FAMILY STRUCTURE, RESIDENTIAL AREA AND HOUSING DEMAND:

EVIDENCE FROM MICRO-DATA FOR THE U.S.

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The undersigned, appointed by the Dean of the Graduate School, have examined the dissertation entitled

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ABSTRACT

Existing literatures emphasize the estimates of price and income elasticities for housing demand over the whole population. This dissertation analyzes and quantifies different responses of whole population and subgroups for housing demand categorized by family structure and residential area. Micro data for the U.S. are used to analyze the effects of family structure and residential area on tenure choice and housing demand. This data is used to model hedonic house price, tenure choice and housing demand. This dissertation presents the significant differences in the housing demand between the subgroups.

First, the effect of family structure on tenure choice and housing consumption is very significant. Single person and single parent households are less likely to own their house, while couples with children are likely to consume more housing. Second, the location of households affects tenure choice significantly. The households living in the center of a big city are less likely to own than the households living small urban and rural areas. Third, each family structure has different income and price elasticities of housing demand. Single parent households are more responsive to change in income and less responsive to change in price compared to other types of households. Single person household has relatively high price elasticity.

Chapter 1

Introduction

Housing is the consumption good which consists of the largest portion of the average household budget. The average housing expenditure of households in the U.S. consists of more than thirty percent of the total expenditure and more than one quarter of total household income according to Consumer Expenditure Survey data. [1] Thus, many economists have regarded the question of what factors affect housing demand as an important issue. To solve this question, they have attempted to construct a general model for housing demand over the whole population.

The main determinants of housing demand considered in the previous housing studies models are income and price. Polinky and Ellwood (1979) show the difference of income and price elasticities from micro data and grouped data, and Harmon (1988) shows that income elasticity varies at different income measures. Henderson and Ioannides (1986) show that housing demand is income-inelastic and price-elastic. Follain and Jimenez (1985) and Gross (1988) analyze income and price elasticity for specific house characteristics. Zabel (2004) shows that income and price elasticity of housing demand change with different concepts of housing demand.

However, these previous studies usually present the estimates of price and income

[1] Average annual expenditures of all consumer units(2003-2005)

Items	Income	Total Expenditures	Main expenditures				
			Food	housing	transportation	Health care	Education
2003	$51,128	40,817	5,340	13,432	7,781	2,416	783
2004	$54,453	43,395	5,781	13,918	7,801	2,574	905
2005	$58,712	46,409	5,931	15,167	8,344	2,664	940

Source : Consumer Expenditure Survey, 2005, U.S. Bureau of Labor Statistics

elasticities for housing demand over the whole population. Even if they derive the accurate income and price elasticities of housing demand, they have overlooked the existence of meaningful differences in the demand of housing services between the whole population and subgroups within the population.

On the other hand, some demographic factors have been included in the housing model to reflect consumers' preferences. Mayo (1981) presents that demographic variables have been poorly integrated in housing demand models and appear to have significant impacts on demand. Since Mayo's paper, many papers have included demographic variables such as age, race, education, marriage and household size. However, the demographic factors used in the housing model vary by author. For example, Rapaport (1997) introduces spouse, sex, immigrant, white and education variables while Ioannides et al. (2003) present race, education, marital status and household size as independent variables that affect housing demand.

Even if the previous studies have included various demographic factors, only a few papers include family structure variables in the housing model. Ermisch (1996) shows that households with children have higher housing consumption than other types of households. Ras et al (2005) also introduce family structure in their housing model and find that single person [2]and single parent households consume less housing than other households. Coulson et al (2003) state that homeownership is highest in rural areas, while non-metropolitan urban areas have the lowest probabilities of homeownership.

Overall, many papers have not considered residential area characteristics in the housing model. Only a few papers include regional factors in the housing model. Ermisch

[2] Single person household is a household which includes single male or single female with no other family members.

(1996) includes city region in the housing model and Ioannides and Zabel (2003) consider regional factors by using the mean of housing demand in neighborhood clusters.[3] Recently, Cho et al. (2005) show that while environmental variables affect housing demand in rural communities,[4] socio-economic variables significantly affect housing demand in urban communities.[5]

Based on these previous studies this paper attempts to analyze and quantify different responses of subpopulations for housing demand according to family structure and residential areas. These differences might have implications for developing and executing housing policy.

Therefore, this paper contributes to the existing literatures in the following ways.

First, this paper analyzes the effect of family structure along with other demographic factors on housing demand and tenure choice. Family is a unit that makes consumption choices and housing is the single largest expenditure item in the budget of family. Thus, family structure can have an effect on the demand of housing services. So, this paper might provide useful information for developing housing polices such as the tax treatment of owner-occupied housing and subsidies to renter households. Panel Study of Income Dynamics (PSID) [6]data are useful in analyzing family structure effects since it has the information for family structure as well as the previously mentioned demographic variables. Thus, this paper will use PSID survey data for 2003.

[3] This paper models housing demand for a group of neighbors by using micro data from selected sub-samples of the national sample of the American Housing Survey. The sub-samples are referred to as kernels for neighborhood clusters.
[4] Environmental variables are distance to lake, air pollution level, and open space index.
[5] Socio-economic variables are income, population density, crime rate, and education.
[6] PSID is a longitudinal survey of a representative sample of U.S. individuals and families which have been executed at Survey Research Center, University of Michigan since 1968. It includes a variety of information about income, employment, housing, health, wealth and retirement plans.

Second, this paper analyzes the effect of residential area on tenure choice and housing demand. Many studies of housing demand have not considered regional differences in housing demand. By considering different demand patterns by residential area, this study attempts to provide helpful information to set up housing policy. PSID data also provides valuable information for residential characteristics.

Third, this paper analyzes how responsive households are to changes of income and prices with regard to their family structure. As mentioned above, most existing papers on housing demand provide income and price elasticity measures and try to provide accurate income and price elasticities for all households. This paper will analyze the differences of income and price elasticities between family structures.

This study also compares the effects of other demographic variables on the housing model with existing studies. I include variables pertaining to age, education, race and migration.

My approach to modeling housing decisions in this paper resembles the methodology of recent studies. A household's choice of tenure and its demand for housing services is a joint decision. We construct a model in which both discrete and continuous decisions are derived from utility maximization framework.

The structure of this paper is as follows. Chapter 2 reviews existing empirical studies. Chapter 3 provides the empirical framework of this paper with the description of the data used. An econometric model for both tenure and demand decisions is proposed. Chapter 4 presents the results of the empirical tests and is divided into four parts. The first part shows the regression results of hedonic house price equations. The second part

documents the results of family structure and residential effects on tenure choice. The third part presents the results of family structure effects on housing demand. The fourth part examines the price and income elasticities of each family structure on housing demand and compares them with the income and price elasticity of the whole population. Chapter 5 presents the summary and conclusion of the paper.

Chapter 2

Literature Review

Booms in housing prices across many countries have resulted in several economic studies on housing markets, especially explaining the causes that affect housing demand.[7] In this chapter, I review previous studies which are distributed into three categories. First, I analyze studies of the measures of house price indices and the determinants of hedonic house price indices. The second section reviews the theoretical and empirical studies on tenure choice decisions. The final section reviews papers which analyze the effect of income and price on housing demand. In each section, various studies are presented and the data and methodology used will be provided.

1. House Price Index

1.1. The measures of the house price index

When consumers of housing make a decision or economists model housing markets, they consider information on house prices as a crucial factor. Thus, on accurate measure of housing prices is an important starting point for housing studies. House price indices can be measured in several ways. The several index methods have different characteristics in consideration of quality of the house and the selection process of representative samples for the population.

The simplest measure of a house price index is to find the median sales price. The

[7] Rodda et al. (2005) state that the nominal house price rose 7.7 percent annually from 2001-2003 in the U.S., while disposable income increased by only 3.4 percent.

National Association of Realtors (NAR) provides median prices of the existing home sales since 1981. To calculate median sales price, the NAR collects pending home sales data from Multiple Listing Service (MLS[8]).

When a seller accepts a sales contract on a property, Multiple Listing Service records it as a "pending home sale." The NAR receives data from over 100 MLSs and 60 large brokers during a month or quarter, covering 50% of the EHS [9]sample. Then, the median value is calculated by using the transaction data. One of the advantages of this measure is to collect small amount of information from various geographical areas. Another advantage is the ability to calculate the actual levels and changes of house prices in nominal values. The disadvantage of this index is that it does not to allow for changes in house quality; the median sales price is not appropriate to use as a measure of appreciation because the quality of the houses sold may change each year.

To correct the deficiencies of the median sales method the following two methods are used. First, some studies use data on houses that have been traded more than once for a given period. The repeat sales method assumes that the quality of houses in the sample should be constant over time. This method also requires small amount of information. It does not require characteristics of the repeated sale houses, only the sales prices. However, by only using repeated sales prices, this method abandons some collectable data when calculating the index. The data on non-repeated sales samples are not used in this method. Another disadvantage of this measure is that repeated sales samples might not represent the population. In this case, the house price index is biased. Case and Shiller

[8] When a seller accepts a sales contract on a property, it is recorded by a Multiple Listing Service as a pending home sale. The majority of pending home sales become home sale transactions one or two months later

[9] Existing home sales

(1987) propose a weighted repeated sales method to construct indices of existing home prices and show that it is a good index of appreciation in single family home prices.

The second method is hedonic price indices. The hedonic approach requires much information on the characteristics of the houses. The house value is regressed by a set of structure characteristics and neighborhood characteristics. A separate regression is run on data in each period. The estimates can be used to calculate the price of a standard house by time and location. The hedonic price equation is not decided by economic theory; thus the various model specifications depend on the data. The accuracy of the hedonic approach depends on the specifications; so the hedonic data should include variables that reflect the real quality of the houses. If the hedonic equation fails to reflect the quality of the houses, the hedonic method may not be a good measure. In reality, many studies try to adopt all factors that are available in the data set. The independent variables in the regression model are arbitrary. Rosen (1974) introduces the hedonic price method to break down the house value by its attributes. Thibodeau (1995) shows an example of the hedonic approach using American Housing Survey (AHS) data at both national and metropolitan levels[10].

Another approach to improve existing house price index methods is the Hybrid method. The main problem in this method is its difficulty to get the appropriate data. Gatzlaff and Ling (1994) attempt an assessed-value technique by using the samples excluded in the repeat sales method. They use single sale houses using an assessed value,[11] which comes from property tax records**.**

[10] The AHS conducts a national survey and a metropolitan area survey. The national survey gathers information on housing throughout the country every 2 years; the metropolitan area survey consists of 47 metropolitan areas and collects data about metropolitan areas on even numbered years.

[11] The assessed value is constructed by substituting the local tax assessor's opinion of value for the most

Kiel and Zabel (1997) compare the repeat sales, hedonic, and hybrid house price method by using the AHS data form 1978 to 1991. They find that the significant differences in housing price indices existed between the full sample and the sub-sample sold. They also present that self-reported information on the neighborhood in the AHS data causes a problem in deriving housing price estimates.

1.2. The Determinants of Hedonic House Price Index

The U.S. Census Bureau provides house prices by using the hedonic house price method.[12] The house prices are regressed by 10 attributes; number of bathrooms, floor area, land area, number of stories, air-conditioning, presence of a fireplace, type of parking, type of foundation, geographic location, and proximity to a metropolitan area.

