parameter for Asian side



estimated for the analysis that studied house selection behaviors of tenants in European and Asian side of Istanbul. WTP values will be used to interpret coefficients of the estimated models. The results of the model estimated both for European and Asian side are presented in Table 4.

While 12 variables in mixed logit model estimated for European side are deterministic variables, Earthquake rent is the variable that expresses the random effect in the model. As for Asian side, while 14 variables are deterministic variables of the estimated mixed logit model, Earthquake rent and Luxury comfort are random variables. According to estimation results of the model for European side, Monthly rent variable has a negative effect and is statistically significant. This indicates that while detached house is reference level, if the monthly rent of the house increases when compared to the present house, the benefit the individuals obtain will decrease. In mixed logit model, earthquake resistance, luxury, proximity to hospital, presence of green areas, luxury-comfort degree and earthquake resistance according to monthly rent of the house received a positive value. It was observed that when earthquake resistance of the houses selected by the households in European side increases when compared to the present house, they will provide the highest benefit than other characteristics. Other variables that provide high benefit to households are luxury level of the house and green areas respectively.

According to the model above that was estimated to analyze house preferences in Asian side of Istanbul, the variables of monthly rent and tiring effect of working time have a negative impact on house preferences, while other variables have a positive impact on house preferences. This indicates that, when detached house is reference level, if monthly rent of the house and tiring effect of working time increase when compared to the present house, the benefit the individuals obtain will decrease. It was observed that when the proximity to city center of the house selected by the households living in Asian side increases, they will obtain the highest benefit than other characteristics. Other variables providing high benefit to households are size of the house, presence of green areas and proximity to educational facilities.

Table 4: House Preference Models in Istanbul

	European Side		**Asian Side**	
Variables	**β**	***t* statistics**	**β**	***t* statistics**
Detached House				
Apartment	2.1947	5.456***	0.246	36.737***
Residence	-2.6516	-6.328***	0.219	44.972***
Monthly rent	-0.2421	-3.989***	-3.998	-32.965***
Worktime	0.2913	7.261***		
Earthquake	6.6434	60.606***	0.299	115.379***
Green	1.8912	19.900***	4.319	17.784***
Lux	3.3505	42.942***	0.121	88.428***
Hprox	1.2210	17.916***	0.141	123.212***
Earthquake rent	0.0020	52.362***	0.0388	360.495***
Luxury comfort	0.0671	4.506***	0.778	35.417***
Apartment: age	0.0319	3.459***		
Residence: age	0.0246	2.556**		
Detachedhouse: hexpenditure	0.0258	56.362***	0.0979	153.001***
Apartment: hexpenditure	0.0302	43.122***	0.111	112.161***
Residence: hexpenditure	0.0417	79.665***	0.120	130.487***
Hsize			7.410	129.637***
Cprox			8.956	63.936***
Eprox			3.606	38.059***
Worktimetiring			-1.087	-54.352***
Apartment: income			-0.0008	-6.800***
Residence: income			-0.0061	-110.770***
sd. Luxury comfort			0.122	37.532***
sd.Earthquakerent	0.1003	660.634***	0.038	202.440***
Log-Likelihood:	-1385.1		-548.06	
McFadden R^2:	0.35694		0.84473	
Likelihood ratio test : chisq	1537.7 (prob= < 2.22e-16)		5963.2 (prob= < 2.22e-16)	

Note: ***, ** and * indicate significance at the level 1%, 5% and 10%, respectively.

Goodness of fit measure of the model McFadden R^2 value was found to be 0.36 for European side and 0.84 for Asian side. McFadden R^2 value for the model estimated for European side was found to be higher; Log-Likelihood value was found to be less negative and likelihood ratio test statistic was found to be greater. WTP values calculated using the models estimated for European and Asian sides are presented in Table 5.

Table 5: WTP Values for Houses for Rent Preferences for European and Asian Side of Istanbul

	WTP (Willingness to pay)	MODELS	
		European Side	Asian side
Variables	Worktime	1.2035	
	Earthquake	27.4412	7.495
	Green	7.8116	1.080
	Lux	13.9384	3.037
	Hprox	5.0435	3.522
	Earthquakerent	0.0082	0.009
	Luxurycomfort	0.2771	0.194
	Apartment:age	0.1319	
	Residence:age	0.1015	
	Detachedhouse:hexpenditure	0.1065	0.0244
	Apartment:hexpenditure	0.1247	0.0277
	Residence:hexpenditure	0.1724	0.0277
	Hsize		1.853
	Cprox		2.240
	Eprox		0.902
	Work time tiring		-0.272
	Apartment:income		-0.0002
	Residence:income		-0.0015

WTP value is the amount the households are willing to pay to have the relevant characteristics. The value the households are willing to pay to make their houses have one unit higher earthquake resistance was found to be 27.5 TL in European side and 7.5 TL in Asian side. The amount the households are willing to pay to make their houses one unit more luxurious was found to be 13.9 TL in European side and 3.04 TL in Asian side. The amount the individuals are willing to pay to have a house one unit closer to the hospital was 5.04 TL in European side and 3.5 TL in Asian side. Other WTP values can be interpreted similarly.

6. Conclusion

It is important for the producers to determine perceptions, attitudes and preferences of customers and to produce such products. Qualitative preference models are developed to accurately estimate preference behaviors of individuals. Preference structure is attempted to be estimated in the most accurate manner with the development of methods that enable inclusion of characteristics of individuals and the alternatives into the model especially in recent years. In this study, mixed logit model that allows including characteristics of the

individual and the alternative in the model was used to analyze the preferences of tenants in Istanbul for houses for rent. Unobserved factors of the individuals and the alternatives show variations between units. Based on the information that the benefit obtained from preference models can vary for each individual, mixed logit model considers that parameter values can have different random distribution.

In the study, data was collected from households residing in European and Asian sides of Istanbul through questionnaires to determine the factors affecting preferences for houses for rent. We determined what distribution the parameters of the models estimated for both sides have and whether these parameters were constant or random. Based on obtained data, mixed logit models were estimated for Asian and European side. In the model estimated for European side of Istanbul, earthquake resistance, luxury level, proximity to hospital, presence of green areas, luxury-comfort degree when compared to the present house were found to have positive effects. On the other hand, monthly rent of the house was found to have a negative effect. As for Asian side of Istanbul, proximity to city center, size of the house, presence of green areas and proximity to educational facilities positively affected preference probability of the house. On the other hand, monthly rent when compared to the present house and tiring effect of working time were found to be the factors that negatively affect house preferences.

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