Thibodeau (1995) presents a hedonic house price index using data from the 44 metropolitan statistical areas (MSAs) surveyed in American Housing Survey (AHS) for 1984 to 1992. He regresses the log of house value on a linear combination of housing structure and neighborhood characteristics for specified owner-occupied[13] and renter occupied[14] housing. His dependent variable for the owner-occupied equation is usually the log of the owner's estimate of the market value of the house. In his regression the structural variables are the number of rooms, number of units in the structure, dwelling age, the presence of garage or a basement, and type of heating or air conditioning. He also uses quality variables which are available in AHS data. Dwelling quality variables

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recent sales price.

[12] This is used by the Census's Constant Quality C-27 Series (now part of the C-25).

[13] A specified owner-occupied unit is a single family dwelling on less than 10 acres with no commercial, medical, or dental offices on the property.

[14] The specified renter-occupied category excludes single-family dwellings on 10 acres or more.

include the presence of structural defects and frequency of equipment breakdowns. Neighborhood quality is measured by resident's opinion of the neighborhood and whether the resident recently observed rats in the building. In addition he includes race[15] of household head and contract conditions.

Following Thibodeau (1995) for independent variables in the hedonic house price equation, Rodda et al. (2005) present an analysis of house price trends using the AHS data from 1985-2003. Trends include demographic characteristics of the occupants including race and household size.

[15] The race of the household head functions as a proxy for neighborhood conditions.

2. Tenure Choice Decision

2.1. Theoretical approach

Housing has different characteristics than common goods. Housing is durable because consumers buy houses and generally hold them for several years. Housing is consumption good. Households get utility by consuming housing units in the rental housing market. On the other hand, housing units are regarded as a capital investment which is traded in the housing capital market. With a perfect housing market households are indifferent between rental housing and owner-occupied housing. However, there exist some factors that distort the housing market in real world. For example, consumers may include housing assets in their wealth portfolio due to uncertainty or institutional factors. For example, in the U.S. homeownership is subsidized by the federal government through deductibility of mortgage interest from income taxes. The federal government also does not include implicit rent income for homeowners when it levies the income tax. This tax policy enables the households to own more housing than the optimal level. Therefore, households make a decision on whether they own their house or rent by comparing their satisfaction from renting with that from owning.

2.2. Empirical Approaches

A. Econometric Model

The basic tenure choice model is proposed by Lee and Trost (1978). They estimate a housing expenditure model which takes into account the simultaneous tenure

determination.

Goodman (1981) considers a tenure choice equation which is a function of relative price γ, value-rent ratio, ψ, income, and age.

$$Q_0 = Q_0(P_0, \psi, Y, A) \quad and$$

$$Q_r = Q_r(P_r, \psi, Y, A)$$

Based on these equations the probability of owning is:

$$f = f(\gamma, \psi, Y, A)$$

Coulson et al. (2003) considers a similar model to Goodman (1981). The choice between owning and renting is assumed to be decided by a set of observable and unobservable characteristics of household and the prices of the alternative. Then standard utility model is as the following, assuming a fixed housing supply.

$$U_i^o = \alpha_0 + \alpha_1 X_i + \alpha_2 \log(P_i) + v_i \quad and$$

$$U_i^r = \beta_0 + \beta_1 X_i + \beta_2 \log(R_i) + w_i$$

where *o* represents ownership, *r* rental, *i* indexes individual household, X is a vector of individual and household characteristics, and P and R refer to prices of owning or renting a housing unit. The two residuals are individual random noises in the utility model.

$$\begin{aligned} T_i &= U_i^o - U_i^r \\ &= \gamma_0 + \gamma_1 X_i + \gamma_2 \log(P_i / R_i) + \varepsilon_i \end{aligned}$$

Where γ_0 *and* γ_1 are defined as the difference between the parameters in the owner and rental utility equations. γ_2 is the marginal utility of the foregone dollar of housing expenditure and the new error term is defined as the difference between the two

previous error terms. The household decide to own a house if T_i >0; otherwise, it rents.

Most studies in the literature of tenure choice start from this type of basic utility function.

According to Rosen (1979) the index which household chooses owning rather than renting is approximated by:

$$I_j = \gamma_0 + \gamma_1 \log(Y_j) + \gamma_2 \log(P_{0j} / P_{xj}) + \gamma_3 (\log P_{rj} / P_{xj}) + \sum_{i=1}^{m} \gamma_{3+i} Z_{ij}$$

where P_{0j} is the net price of housing services generated by owner-occupied housing, P_{rj} is the price of renting, P_{xj} is the price of all other goods, and Y_j is real income.

Goodman (1981) proposes a model as follows:

$$f_i = \gamma_0 + \gamma_1 income_i + \gamma_2 (P_0 / P_r) + \gamma_3 (value\, rent\, ratio) + \gamma_4 D_i + \varepsilon_i$$

where f_i is tenure choice, income_i is total family income, P_o / P_r is price-rent ratio, and D_i is a demographic factor.

Ermisch (1996) introduces the following model for tenure choice.

$$T_i = \beta_0 + \beta_1 \log(I_i) + \beta_2 (age_i) + \beta_3 (age_i)^2 + \beta_4 H_i + \beta_5 C_i + \beta_6 R_i + U_i$$

where I_i is income, C_i is a vector of dichotomous variables for region, R_i is the rent and U_i is an error term.

Coulson et al. (2003) suggest a model as follows:

$$T_i = \gamma_0 + \gamma_1 \log income_i + \gamma_2 \log(P_i / R_i) + \gamma_3 D_i + \gamma_4 R_i + \varepsilon_i$$

Where T_i is tenure choice, logincome_i is the natural log of family income,

$\log P_i / R_i$ is the log price-rent ratio, D_i is a demographic factor and R_i comprises regional variables.

Boersch-Supan and Pitkin (1988) estimate the choice between three types of homeownership[16], five types of rented housing,[17] and shared housing.

Bajari and Kahn[18] (2005) include price of ownership and various demographic variables in their tenure equation such as age, education, race, household size, sex, and marital status.

B. Empirical Results

Many studies on tenure choice focus on the dual characteristics of housing as consumption and investment good.

Lee and Trost (1978) introduce income and a variety of demographic variables in the tenure choice equation. Their study is one of the earliest studies to show the effect of demographic variables on tenure. They conclude that family size and income are significant and positive, indicating that old head and high income families are more likely to own than rent. They also show a negative impact of female, black, and mover on tenure. Distance from the center of the city is shown to have a positive impact on tenure choice.

Rosen (1979) suggests that high income and families whose head is older are more likely to own. He also estimates the effect of relative price on tenure choice, concluding that a higher price decreases the probability of owning.

[16] The ownership for a single family house is divided by the number of the rooms.
[17] The rental is divided into five types by the number of the rooms and the dwelling type.
[18] They present the estimates of the demand for owning in Chicago, Atlanta, and Dallas as well as the estimates of the demand for physical housing attributes and housing type.

Another study on tenure choice is conducted by Coulson et al. (2003), which justifies tax subsidies[19] on owner housing by providing a significant external benefit of homeownership. They show that a higher ownership rate in neighborhoods brings about higher house prices within the neighborhoods. Like other studies they find age of household head and income to be significant and positively correlated with probability of owning. The results also show that black household heads are 3.6% less likely to be owners and education has a significantly positive effect on tenure choice.

Bajari and Kahn (2005) present estimates of demographic variables on the demand for owning normalizing the price coefficient to equal -1. They present that household income, age, and household size increase willingness to pay for owning.

[19] The U.S. federal government subsidizes homeownership by excluding implicit rent and deducting mortgage interest from income tax.

3. Housing Demand Decision

3.1. Theoretical Approach

Despite various models related to the determinants of housing demand, housing economists still have difficulty analyzing housing demand accurately. The usual economic theory for analyzing housing decisions assumes that consumers optimize their utility with respect to different goods and services, including housing. To advance our understanding of housing consumption decisions the housing models have tried to introduce a more accurate analysis of the impact of demographic factors on housing demand. Smith et al. (1988) and Follain and Jimenez[20] (1985) state that the incorporation of information about consumer attitudes and preferences into economic models of housing demand is critical to reducing the effect of unexplained factors in housing consumption behavior.

3.2. Empirical Approach

A. Categories of empirical literatures

According to Rothenberg et al (2000) the studies for housing demand can be categorized into several groups such as the demand for housing services, the individual attributes of the housing services, the demand for owner occupancy and spatial allocation of households.

The demand for housing services is modeled as continuous housing expenditures

[20] They propose that the theoretical basis for housing demand is sound but the econometric procedures need to be developed.

on price, income, and demographic variables. This method is beneficial to estimating income and price elasticity of housing demand. Many studies followed this approach: Polinky and Ellwood (1979) attempt to reconcile the disparity between the estimates of income and price elasticity based on micro data and those on aggregate data,[21] and Harmon (1988) tries to analyze the elasticity with current income and permanent income.

The second approach starts from the housing demand for specific house characteristics instead of the flow of housing services. This approach focuses on the demand of particular housing attributes and neighborhood characteristics. Goldstein and Pauly (1981) show how valid typical cross sectional demand estimations are when migration among jurisdictions is taken into account. They state that if a full Tiebout [22]equilibrium has been achieved in a set of communities, there is a good way to estimate demands for local public goods. Gross (1988) uses a similar bid-rent model[23], which reflects the maximum amount that a household would pay for a given unit of housing services, to estimate households' willingness to pay for housing attributes. He estimates the willingness to pay for marginal changes in various housing attribute levels, the corresponding housing demand prices and the probability of occupancy by different household groups.

The third approach, which has been given a lot of attention in the housing literature, considers the joint decision of housing quantity and tenure. Goodman (1988) and Rapaport (1997) consider significant simultaneity between tenure choice and housing demand decisions and Boersch-Supan and Pollakowski (1990) estimate a discrete choice

[21] The BLS metropolitan housing price index is used as aggregate data.
[22] Tiebout system is the mechanism is a process of sorting by costless moving from a house in community to a house in another place.
[23] This paper uses the bid-rent model developed by B. Ellickson.

model of the housing tenure choice and size. Haruin and Lee (1989) concentrate on the portfolio choice aspects of housing demand by estimating a structural model of the demand for owner-occupied housing. They construct the model in which the amount of housing and the length of stay in the house are chosen simultaneously. Recently, Ras et al (2005) and Cho et al (2005) follow this approach.

The fourth approach is to analyze how various households make a decision over different space and housing types. This includes applications of the random utility model. McFadden (1977) constructs a choice model of housing location in which rational consumers weigh the attributes of each available alternative, such as accessibility of workplace, shopping, and schools. His paper may be regarded as a seminal paper for this approach. Quigley (1985) considers the household choice of dwelling which involves comparison of the house characteristics, the selection of neighborhood and the accessibility to the planned work place. Bayer et al (2002) permit more flexible characterization of preferences for many housing and neighborhood attributes based on the discrete choice framework developed by Mcfadden (1977). Bajari and Kahn (2005) estimate willingness to pay for housing attributes such as rooms, owning, and single detached housing.

B. Econometric model

Harmon (1988) provides an empirical model for estimating the income elasticity of housing demand, as shown below. In this model, permanent income is estimated by different measures such as the group median income[24], weighted average of income, and lagged income:

[24] The median income of observations grouped by income class is used.

$$\log(H / P_a) = b_0 + b_1 \log(Y_p / P_a) + b_2 \log(p_{th} / P_{nh}) + b_3 \log age + b4 \log children + b5\, female + b_6 race$$

where the dependent variable is the owner's estimate of the market value of the family house (H) deflated by a regional price index for all items (P_a). The first explanatory variable is permanent income divided by the regional price index. P_{th} / P_{nh} is the relative net tax price of housing. Age, children, female are demographic variables.

In a similar way, Ioannides and Zabel (2003) present a behavior model for estimating neighborhood effects on housing demand. The individual's utility function is

$$U_h = U(C_h, y_h, z_h, y_{n(i)}, z_{n(i)})$$

In this model individual utility depends on non-housing consumption, C_h, consumption of housing services y_h, personal demographic characteristics that might affect preferences, z_h, the vectors of housing consumptions in the neighborhood, $y_{n(i)}$, and on the observable socioeconomic characteristics of neighborhood, $z_{n(i)}$.

They use the following housing demand equation:

$$\ln y_{ikh} = a + \mu \ln p_k + \xi \ln z_h + \delta \ln I_h + \beta \prod_y (\ln y_{n(i)}) + \gamma \prod_z (z_{n(i)}) + v_k + \varepsilon_{ik}$$

where v_k is an unobservable cluster random effect and ε_{kh} is an unobservable random variable.

Zabel (2004) constructs a basic regression from a similar individual utility function to Ioannides and Zabel (2003). The housing demand equation is specified as follows:

$$\ln H_i = \beta_0 + \beta_1 \ln p + \beta_2 \ln y_i + \beta_3 \ln Z_i + \varepsilon_i$$

where H_i is housing services, P is the price of a unit of housing services, y_i is income and Z_i captures demographic characteristics.

From this equation, Zabel (2004) attempts to decompose housing services into structure and neighborhood demand.

Gross (1988) constructs the housing demand model from a bid-rent function that reflects the household's bid for dwelling, which is in fixed supply. His bid-rend function is as follows.

$$B_i = B(z_1, z_2, z_3, ..., z_n; y, p_x, s, U^0)$$

where U^0 is the minimum level of utility that a household seeks to achieve, y is the household income, z is the level of attribute, p_x is the price of all nonhousing goods, and s is a vector of household characteristics. By assuming that households can be grouped into homogenous types based on y, s, and U^0 , the bid-rent function for a household *i* and type *t* can be written as

$$B_{ti} = b_t(Z) + \varepsilon_{ti}$$

where b_t (Z) is the valuation that a household of type *t* assigns the bundle of housing attributes and ε_{ti} is the error term. Since the highest bidder is the occupant of the dwelling the probability of winning is

$P(t/Z) = P(B_t > B_{t'}) = P(b_t(Z) + \varepsilon_t) > (b_{t'}(Z) + \varepsilon_{t'})$ for all $t \neq t'; t, t' \in T$, the number of household groups in the sample.

From this probability function the following maximum likelihood function is derived:

$$\ln L = \sum_{t=1}^{t} \sum_{h=1}^{H} f_{th} \ln P(t, R^* / Z_h)$$

where f_{th} is equal to 1 if dwelling *h* is occupied by a type *t* household and zero otherwise. *H* is the number of dwellings in the sample. The estimates can be obtained through maximizing the above function. The bid-rent function in his empirical model follows the form:

$$\ln \text{Re}nt = a_0 + a_1 \ln rooms + ... + a_7 \ln toillet + \varepsilon$$

Rapaport (1997) and Cho et al (2005) provide an empirical model for estimating housing demand as below.

A simple indirect utility function for household *i* living in community j is

$$V_{ij} = V(P_{hj}, t_j, P_x, Y_i, X_i, Z_j, \varepsilon_{ij})$$

where P_{hj} is the price of a unit of housing services in community j, t_j is the statutory property tax rate, P_x is the price of the composite good, Y_i is income, X_i is a vector of household characteristics that are independent of the choice of community/tenure, Z_j is a vector of local public goods and other community characteristics and ε_{ij} contains unobservable characteristics that vary by households and communities. The probability that household *i* chooses community/tenure status j is

$$\pi_{ij} = prob\{V(P_{hj}, t_j, P_x, Y_i, X_i, Z_j, \varepsilon_{ij}) > V(P_{hk}, t_k, P_x, Y_i, X_i, Z_k, \varepsilon_{ik})$$

The commonly estimated constant elasticity demand for owner-occupied housing is

$$\ln H_{ij} = -\alpha \ln((1 + t_j)P_{hj}) + \beta \ln Y_i + X_i \delta + \eta_{ij}.$$

In this model, H_{ij} is the quantity of housing consumed by household *i* in community *j*, Y_i is the household income and X_i is defined as a vector of household characteristics.

η_{ij} contains household specific unobservable variables such as household *i*'s taste for open space.

The estimated housing demand equation for reflecting selection equation is transformed by

$$\ln H_{ij} = -\alpha \ln((1+t_j)P_{hj}) + \beta \ln Y_i + X_i\delta + \lambda_0 \frac{f(I_i)}{F(I_i)} + \xi_i$$

Where I_i is derived from the probability equation and f(.) and F(.) are the normal density and cumulative distribution functions respectively.

Bajari et al (2005) construct a model by considering the housing price and utility function.

A simple price equation of the housing units can be expressed as follows.

$$p_J = p_m(x_j, \xi j)$$

where p_J is the price of the housing unit j, p_m is a function which maps the characteristics of a housing unit, x_j represents observable housing characteristics and ξj is the unobserved housing characteristics. The household utility function is a combination of housing characteristics and consumption of a composite commodity *c*. The utility that consumer *i* receives for product *j* can be written as

$$u_{ij} = u_i(x_j, \xi j, c).$$

Then, they model the choice of housing as a static problem. The first order condition for this utility function corresponds to the implicit rent value of housing if there are no cost adjustments. The utility function is interpreted as the household utility from the flow of housing services.

Product $j^*(i)$ is utility maximizing for household i if

$$j^*(i) = \arg\max_j u_i(x_j, \xi j, y_i - p_m(x_j, \xi j)).$$

The budget constraint equation is substituted into the above equation and the following first order condition should hold when x_{j^*} is utility maximizing for household *i.*

$$\frac{\partial u_i(x_{j^*}, \xi j, y_i - p_{j^*}) / \partial x_{j,k}}{\partial u_i(x_{j^*}, \xi j, y_i - p_{j^*}) / \partial x_c} = \frac{\partial p_m(x_j, \xi j)}{\partial x_{j,k}}$$

where k is product characteristic and $x_{j,k}$ is a continuous variable. This equation explains that the marginal rate of substitution between a continuous characteristic and the composite commodity is equal to the partial derivative of the hedonic house price equation.

From this equation, Bajari and Kahn (2005) construct the following specification for consumer preferences:

$$u_{ij} = \beta_{i1}\log(room_j) + \beta_{i2}\log(age_j) + \beta_{i3}\log(\xi_j) + \beta_{i4}\log(own_j) + \beta_{i5}\log(\sin gle_j) + \beta_{i6}\log(mblack_j) + \beta_{i7}\log(mba_j) + \beta_{i8}\log(city_j) + c$$

$$where\ \beta_{i,k} = f_k(d_i) + \eta_{i,k}$$

herefore, utility is estimated as a function of the number of rooms (room), the age of the unit (age), the value of the characteristics of housing unit *j* seen to the consumer, ownership dummy (own), single detached dwelling (single), the percentage of black households (mblack), the percentage of college-educated households (mba), the center of the city dummy (city), and composite good(c). d_i is demographic characteristics, and $\eta_{i,k}$ is an orthogonal household-specific residual.

C. Empirical Results

Due to different definitions of housing demand, studies are difficult to directly compare. For example, different concepts of housing demand result in a variety of income and price elasticities of housing demand. So, empirical results are presented in this part according to the four categories which are mentioned before.

(1) The demand for housing services

Many studies follow this basic approach because it is very useful to derive income and price elasticity of housing demand.

Polinky and Ellwood (1979) show that model specification errors can explain the reason why the estimates from the micro data and grouped data are different using Federal Housing Administration's (FHA)[25] household level data. They also use general price indexes from the Bureau of Labor Statistics' urban family budget survey over the period 1968-1982. They suggest that the micro price elasticity estimate is very sensitive to model specification errors, while the grouped price elasticity estimate is less sensitive to the individual specification errors. They present that with some specification errors the average income elasticity of micro data is 0.42 but the average grouped income elasticity is 0.74. However, if model specification errors are corrected, the difference between the micro and grouped income elasticity reduces to 0.39 and 0.57, respectively.

Harmon (1988) shows that the estimation of linear expenditure systems based on individual utility functions makes it easy to compare elasticities that vary at different income measures. He concludes that housing demand elasticity of income is less than one in the short run due to the presence of significant transaction costs, but it is approximately

[25] FHA is a United States government agency created as part of the National Housing Act of 1934. http://www.fha.gov

one in the long run.

Ioannides and Zabel (2003) examine the effect of neighborhood on housing demand by using the data of the American Housing Survey. They show that the elasticity of housing demand with respect to the mean of the neighbors' housing demands is very significant and it ranges from 0.19 to 0.66. The elasticity with respect to neighbors' mean income is also significant and it ranges from 0.17 to 0.54.

Zabel (2004) estimates the different models of housing demand assuming that housing demand is decomposed into structure and neighborhood or comes from only structure. He shows that income elasticity of housing demand changes form 0.36 to 0.39 under the former assumption, and price elasticity ranges from -0.052 to -0.091. Under the latter assumption, the income elasticity ranges from 0.27 to 0.43 and price elasticity ranges from -0.353 to -0.505, which is relatively large.

(2) The individual attributes of the housing services

Follain and Jimenez (1985) is comparable to many empirical studies that have analyzed income and price elasticity for specific house characteristic such as size, rooms, dwelling unit type, and quality. According their paper the income elasticity for rooms and house size is inelastic, and income elasticity for quality is elastic.

Gross (1988) tests the estimation of willingness to pay for housing characteristics by using survey data which is executed by the City Study in Colombia. He shows that the bid-rent model is efficient in the estimation of the demand for housing attributes.

(3) The demand for owner occupancy

Henderson and Ioannides (1986) take into account the simultaneous decision of how much to spend and whether or not to own or rent, in order to estimate the effect of income and price on housing demand. They assume the same utility function for both discrete and continuous decisions. They show that housing demand is income inelastic and price elastic. Lower education, age, and income reduce the probability of owning.

Goodman (1988) estimates the determinants of housing price, permanent income, tenure choice, and housing demand by using the data from the American Housing Survey. He uses the house value to rent ratio[26] to consider the characteristics of housing as consumption good and investment capital in the tenure choice equation. He shows that the value to rent ratio has a significant and positive effect. Also, demographic variables increase the explanatory power of the model. According to his study, income elasticity of housing demand ranges from 0.173 to 0.206 and price elasticity ranges from -0.450 to -0.499. In addition, household size and black affect housing demand negatively.

Horioka (1988) reports an empirical analysis of tenure and housing demand by using household level data from Japan. According to his study, the price and income elasticities of housing demand are about -0.8 and 1.4, respectively. He proposes that the reason why the income elasticity is much higher than other studies' estimates is due to the accurate income variable. He notes that the positive effect of income result from the characteristic of housing as normal good and the reduction of risk aversion with income, and imperfect financial markets.

Boersch-Supan et al (1990) present that under panel data, the estimates of age and price on housing demand are different from the estimates gained from using cross sectional data. According to their study, age and household size have positive effects and

[26] High house value-rent ratio indicates that owning is more attractive from an investment point.

price has a negative effect.

Rapaport (1997) reflects simultaneous choice of the neighborhood as well as tenure choice and the quantity of housing services in his model. He shows that the consideration of community increases the estimated price elasticity and the racial differential between black and white diminishes when comparing to the tenure-corrected estimates. That is, the price elasticity changes from -0.79 to -1.63, and the coefficient of the white dummy variable falls from 0.41 to 0.33.

Ermisch (1996) estimates income, price, and age effect on housing demand with the data from the Joseph Rowntreee Foundation (JRF)[27] Housing Finance Survey in Britain. He shows that income and price elasticities are -0.4 and 0.5, respectively and age has a very positive effect on housing demand. He also finds that the households with two or more children have more housing consumption than other types of household.

Ras et al (2005) investigate the housing demand in the Netherlands with data from the Housing Needs Survey. Their main concern is the estimation of price and income effects on housing demand. They find that income and price elasticities are 1.60 and -0.44, respectively, and a single person and single parent household consume less housing than other households. He also suggests that physical disabilities and bad health are negatively correlated with the housing consumption, while age has a positive effect.

Cho et al (2005) estimate a housing demand model with community choice in the southern Appalachian region instead of tenure choice, using the data from the US Census, the FBI, and the EPA[28]. Under the assumption of distinct difference in the characteristics

[27] JRF is one of the largest social policy research and development charities in the U.K. http://www.jrf.org.uk

[28] This paper collects crime rate and pollution data from the Federal Bureau Investigation (FBI) and Environmental Protection Agency (EPA).

of community choices, they show that socio-economic variables such as housing value, income, population rate, and education significantly affect housing demand in urban communities, while environmental variables such as distance to lakes and levels of air pollution affect housing demand in rural communities.

(4) Spatial allocation of households.

Quigley (1985) uses the data from Southwestern Pennsylvania Regional Planning Commission to estimate housing choice of dwelling characteristics. He shows that housing choice sensitively depends on the accessibility to the work place in the owner-occupied housing market. That is, less travel time to the work place increase the probability of selecting a dwelling unit.

Bajari et al (2005) show why white people live in the suburbs, while black people live in the center area of the city by using data from the 1990 Census of Population and Housing Integrated Public Use Micro data Series (IPUMS)[29] in Atlanta, Chicago, and Dallas. He estimates household demand of white and black people for specific house structure, peers, and commuting place. According to their study, white people have stronger demand for the housing with many rooms and single detached housing, while blacks are willing to less pay for such housing. They state that the difference in income, education, and marriage rates between white and black contributes to the preference gap for physical housing. On the other hand, black people are likely to live in the center of the city because of the accessibility to the work place.

[29] IPUMS-CPS is a project dedicated to integrating and disseminating data from the Current Population Survey.

(5) Other studies

Halicilglu (2005) estimates aggregate new residential housing demand by using time series data from 1964 to 2004 in Turkey. His paper indicates that income has a very positive effect on aggregate demand for new housing, and proposes that aggregate housing demand can work as a policy tool in Turkey.

Chapter 3

Empirical Framework

1. Basic Framework

This paper estimates a joint housing demand model. This paper adopts the third approach mentioned in Chapter 2. This paper will try to analyze the effects of family structure and residential area on housing. To check the effects of family structure and residential area on tenure choice and housing demand, this paper uses data from Panel Study of Income Dynamics to regress on three dependent variables: house value, tenure choice, and housing demand.

The empirical framework of this paper consists of three parts.

First, the hedonic house price equation will be estimated to get a constant quality price of unit housing demand in each housing market. [30] As Thibodeau (1995) and Rodda et al. (2005) suggest, this paper regresses the log of house value on a linear combination of housing structure and neighborhood characteristics for owner-occupied housing, and includes demographic characteristics of the occupants including race and household size.

Second, the choice model between owning and renting proposed by Coulson et al (2003) and Ras et al (2005) will be estimated to analyze the effect of observable characteristics of household on tenure.

Third, housing demand for owners is analyzed with respect to all related factors such as income, price, family structure, and residential area, recognizing the interdependent tenure choice.

[30] The constant quality price is obtained by taking the average characteristics of housing structure and neighborhood characteristics.

2. Deriving Hedonic House Price Index

The econometric models for hedonic house price indides are based on the model specification as well described in Thibodeau (1995) and Rodda et al. (2005). The general form of the empirical model can be expressed as follows.

For each state, a separate house price equation is estimated. The hedonic house price equations include structure variables and neighborhood variables. These take the following form:

$$Log\ (H_{ij}) = Constant + \alpha_1(X_i) + \alpha_2(Y_i) + e_i \quad j=1, 2, \ldots j$$

where H_i is a house value, X_i is a vector of characteristics of the house structure, and Y_i is a vector of its neighborhood characteristics.

In this paper the actual empirical model is shown as following equation:

$$Log\ H_i = \alpha_0 + \alpha_1 NPROOM_i + \alpha_2 ROOM5MORE_i + \alpha_3 DETACHED_i + \alpha_4 AIRCON2_i$$
$$+ \alpha_5 GAS_i + \alpha_6 ELEC_i + \alpha_7 BIGMETRO + \alpha_8 BLACK_i$$

where H: House value

NPROOM : Number of people per room

ROOM5MORE: Dummy variable for the households who have 5 rooms or more

DETACHED: Dummy variable for households who live in one-family house

AIRCON2: Dummy variable for households who have air conditioners in all rooms

GAS: Dummy variable for households that are heated with gas

ELEC: Dummy variable for households that are heated with electricity

BIGMETRO: Dummy variable for households who live in the counties of Metropolitan areas[31]

BLACK[32]: Dummy variable for households whose head is black

After estimating the hedonic equations, the standard house price is constructed for a constant quality of house, which is defined in terms of average value for the structure variable and neighborhood variables. Then, a house price index for each state is induced by dividing its standard house price by the standard price of the reference state that is normalized to 100. The reference state is Arkansas.

[31] A Metropolitan Statistical Area is a city of at least fifty thousand people with a surrounding rural population.

[32] Thomas G. Thibodeau (1995) proposes that the race of a household head serves as a proxy for neighborhood.

3. Analyzing the Effects of Family Structure and Residential Area on Tenure Choice and Housing Demand

In this paper, the effects of family structure and residential area on tenure choice and housing demand will be analyzed. For this purpose, this paper will test how family structure and residential area affect housing and how responsive each family structure is to changes in income and price.

3.1. Model Specification

The two equations for tenure choice and housing consumption levels are estimated as follows.

First, the econometric models for tenure choice are based on the utility model as described in Goodman (1988). In this model, a representative household's optimizing behavior is to make a choice that maximizes expected utility. The empirical models for tenure choice are derived from this utility function. The general form of the empirical model can be expressed with some control variables as shown in Ermisch (1996) and Coulson et al. (2003).

$$T_i^* = \gamma_0 + \gamma_1 \log income_i + \gamma_2 \log(P_i / R_i) + \gamma_3 D_i + \gamma_4 R_i + \varepsilon_i$$

where T_i is tenure choice, $\log inocme_i$ is the natural log of total family income, $\log P_i / R_i$ is the log price-rent ratio, D_i is a demographic factor, and R_i represents regional variables. T_i^* is a continuous latent variable, indicating the underlying demand for owner-occupation such that when $T_i^*>0$, a household owns its house. Thus, the house value is observed if a household is an owner.

In this paper, I construct a new basic empirical model, adopting basic ideas from Ermisch (1996) and Coulson et al. (2003), which is shown below.

$$T_i = \alpha_0 + \alpha_1(lrprice_i) + \alpha_2 \log income_i + \alpha_3 age_t + \alpha_4 white_i + \alpha_5 hdhi_i$$
$$+ \alpha_6 moved_i + \alpha_7(Single_i) + \alpha_8(Singleparent)_i + \alpha_8 couplechi_i$$
$$+ \alpha_9 others_i + \alpha_{10} cen1m_i + \alpha_{11} fri1m_i + \alpha_{12} surban_i$$
$$+ \beta_{14} rural_i + \beta_H state_i + \xi_i \ .$$

This specification is similar to the form of Coulson et al. (2003). The estimation will be conducted using a cross sectional model by using the maximum likelihood method (MLE),[33]along with a housing demand equation.

Second, the econometric models for housing demand are based on the utility function of Goodman (1988), Rapaport (1997), Ras et al (2005), and Cho et al (2005). The estimated housing demand equation is changed into

$$\log HD_i = \beta_0 + \beta_1 lmch_i + \beta_2 \log income_i + \beta_3 age_t + \beta_4 white_i + \beta_5 hdhi_i$$
$$+ \alpha_6 moved_i + \alpha_7(Single_i) + \alpha_8(Singleparent)_i + \alpha_8 couplechi_i$$
$$+ \alpha_9 others_i + \alpha_{10} cen1m_i + \alpha_{11} fri1m_i + \alpha_{12} surban_i$$
$$+ \beta_{14} rural_i + \beta_H state_i + \xi_i \ .$$

This specification is similar to the tenure choice equation above. However, a user cost for owner-occupied housing is included as a price variable instead of the ratio of price to rent cost.

[33] MLE uses the estimates from the two-stage procedures as initial values to get consistent and asymptotically efficient estimates.

<Table 1> Descriptions of Main Variables

Variables	Description
T	Tenure choice
Log HD	Natural log of housing demand which is the house value divided by a regional house price index.
LRPRICE	Natural log of price to rent ratio
LMCH	Natural log of unit price of housing services
LOGINCOEME	Natural log of household income
AGE	Age of household head
WHITE	Dummy variable for the households whose head is white
HDHI	Dummy variable for the households whose heads have graduated from high school
MOVED	Dummy variable for the households who moved at prior year
SINGLE	Dummy variable for the households whose head is a single male or female with no family members
SINGLEPARENT	Dummy variable for the households whose head is a single parent with children
COUPLECHI	Dummy variable for the couples with children
OTEHRS	Dummy variable for other multi-person households without children
CEN1M	Dummy variable for the households living in the central counties of metropolitan areas of 1 million populations or more
FRI1M	Dummy variable for the households living in the fringe counties of metropolitan areas of 1 million populations or more
SURBAN	Dummy variable for the households living in the counties of urban population of less than 50 thousand
RURAL	Dummy variable for the households living in the rural areas
STATE	Dummy variables for 20 states

Third, this paper analyzes and quantifies income and price elasticities of subgroups divided by family structure. For this purpose interaction terms between income and price and the variables for subgroups are introduced in the housing model. The econometric model has the following specification:

$$Log\,HD_i = \beta_0 + \beta_1 lmch_i + \beta_2 \log income_i + \beta_3 age_t + \beta_4 white_i + \beta_5 hdhi_i + \alpha_6 moved_i$$
$$+ \alpha_8 (Single_i) + \alpha_9 (Singleparent)_i + \alpha_{10} couplechi_i + \alpha_{11} others_i + \alpha_{12} cen1m_i$$
$$+ \alpha_{13} fri1m_i + \alpha_{14} surban_i + \beta_{14} rural_i + \alpha_{15} (Singleinco_i) + \alpha_{16} (Singpainco_i)$$
$$+ \alpha_{17} (Cochiinco_i) + \alpha_{18} (Others\,inco_i) + \beta_{19} (Singlelmch_i) + +\alpha_{20} (Singpalmch_i)$$
$$+ \beta_{21} (Cochilmch_i) + \alpha_{22} (Otherslmch_i) + \beta_H state_i + \xi$$

<Table 2> Descriptions of Interaction Variables

Variables	Description
SINGLEINCO	Interaction variable between LOGINCOME and SINGLE
SINGPAINCO	Interaction variable between LOGINCOME and SINGLEPARENT
CHCHIINCO	Interaction variable between LOGINCOME and COUPLECHI
OTHERSINCO	Interaction variable between LOGINCOME and OTHERS
SINGLELMCH	Interaction variable between LOGINCOME and SINGLE
SINGPALMCH	Interaction variable between LMCH and SINGLEPARENT
COCHILMCH	Interaction variable between LMCH and COUPLECHI
OTHERSLMCH	Interaction variable between LMCH and OTHERS

3. 2. Variables and Hypothesis to Be Checked

The tenure choice and housing demand equation consists of the main explanatory variables: income, price, family structure, residential area, age, education, and other independent variables.

3.2.1. Tenure choice (Dependent Variable)

The tenure choice equation has been regarded as one housing demand measure and has received much attention in housing literature. Many studies on housing demand have attended to the relationship between tenure choice and housing demand decisions. Goodman (1988), Rapaport (1997), and Ras et al (2005) estimate housing demand equations considering tenure choice decisions. So, tenure choice plays an important role in housing demand equations. The choice of tenure is assumed to be a binary choice between owning and renting.

This paper focuses on analyzing the effects of family structure and residential area on tenure choice as well as the housing demand equation.

3.2.2. Housing demand (Dependent Variable)

The existing empirical studies on housing demand use housing value to calculate the amount of housing demand. The housing value is converted into the flow of housing services demanded. The flow of housing services from the housing unit is the ratio of the housing value divided by a regional house price index, which is derived from the hedonic house price equation in each region. This paper uses the house value reported by owners, which is the price owners expected to get if the house was sold. Kiel and Zabel (1999)

find that overall owners overestimated house value only by 5.1 percent[34].

Many studies including Harmon (1988), Rapaport (1997), and Zabel (2004) calculate the flow of housing demand by using self-reported housing values.

This paper will use the owner-reported house value that the PSID data provide to derive the flow of housing services.

3.2.3. Family Structure

One of the important purposes in this paper is to check the effect of family structure on housing demand and tenure choice. Although it is important to derive appropriate family structure variables from the whole household data, many papers have not considered such variables for analyzing housing. A few papers, however, introduce family structure variables. Ermisch (1996) includes family structure variables in his housing demand equation to estimate the demand for housing in Britain. He divides the whole household into nine family structures, which are single male, single female, lone mother, couple plus one child, couple plus two children, couple plus three or more children, more than two adults and no children, and more than two adults plus children. The estimates for family structure variables are significant in his tenure choice equation. Ras et al (2005) also introduce family structure variables as important factors for housing demand and tenure choice. Their division is simpler than Ermisch's (1996) family structure, including single man, single woman, couple with children, single parent family, and others. Ras et al (2005) present that family structure has a very significant impact on both housing demand and the tenure choice equation.

[34] They present that recent homeowners overestimate house values by 8.4 percent, and longer tenure owners overestimate by 3.3 percent.

This paper introduces similar family structure variables[35] to Ras et al's (2005).

Family structure effects can be shown to be different across countries, depending on data characteristics. However, family structure effects seem to play an important role for housing in every country. The following hypothesis will be tested.

H1-1: Single person and single parent household are less likely to own their house.

According to Ermisch (1996) and Ras et al (2005) single person and single parent households have lower probability of owning.

To compare the probability of owning of single person and single parent household this study uses childless couples as a reference.

H1-2: Couples with children are likely to consume more housing.

In previous studies, marriage and the number of children have positive effects on housing demand. Rapaport (1997) and Ioannides et al (2003) present that marriage and children have positive effects on housing demand. According to Ermisch (1996) and Ras et al (2005) couples with children have more housing consumption than other types of households.

H1-3: Each family structure has significantly different income and price elasticities on housing demand.

Based on the above hypotheses each family structure has different effects on

[35] Single man and single woman are combined into single person household.

housing demand and tenure choice. So, the income and price elasticity of each family structure might be different. To test the income and price elasticity of each family structure, this paper introduces interaction variables between family structure variables and income and price variables in the housing demand equation. This paper is interesting because many papers have not checked how different each family structure's responsiveness is to change of income and price.

3.2.4. Residential Area

In the literature for housing, some papers attempt to analyze regional effects on housing demand. Coulson et al (2003) state that non-metropolitan urban areas have the lowest probabilities of owning and homeownership is highest in rural areas. Thus, the residential area may affect tenure choice. This paper introduces few different regional variables from other papers by dividing the whole country into five categories to test the effect of residential area on tenure choice. Those categories are center of a big metropolitan city[36], fringe of a big metropolitan city, medium metropolitan city, small urban area, and rural area which the PSID data set provide. The following hypotheses will be tested.

H1-4: Households living in the center of a big city are less likely to own.

This paper assumes that households which live in the center of a big city have lower probability of owning.

H1-5: Households living in the small urban and rural areas are more likely to own.

[36] Big metropolitan city means an area of more than one million people with internal and social links.

This paper assumes that the households living in the small urban and rural areas are predicted to have higher probability of owning.

3.2.5. Other Independent Variables

Independent variables are selected among the variables that are generally used in housing demand models. Most of the papers such as Horioka (1988), Goodman (1988), Rapaport (1997) and Zabel use income and price as important variables that affect housing demand. On the other hand, many papers use demographic factors such as age, marriage, number of children, education, and household size in addition to income and price variables.

This paper will use income, price, and some demographic factors as independent variables in analyzing the effects of these variables on housing demand.

First, following other studies, household income will be used to derive income elasticity of housing demand in this paper.

Second, like Rapaport (1997), Zabel (2004) and Ras et al (2005), the price variable for the house demand equation will be derived from a hedonic house price equation. Although the price of owner-occupied housing is difficult to measure, this paper utilizes a user cost of capital approach, which is based on an analogy from the literature on the neoclassical theory of investment. The user cost of capital simplifies to following expression based on Hendershott and Shilling (1980), Horioka (1988), Rapaport (1997), and Ras et al. (2005).

$$P = [(1-t_y)\, i + [(1-t_y)\, t_p + k_s\, d - q]\, H$$

where t_y is the marginal income tax rate, i is the mortgage rate, t_p is the property tax rate,

k_s is the structure-to-value ratio (the ratio of the value of the structure to the total value of the investment), d is the rate of depreciation, q is the expected rate of increase in housing prices, and H is the unit price of owner-occupied housing. That is, the price of housing services is adjusted by mortgage rate, income tax rate, depreciation, and expected rate of increase in the housing price. The marginal income tax rate is assigned according to the taxable income of the household. The mortgage rate on a 30-year fixed mortgage is taken from the Mortgage Bankers Association Survey. The property tax rate is assumed to be 0.025 and the depreciation rate is fixed at 0.017. The structure-to-value ratio is assumed to be 0.83. The expected rate of house price is assumed to be the same as that of the last eight years.

Third, demographic factors such as age, education, migration, and race will be used as independent variables. Age of the household head and high school graduation status of the household head are used. The race of the household head is also included in the model. Migration is used as another independent variable. This paper will test the effect of these demographic variables and compare them with the results of previous studies.

H1-7 Age has a positive effect on tenure choice and housing demand.

Many studies including Rapaport (1997), Zabel (2004), and Ras et al (2005) present that age has a positive effect on housing demand, while Harmon(1988) and Goodman (1988) show that its effect is negative.

H1-8: Education has a positive effect on tenure choice and housing demand.

Rapaport (1997)[37], Ioannides et al (2003), and Zabel (2004) show that the effect of education on housing demand is positive.

H1-9: White has a positive effect on tenure choice and housing demand.

Rapaport (1997) and Ioannides et al (2003) show that white household head has a positive effect on housing demand.

[37] Rapaport (1997) uses the education variables for the schooling years, high school graduation, and college graduation of head and spouse.

4. Data Description

4. 1. Data Characteristics

To estimate the housing models mentioned, this paper needs the U.S. household-level data and some macro data such as interest rates, income tax rate, and house price indices to adjust the user cost of housing.

This paper uses the Panel Study of Income Dynamics (hereafter PSID) data for the empirical analysis of family structure and residential area effects. The PSID is conducted by The Institute for Social Research, University of Michigan. It is a longitudinal survey of a representative sample of U.S households since 1968. The survey uses a computer assisted telephone interview and is conducted every year from 1968 to 1996. After 1996 it was redesigned for biennial data collection. The survey includes household-level data for income, housing, regional characteristics, demographic factors such as age, family size, education, and other housing related data such as housing ownership status and housing types. Housing information includes dwelling type, number of rooms, air conditioning, type of heating, monthly payments, and homeownership. The PSID data provides a family weight variable to represent the corresponding United States population estimates. This paper reflects the family weight[38] variable in estimating all regression models.

I use cross sectional survey data from 7,822 units in 50 states for 2003. The analysis is restricted to states with enough owner-occupied samples to run basic hedonic house price regressions, because the hedonic regressions are necessary to analyze the demand of housing services. About 4,700 household samples are analyzed for this paper.

[38] The family weight is assigned to the average of the individual weight of all members.

A marginal income tax rate for each household is assigned based on 2003 Marginal Tax Brackets according to the taxable income of each household. To measure the expected increase of house price I use the house price index provided by the Office of Federal Housing Enterprise Oversight (OFHEO)[39] is used. The Mortgage Bankers Association provides the 30- year fixed mortgage rate.

4. 2. Description of important variables

In this section the description of the main variables of the paper will be presented. The main variables can be divided into three parts: family characteristics, housing characteristics, and residential characteristics.

(1) Family characteristics

Variables	Description
Number of Children	Number of persons in the household under 18 years of age
Head marital Status	1. Married 2. Widowed 3. Divorced 4. Separated
Number of family unit	Number of persons in household at the time of the 2003 interview
Age of head	Actual age of the 2003 head. Minimum value is usually 18.
Family type	1. Head is male with wife 2. Head is male with no wife 3. Head is female
Health status of head	1. Excellent, 2. Very good, 3. Good, 4. Fair, 5. Poor
Race of head	1. White 2. Black 3. Native American 4. Asian 5. Latino origin or descent 6.Others
Total family income	It includes taxable income, transfer income, and social security income. It can be a negative value.
Head and wife taxable income	Head's and wife's total taxable income. It can be a negative value.
Education of head and wife	Values in the range represent the actual grade of school completed.

[39] OFHEO's mission is to promote housing and a strong national housing finance system. It produces separate house price indexes for the 50 states and the District of Columbia.

(2) Housing Characteristics

This survey provides valuable information for housing characteristics.

Variables	Description
Dwelling type	1. One-family house 2. Two family house 3. Apartment 4. Mobile home 5. Row house 6. Other
Type of heating	1. Gas 2. Electricity 3. Oil 4. Wood 5. Coal 6. Solar 7. Bottled gas 8. Others
Actual number of rooms	Actual number of rooms the household has, excluding bathrooms
Own or Rent	Indicator for whether household owns a house or not.
House value	House value which household head expects to get when he sell the house in housing market.
Air conditioning	Indicator for whether household has air conditioning for all rooms or some rooms.

(3) Residential Characteristics

The variables for residential characteristics are as follows.

Variables	Description
Current state	It represents the state which the household lives in at the current time. This is expressed as FIPS state code. (1 to 56)
Current region	1. Northeast (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont) 2. North central (Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, Wisconsin) 3. South (Alabama, Arkansas, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Washington DC, West Virginia) 4. West (Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming)

Rural Urban Code		1. Central counties of the metropolitan areas of 1 million population or more 2. Fringe counties of the metropolitan areas of 1 million population or more 3. Counties in metropolitan areas of 250 thousand to 1 million.[40] 4. Counties in metropolitan areas of 50 thousand to 250 thousand. 5~8. Urban area 9~10. Rural area

4. 3. Summary of Original Data Statistics

In this section the survey data for 2003 is summarized for family characteristics and house characteristics.

First, family characteristics are presented. As shown in the Table 3, the mean of the number of household members is 2.71. For age of household head, the mean is 44.98 years for 2003. The average income is $56,424, and the average of head & wife taxable income is $51,966 in 2003. For marital status, the proportion of married household is 50.5%. For family type, the households, in which the head is male with wife consist of 54.9% of whole samples. For health status of the household, the household heads which maintain better than a very good condition consist of 55.5% of whole samples. For race, the proportion of white households is 58.6% in 2003.

Second, house characteristics are explained. The average number of rooms is 5.68. This excludes bathrooms. For type of heating, a gas heated house characterizes 55.7% of whole sample households. For the own or rent variable, the proportion of owner-occupied housing is 60.8%. For dwelling type, 66.4% of households live in one family houses in 2003.

[40] Rural Urban Code 3 and 4 are used as reference areas for analyzing the effects of other residential areas.

<Table 3> PSID Data Summary (2003)

Variables	Observation	Mean	Standard Deviation
(a) family characteristics			
. Number of Children	3545	1.89	0.98
. Number of family unit	7822	2.71	1.47
. Age of head	7821	44.98	15.97
. Total family income	7780	56,424	77,295
. Head and wife taxable Income	7065	51,966	79,041
. Head marital status	7822	. Married : 50.5%	
. Family type	7822	. Head is male with wife : 54.9%	
. Health status of head	7822	. Excellent or very good : 55.5%	
. Race of head	7822	. White : 58.6%	
(b) Housing characteristics			
. Actual number of rooms	7626	5.68	2.20
. Type of heating	7822	.Gas : 55.7%	
. Own/Rent	7822	. Own : 60.8%	
. Dwelling type	7822	. One family house : 66.4%	
. Rural Urban Code	7822	. Big city(1 million or more) : 42.0%	

Chapter 4

Empirical Results

In this chapter the empirical results of the paper are presented in four sections. The first section provides the regression results of hedonic house price equations. In the second part, the tenure choice equation is estimated for the whole cross sectional households. The impacts of family structure and residential area on tenure choice are captured with the impacts of income, price, and other demographic factors. The third part analyzes the impacts of family structure on housing demand. The last part provides the differences in the demand of housing between the whole population and subgroups within the population.

1. Hedonic House Price Indices

This section estimates the hedonic house price equation to get a house price index in each housing market. The hedonic house price equations are estimated for the states which have enough owner-occupied households to regress the hedonic equation. So, the house price indices are provided across the highest 20 states by the number of owner-occupied households. The regression model is based on Thibodeau (1995) and Rodda et al. (2005). It estimates the log of house value on a linear combination of structure and neighborhood characteristics. Ordinary least squares is used to estimate the parameters. The house price indexes are computed by pricing a constant bundle of housing characteristics using estimated hedonic coefficients for the states. The constant quality

bundle is the average bundle of housing characteristics for all owner-occupied households in all states. So, the house price index is calculated by substituting estimated coefficients and average housing characteristics into the hedonic house price equation. These hedonic house price indices are used as a price variable in the housing demand equation and are also used to calculate the quantity of housing demand.

1.1. Descriptive Statistics

Table 4 provides descriptive statistics from the samples of 20 states used in the house price indices of this research[41]. The summary statistics present the number of observations, means, and standard deviation values of each variable.

The mean of the natural log of house value is about 11.28. The used house value is the owner-reported house value which it brings about when the owners sell the house at the survey time.

The average number of people per room is about 0.42, indicating that the number of household members is less than the number of rooms on average.

The mean value of ROOM5MORE, which is the dummy variable for the households who have 5 rooms or more, is about 0.88. This shows that most of the owner-occupied households live in a house with more than 5 rooms.

The mean value of DETACHED, which is the dummy variable for the households who live in single family house, is about 0.86. Thus, households prefer single family houses to other types of dwellings.

[41] The 2003 PSID data consists of 7,822 households. However, about 3,000 households are used in this part since other households are dropped in the process of data construction.

The average value of the dummy variable AIRCON2 is about 0.69 showing that 70 percent of households furnish air conditioners in all rooms.

The mean value of the dummy variable GAS is about 0.59. This means that about 60 percent of the owner occupied households use gas to heat the houses. The mean value of the dummy variable ELEC is about 0.27, reflecting that about 27% of the owner occupied households use electricity to heat their houses.

The average value of BLACK[42], which is the dummy variable for the households whose head is black, is about 0.09. It is used as a proxy variable, which captures the neighborhood characteristics.

The average value of BIGMETRO is about 0.72. Because this is the dummy variable for households which live in the counties of metropolitan areas of more than 50 thousand populations, we know that 72 percent of the owner-occupied households live in metropolitan areas.

[42] Thomas G. Thibodeau (1995) proposes that the race of household heads serves as a proxy for neighborhood.

<Table 4> Descriptive Statistics of Owner Households for Hedonic House Price Index

Variables	Observations	Means	St. Dev.
Natural log of house value (LHV)	2962	11.2838	0.9533
Number of people per room (NPROOM)	2934	0.4158	0.2626
Dummy variables for households living in single-family house (DETACHED)	2962	0.8619	0.3451
Dummy variable for the households living in the house with 5 rooms or more (ROOM5MORE)	2962	0.8810	0.3238
Dummy variable for households living in the house with air conditioners in all rooms (AIIRCON2)	2962	0.6911	0.4621
Dummy variable for households living in the house heated with gas (GAS)	2962	0.5868	0.4925
Dummy variable for households living in the house heated with electricity (ELEC)	2962	0.2719	0.4450
Dummy variable for households living in the counties in the metropolitan areas (BIGMETRO)	2962	0.7161	0.4510
Dummy variable for households whose head is black (BLACK)	2962	0.0936	0.2914

1.2. Empirical Results

This section aims to derive the house price index for each state. To get accurate hedonic house prices the hedonic method includes all the variables that reflect the quality of the houses from the data. For this purpose, cross sectional analysis is applied to the owner-occupied samples in 20 states from 2003 PSID survey data. The data set includes useful information about housing characteristics, which is necessary for estimating hedonic house price indices. The model uses independent variables such as structural characteristics, type of heating and air conditioning, contract conditions and regional variables, which have generally been included in the hedonic house price literatures

Table 5 reports the empirical results of the standard house prices and house price indices, which are obtained from the separate cross sectional regressions for 20 states by using 2,934 owner-occupied household samples. Table 5 also specifies the actual regression model.

The hedonic house prices are listed in alphabetical order by states. Arkansas is used as the reference state with a price index value which is normalized to 100. In order to get a regional house price index, the standard house price of each state is compared with the standard house price of the reference state. That is, the regional house price index of each state is derived from dividing its standard house price by the standard house price in Arkansas. These regional house price indices reflect the difference between the states. The price indices indicate the unit price of housing service in each state and are later used to calculate the quantity of housing demand.

According to the Table 5, the standard house prices range widely. The standard

house price ranges from 68,488.79 to 298,585.24. Massachusetts has the highest priced owner-occupied housing. The standard house price in Massachusetts is 4.4 times that of the reference state. The lowest standard house price is for Mississippi. Its standard house price is only 92 percent of the reference state. A comparison of the standard house prices are represented in the third column of Table 3, which shows the house price index for each state.

<Table 5> House Price Index by State

States	Observations	Standard house price	House price Index
Arkansas (AR)	119	68,488.79	100.00
California (CA)	318	234,128.38	341.85
Florida (FL)	199	98,943.51	144.47
Georgia (GA)	88	131,539.89	192.06
Illinois (IL)	116	183,745.87	268.29
Indiana (IN)	109	91,607.87	133.76
Iowa (IA)	103	101,687.99	148.47
Maryland (MD)	72	156,079.98	227.89
Massachusetts (MA)	104	298,585.24	435.96
Michigan (MI)	192	128,059.96	186.98
Mississippi (MS)	100	63,306.62	92.43
Missouri (MO)	129	84,081.81	122.77
New Jersey (NJ)	122	212,633.96	310.47
New York (NY)	158	204,149.25	298.08
North Carolina (NC)	196	128,346.09	187.40
Ohio (OH)	180	104,422.64	152.47
Pennsylvania (PA)	165	104,664.72	152.82
South Carolina (SC)	140	75,386.83	110.07
Texas (TX)	194	84,953.55	124.04
Virginia(VA)	130	141,850.3	207.11

2. The Effects of Family Structure and Residential Area on Tenure Choice

This section presents the impacts of family structure and residential area on tenure choice. Tenure choice is the discrete decision on whether the households own their house or rent. The impacts of other demographic factors on tenure choice are analyzed together. This paper focuses on analyzing the differences in tenure choice between each family structure and residential area household. The regression model is constructed following Ermisch (1996) and Coulson et al. (2003).

The model includes the variables for family structure and residential area along with income and price. Some demographic factors, which have been used in previous housing studies, are included in the model to compare with the results of other studies.

For this purpose, the data are managed for the all households, restricting samples of the states which have hedonic house price indices in the previous step. About 4,700 households are used to estimate the tenure choice equation.

2.1. Descriptive Statistics

Table 6, 7, and 8 provide descriptive statistics for variables of interest for owners, renters and the whole samples from the PSID survey data for 2003. The summary statistics state the number of observations, means, and standard deviation (St. Dev.) values of the variables[43] used in the tenure choice equation. The tenure choice analysis includes income, price, age, education and race, as well as the family structure and residential area variables. Price is derived from the hedonic equation for each state. Price

[43] The variables for the states are not reported in the summary statistics.

is a unit price of housing services.

The mean values of the variables for all households are shown in Table 6. 2952 households are owners and 1740 households are renters. The mean value of the natural log of relative price is -7.2998; this shows that the unit price of housing demand is less than rent cost. The natural log of relative price equals the natural log of the price of housing services minus the natural log of the rent cost. The mean value of the natural log of income is about 10.6146, and the average age of the household heads is about 49 years.

The model includes four family structure variables. The family types are divided into single person, single parent, couple alone, couple with children, and others. Couple alone is the reference household. The mean values of family structure variables in Table 4 show the portion of each family structure among total sample households. First, the mean value of the dummy variable SINGLE is 0.3333. It shows the proportion of the households whose head is single male or single female with no family members. Second, the mean value of the dummy variable SINGLEPARENT is 0.0899, which represents the households whose head is a single parent with children. Third, the mean value of the dummy variable COUPLECHI is 0.2458. This indicates that about 25 percent of total households are married couples with children. Fourth, the mean value of the dummy variable OTHERS is 0.0518, which represents the proportion of the household group with other multi-person without children.

The model also includes residential areas to the urban status of the household location. The areas are divided into the center of the big city, the fringe of the big city, the medium city, the small urban area and the rural area. The reference is the household living in the medium city. The mean value of the variable CEN1M is 0.2819 implying

that about 28 percent of households belong to the household group living in the central counties of metropolitan areas of 1 million populations or more. Second, the mean value of the variable CEN1M is 0.2032, showing that about 20% of the households live in the fringe counties of metropolitan areas of 1 million populations or more. Third, the mean value of the variable SURBAN is 0.1735, which suggests that about 17% of the households live in the urban areas of less than 50 thousand populations. Fourth, the average value of the variable RURAL is 0.0274, which represents the households which live in the completely rural areas.

The average values of other dummy variables show the portion of each group among total sample households. The mean value of the dummy variable HDHI is about 0.7868, indicating that about 80% of household heads have graduated from high school. The mean value of the dummy variable MOVED is about 0.3009. This means that about 30% of the households have moved since 2001. The average value of the variable WHITE is 0.7343, showing that the households with white heads are about 73 percent of all households.

Table 7 and Table 8 provide the summary statistics for owner samples and renter samples. Some differences are observed between owners and renters. First, the average age of the household head in renter units is younger than that of owner household heads. Based on this difference it might be predicted that an older age increases the probability of owning house. Second, the mean value of the natural log of income is bigger in owner samples than renter samples, implying that the owner households earn more income on the average than renter households. Third, owners are more likely to be white because about 60 percent of renter samples are white while 80 percent of owner samples are white.

There also exist differences in the mean values of family structure variables between owner samples and renter samples. Almost all of the mean values of the variables are different between the sub-group samples. First, the average value of single person households in renter samples is larger than that in owner samples. Second, the single parent household group also records a higher average value in renter samples than owner samples. Third, the couples with children consist of 30 percent in owner samples but only 14 percent in renter samples. Fourth, the mean value of the variable OTHERS is slightly less in owner samples than renter samples. Therefore, it might be predicted that the couples with children have a higher probability of owning their house.

The mean value of the residential variable CEN1M is smaller in owner samples than renter samples. However, the average value of the variable FRI1M is bigger in owner samples than renter samples. It might imply that the households in the central counties of a big city have lower probability of owning their house. For the variables SURBAN and RURAL, average values are bigger in owner samples than renter samples.

<Table 6> Descriptive Statistics of All Households for Tenure Choice

Variables	Observations	Means	St. Dev.
Owners	2952		
Renters	1740		
Natural log of relative price (LRPRICE)	4692	-7.2998	0.3667
Natural log of income(LOGINCOME)	4692	10.6146	0.9744
Household head age (AGE)	4692	48.6750	16.7173
High school graduated Dummy (HDHI)	4692	0.7868	0.4096
Household moved at prior year Dummy (MOVED)	4692	0.3009	0.4587
White Dummy (WHITE)	4692	0.7343	0.4418
Single Dummy (SINGLE)	4692	0.3333	0.4714
Single parent Dummy (SINGLEPARENT)	4692	0.0899	0.2861
Couple with children Dummy (COUPLECHI)	4692	0.2458	0.4306
Others Dummy (OTHERS)	4692	0.0518	0.2217
Households that live in the center of a big city Dummy(CEN1M)	4692	0.2819	0.4500
Households that live in the fringe of a big city Dummy(FRI1M)	4692	0.2032	0.4024
Households that live in the small urban areas Dummy(SURBAN)	4692	0.1735	0.3787
Households that live in the rural areas Dummy(RURAL)	4692	0.0274	0.1632

<Table 7> Descriptive Statistics of Owner Households for Tenure Choice

Variables	Observations	Means	St. Dev.
Natural log of relative price (LRPRICE)	2952	-7.3686	0.3709
Natural log of income(LOGINCOME)	2952	10.9193	0.8355
Household head age (AGE)	2952	52.1169	15.5892
High school graduated Dummy (HDHI)	2952	0.8317	0.3742
Household moved at prior year Dummy (MOVED)	2952	0.1822	0.3861
White Dummy (WHITE)	2952	0.8055	0.3959
Single Dummy (SINGLE)	2952	0.2326	0.4225
Single parent Dummy (SINGLEPARENT)	2952	0.0466	0.2108
Couple with children Dummy (COUPLECHI)	2952	0.3023	0.4593
Others Dummy (OTHERS)	2952	0.0496	0.2171
Households that live in the center of a big city Dummy (CEN1M)	2952	0.2347	0.4239
Households that live in the fringe of a big city Dummy (FRI1M)	2952	0.2261	0.4184
Households that live in the small urban areas Dummy (SURBAN)	2952	0.1866	0.3897
Households that live in the rural areas Dummy (RURAL)	2952	0.0305	0.1720

<Table 8> Descriptive Statistics of Renter Households for Tenure Choice

Variables	Observations	Means	St. Dev.
Natural log of relative price (LRPRICE)	1740	-7.1754	0.3238
Natural log of income(LOGINCOME)	1740	10.0646	0.9663
Household head age (AGE)	1740	42.4600	16.8940
High school graduated Dummy (HDHI)	1740	0.7056	0.4559
Household moved at prior year Dummy (MOVED)	1740	0.5151	0.4999
White Dummy (WHITE)	1740	0.6056	0.4888
Single Dummy (SINGLE)	1740	0.5151	0.4999
Single parent Dummy (SINGLEPARENT)	1740	0.1681	0.3741
Couple with children Dummy (COUPLECHI)	1740	0.1437	0.3509
Others Dummy (OTHERS)	1740	0.0559	0.2297
Households that live in the center of a big city Dummy (CEN1M)	1740	0.3671	0.4822
Households that live in the fringe of a big city Dummy (FRI1M)	1740	0.1618	0.3684
Households that live in the small urban areas Dummy (SURBAN)	1740	0.1499	0.3571
Households that live in the rural areas Dummy (RURAL)	1740	0.0217	0.1458

2.2. Empirical Results

In this section we compare the observed tenure choice of the samples of 4,692 households. The model focuses on analyzing the difference in the housing preference of each family structure and residential area. The results in Table 7 show the parameters of the choice equation and are familiar from previous studies on tenure choice. Most of the coefficients have the expected sign and are significant at standard levels of confidence.

A. Family Structure Effect on Tenure Choice

As noted in the previous literature, tenure choice is affected by various factors. This section checks how significantly family structure affects tenure choice. The tested hypothesis is whether the probability of owning varies at the different family types.

According to Table 9, each family structure has a different pattern of tenure choice. The existence of a spouse increases the probability of owning because the couples with children are more likely to own their house than other types of households.

The coefficient of a single person household is negative sign: -0.687737. This means that single person households have a low probability of owning. According to Ras et al. (2005) a single man has lower probability of owning than a single woman but the estimates are insignificant. [44]

The single parent households also have a negative coefficient, indicating that the households headed by a single parent are less likely to own their house. The relevant estimate is -0.588669.

[44] The reference category is couple without children in type of family structure.

This result is similar to the estimation results of Ermisch[45] (1996) and Ras et al. (2005) for Britain and the Netherlands.

The couples with children have a positive coefficient, while single person and single parent households have negative coefficients. The couples with children own their house about 19% more often than couple alone households. The corresponding coefficient is 0.195714, which is slightly lower than that of Ras et al. (2005) for Netherlands.

The other households are also less likely to own their house. The relevant coefficient is -0.232078.

B. Residential Area Effect on Tenure Choice

This section tests whether residential areas affect tenure choice. The model includes both the variables related to urban status and the regional dummy variables. The coefficients of the state dummy variables are not reported.

The model specification and results are provided in Table 9. As expected, the households have different probabilities of owning according to the residential areas.

Ownership probabilities are highest in rural areas, even if this result is insignificant, and is based on the small number of observations in rural areas.

The areas which have the lowest probability of owning are the central counties of metropolitan areas of 1 million populations or more. The relevant coefficient is -0.197055. That is, the households in those areas are about 20 percent less likely to own their house, compared to the households which live in the metropolitan areas of less than 50 thousand

[45] However, Ermisch (1996) states that single male and singe female has higher probability of owning in Britain housing market.

populations.

Other areas have slightly higher ownership probabilities, but the estimates are insignificant. Coulson et al (2003) propose similar conclusions to these results. They state that homeownership is highest in rural areas, while non-metropolitan urban areas have the lowest probabilities of owning.

C. Other Effects on Tenure Choice

This section analyzes the effect of income, price, and other demographic factors on tenure choice. These variables have been used as popular independent variables in the literature on housing. Therefore, this section also compares the estimation results with previous results.

Most of the variables have the expected effects on tenure choice and significant coefficients. As well-known from the previous literatures, income affects tenure choice positively. The same result is provided in this model. The coefficient of the natural log of income variable is 0.495557, showing that the ownership probability increases when the household income increases. Income is a very significant and quantitatively substantial variable in tenure choice.

The natural log of the price to rent ratio is also significant and has the expected sign. The probability of owning falls when this price variable rises. The relevant coefficient is -0.410656. Goodman (1988), Coulson et al (2003), and Ras et al. (2005) have similar results to this.[46]

The age of the household head is positively correlated with tenure choice even if

[46] In the paper Ras et al. (2005) the coefficient of the natural log of the price to rent ratio is -0.30, and in Coulson et al. (2003) it is -0.379.

its effect is shown as slight. Goodman (1988), Ermisch (1996) and Ras et al (2005) yield the same result.[47]

Education has a significant effect on tenure choice. The households with heads who have beyond a high school degree are more likely to own their house. This result is similar to the result of Coulson et al (2003).

The households who recently moved have smaller ownership probabilities than those who have not moved. The effect of this variable is very significant and substantial in magnitude. The related coefficient is -0.729700.

The probability of owning varies across different ethnic groups. The households with white heads have higher probabilities of owning. The relevant coefficient is 0.260749, which is very significant. Goodman (1988) and Bajari et al (2005) show that black household heads have a negative effect on tenure choice.

[47] Ermisch (1996) and Ras et al. (2005) use age and the square of age in the model and show that the coefficient of the square of age is negative. However, this paper does not use the square of age because it does not have a significant result.

<Table 9> The Effects of Family Structure and Residential Area on Tenure Choice

Variable	Coefficients
Natural log of relative price (LRPRICE)	-0.410656* (0.210730)
Natural log of income(LOGINCOME)	0.495557*** (0.064745)
Household head age (AGE)	0.025804*** (0.002115)
High school graduated Dummy (HDHD)	0.311733*** (0.071295)
Household moved during prior year Dummy (MOVED)	-0.729700*** (0.063214)
White Dummy (WHITE)	0.260749*** (0.068312)
Single Dummy (SINGLE)	-0.687737*** (0.081465)
Single parent Dummy (SINGLEPARENT)	-0.588669*** (0.102196)
Couple with children Dummy (COUPLECHI)	0.195714*** (0.075554)
Others Dummy (OTHERS)	-0.232078* (0.123979)
Households that live in the center of a big city Dummy (CEN1M)	-0.197055** (0.080621)
Households that live in the fringe of a big city Dummy (FRI1M)	0.009316 (0.089772)
Households that live in the small urban areas Dummy (SURBAN)	0.027650 (0.088607)
Households that live in the rural areas Dummy (RURAL)	0.081305 (0.171135)
Number of Observations	4692

Note. a) Constant and state dummy variables are not reported. b) The numbers in parenthesis are standard errors. c) ***, **, and * denote statistical significance at the 1, 5, and 10% significance level, respectively.

3. The Effects of Family Structure and Other Factors on Housing Demand

This section examines the various aspects of family structure effects on housing demand with owner-occupied household level micro data[48]. In the previous section I showed the effects of family structure and residential area on tenure choice. These results might help to predict the effects of the variables on housing demand, which are included in the model. Housing demand is modeled as a continuous quantity that represents the flow of housing services, while tenure choice is a discrete choice variable. Thus, more aspects of family structure effects can be analyzed in this section. The demand of housing services is total house value divided by the unit price of housing services. The unit price of housing services is derived from the hedonic method which is shown in the first section of this chapter.

The regression model for this purpose is constructed based on Goodman (1988), Rapaport (1997), Ras et al (2005), and Cho et al (2005). The variables related to family structure and residential areas are included along with income and price in the model. As previous housing studies have done, some demographic factors are used as independent variables.

The analysis is focused on estimating and comparing the effects of the family structure on the demand of housing services. As the second section of this chapter shows, the impacts of the demographic factors on housing demand are presented altogether.

The form of the model used in this section looks like that of the second section for tenure choice except it uses different price variables[49].

[48] About 3,000 owner-occupied samples of 4,692 samples are used in this regression.
[49] The housing demand equation uses the adjusted unit price of housing services as a price variable, while

3.1. Descriptive Statistics

A log-linear equation is estimated for housing demand, and the variables used in the equation are shown in Tables 10 and 11. Table 10 presents the summary statistics for the owner-occupied household samples, and Table 11 provides the summary statistics for all household samples. The number of observations, means, and standard deviations for these variables are given in the tables.

Some differences are observed between owners and all households. The mean value of the natural log of the unit price for owners is less than that for all households. It is predicted that a lower unit price makes it the beneficial to consume. The mean value of income for owners is bigger than that for all households; thus owners earn a higher income on average. Therefore the housing demand can be affected affirmatively by the household income. The average age of the household head in owner-occupied units is older than the average all household head: for owners it is about 52.1 years, but for all households it is about 48.6 years. We might hypothesize that age has a positive effect on housing demand. Education is usually regarded to be positively related to the demand of housing. As expected the mean value of the variable HDHI, which is the dummy variable for household heads with beyond high school degree, is 0.7868 for all households and 0.8317 for owners. Race is also a crucial factor for housing demand. The average value of the variable White, which represents white household heads, is bigger in owner samples than all samples.

There exist differences in the mean values of family structure variables between

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the tenure choice equation uses the price to rent ratio.

owner samples and all samples. The average value of single person households in owner samples is larger than that in all household samples. The single parent household group also records beyond the average level of all households. Its mean value is 0.0899 in Table 8 for all households and 0.0466 in Table 9 for owner households. The mean value of couple household with children is 0.2458 in all samples while it is 0.3023 in owner samples. For other households, the mean value is slightly bigger in all samples than owner samples. Based on the summary statistics it might be predicted that the couples with children have a positive effect on housing demand.

<Table 10> Descriptive Statistics of All Households for Housing Demand

Variables	Observations	Means	St. Dev.
Natural log of the unit price (LMCH)	4692	1.4798	0.4785
Natural log of income (LOGINCOME)	4692	10.6146	0.9744
Household head age (AGE)	4692	48.6750	16.7173
High school graduated Dummy (HDHI)	4692	0.7868	0.4096
Household moved at prior year Dummy (MOVED)	4692	0.3009	0.4587
White Dummy (WHITE)	4692	0.7343	0.4418
Single Dummy (SINGLE)	4692	0.3333	0.4714
Single parent Dummy (SINGLEPARENT)	4692	0.0899	0.2860
Couple with children Dummy (COUPLECHI)	4692	0.2458	0.4306
Others Dummy (OTHERS)	4692	0.0518	0.2217
Households that live in the center of a big city Dummy (CEN1M)	4692	0.2819	0.4500
Households that live in the fringe of a big city Dummy (FRI1M)	4692	0.2032	0.4024
Households that live in the small urban areas Dummy (SURBAN)	4692	0.1735	0.3787
Households that live in the rural areas Dummy (RURAL)	4692	0.0274	0.1632

<Table 11> Descriptive Statistics of Owner Households for Housing Demand

Variables	Observations	Means	St. Dev.
Natural log of housing demand (LHC)	2952	6.5698	0.8601
Natural log of the unit price (LMCH)	2952	1.3989	0.4736
Natural log of income (LOGINCOME)	2952	10.9192	0.8355
Household head age (AGE)	2952	52.1169	15.5892
High school graduated Dummy (HDHI)	2952	0.8317	0.3742
Household moved at prior year Dummy (MOVED)	2952	0.1822	0.3861
White Dummy (WHITE)	2952	0.8055	0.3959
Single Dummy (SINGLE)	2952	0.2326	0.4225
Single parent Dummy (SINGLEPARENT)	2952	0.0466	0.2108
Couple with children Dummy (COUPLECHI)	2952	0.3023	0.4593
Others Dummy (OTHERS)	2952	0.0496	0.2171
Households that live in the center of a big city Dummy (CEN1M)	2952	0.2347	0.4239
Households that live in the fringe of a big city Dummy (FRI1M)	2952	0.2261	0.4183
Households that live in the small urban areas Dummy (SURBAN)	2952	0.1866	0.3897
Households that live in the rural areas Dummy (RURAL)	2952	0.0305	0.1720

3.2. Empirical Results

Table 12 reports the estimation results of the housing demand equation for owner-occupied household samples. The maximum likelihood method is used to compute the likelihood functions for the tenure choice and demand equation, and to estimate the parameters of the demand equation since the error terms of two equations might be correlated. The demand equation in Table 12 shows the actual variables that are included in the model. The model specification is constructed to analyze the impacts of family structure, residential area, income, price, age, education level, and race on housing demand. The parameters of the variables have expected signs which are observed in previous studies on housing demand.

A. Family Structure Effects on Housing Demand

This section tests whether the family structure significantly affects housing demand. The tested hypothesis is whether or not each family structure has a different preference for housing. According to the papers of Ermisch (1996) and Ras et al. (2005), the couples with children seem to have more housing demand than other households.

The results are provided in Table 12. The coefficient of the variable, SINGLE, has a significantly negative value, -0.123708 at the five percent confidence level. This means that the housing consumption of a single person household is less than that of the reference household, which is the couple alone household. The same result is shown in the studies of Ermishch[50] (1996) and Ras et al. (2005). They show that single man and

[50] He shows that single male and female households have slightly more housing consumption than couple alone households.

single woman households have relatively small housing demand. Ras et al. (2005) conclude that single households have about 22 percent less housing consumption than couple households without children.

Single parent households also have different housing preferences than other households. The coefficient of the variable, SINGLEPARENT, is -0.107369, even if it is insignificant. This implies that the single parent households also have less housing demand than the reference. Ermisch (1996) and Ras et al. (2005) also show that single parent households have a negative effect on the demand of housing services.

The coefficient of the variable, COUPLECHI, shows that the couples with children have a positive relationship with housing consumption. Its coefficient is 0.071229, and is significant at the five percent confidence level. A similar result is shown in the case of Ras et al. (2005).

According to the coefficient of the variable OTHERS, other households which have multi-person members without children are shown as a family structure with relatively small housing consumption. Ras et al. (2005) have different results showing that other households have more housing demand than other types of households.

In conclusion each family structure has different housing preferences and affects the demand of housing services significantly.

B. Other Effects on Housing Demand

First, the residential area variables are included to control the specific characteristics of each area. The coefficients of the residential area variables are significant. These residential variables help to measure accurate effects of income and

price, especially by giving a control for price measurement error that is likely to be correlated with the residential area. We look at the coefficients of income and price variables, which have the expected sign and are significant at five percent confidence level. Since the model is constructed as log-linear form of the demand equation, the coefficients of the income and price variables are interpreted as elasticities. As expected, income elasticity is positive, 0.398345[51]. The price elasticity of housing demand is -0.293247 indicating that more expensive housing results in less housing consumption. Previous literature on housing shows that income and price elasticities range widely according to the model specifications and the various measures of income and price. Ermisch (1996) presents a range of values between 0.49 and 0.52 for income price elasticity and between -0.39 and -0.41 for price elasticity. Harmon (1988) estimates the income elasticity for owner-occupied housing to be about 0.7. Zabel (2004) concludes that income elasticity ranges from 0.27 to 0.43 and price elasticity ranges between -0.05 and -0.50. A recent study by Ras et al. (2005) shows that income elasticity exceeds one and price elasticity is -0.30.

Now, we discuss the coefficients of the demographic variables. The age of the household head is commonly cited independent variable in the housing model. The coefficient of the age variable is slightly positive and significant. This is the expected result because many studies such as Horioka(1988)[52], Ermisch(1996), Rapaport (1997), and Ras et al. (2005) show that housing demand increases with age. However, Harmon (1988) and Goodman (1988) conclude that age is negatively correlated with housing

[51] Lee and Trost (1979) and Horioka (1988) note that the positive coefficient of income may arise because housing is a normal good, risk aversion declines with income and mortgage market is imperfect.
[52] Horioka (1988) states that housing tastes change over the life cycle, or older households have more savings to own their house.

demand.

The coefficient of HDHI, the dummy variable for the household heads that are high school graduates, is positive and significant. This implies that the households with a high school education consume more housing than other households. Zabel (2004) uses a similar education variable which has a significantly positive coefficient.

Race is also an important variable in the housing demand model for the U.S. The coefficient of the variable, WHITE, is positive and significant, indicating that white households demand about 16 percent more housing than non-white households. Harmon (1988) and Goodman (1988) find a negative coefficient for the black household head. Rapaport (1997) finds that the racial difference between white and nonwhite household heads is large in housing demand.

Finally, the estimation result on migration shows that the recent movers[53] usually consume more housing than non-movers. Ioannides et al. (2003) find that migration is positively correlated with housing consumption.

[53] The recent movers mean the households that have moved since January, 2001 in the survey for 2003.

<Table 12> The Effects of Family Structure and Other Factors on Housing Demand

Variable	Coefficients
Natural log of owner cost (LMCH)	-0.293247** (0.143813)
Natural log of income (LOGINCOME)	0.398345*** (0.059321)
Household head age (AGE)	0.009474*** (0.001409)
High school graduated Dummy (HDHD)	0.257259*** (0.054176)
Household moved last year Dummy (MOVED)	0.084246* (0.043274)
White Dummy (WHITE)	0.161228*** (0.049203)
Single Dummy (SINGLE)	-0.123708** (0.052180)
Single parent Dummy (SINGLEPARENT)	-0.107369 (0.073401)
Couple with children Dummy (COUPLECHI)	0.071229** (0.035791)
Others Dummy (OTHERS)	-0.086270 (0.075483)
Households that live in the center of a big city Dummy (CEN1M)	0.283762*** (0.047884)
Households that live in the fringe of a big city Dummy (FRI1M)	0.349947*** (0.046475)
Households that live in the small urban areas Dummy (SURBAN)	-0.089439** (0.045227)
Households that live in the rural areas Dummy (RURAL)	-0.174032 (0.128744)
Number of Observations	4692/2952

Note. a) Constant and state dummy variables are not reported. b) The numbers in parenthesis are standard errors. c) ***, **, and * denote statistical significance at the 1, 5, and 10% significance level, respectively.

4. Income and Price Elasticities between the Population and Subgroups

This section analyzes and quantifies the responsiveness of subpopulations to changes in income and price. For this purpose, the population is categorized by family structure. Interaction terms between income and price and family structure variables are introduced in housing demand model.

4.1. Descriptive Statistics

Table 13 shows the descriptive statistics for the interaction variables. It includes the number of observations, means, and standard deviations values.

<Table 13> Descriptive Statistics of Interaction Variables

Variables	Observations	Means	Standard deviation
Interaction between SINGLE and LOGINCOME (SINGELINCO)	2952	2.404885	4.390173
Interaction between SINGLEPARENT and LOGINCOME (SINGPAINCO)	2952	0.490146	2.223089
Interaction between COUPLECHI and LOGINCOME (COCHIINCO)	2952	3.397602	5.176763
Interaction between OTHERS and LOGINCOME (OTHERSINCO)	2952	0.527805	2.316775
Interaction between SINGLE and LMCH (SINGELLMCH)	2952	0.348793	0.671046
Interaction between SINGLEPARENT and LMCH (SINGPALMCH)	2952	0.066774	0.313455
Interaction between COCHI and LMCH (COCHILMCH)	2952	0.390079	0.647295
Interaction between OTHERS and LMCH (OTHERSLMCH)	2952	0.078193	0.353218

4.2. Empirical Results

The estimation results of income and price elasticities by family structure are presented in Table 14. As mentioned before, income elasticity is about 0.40 and the price elasticity of housing demand is -0.29 over the whole population.

When looking at the income elasticity of each family structure, single person households have smaller income elasticity, 0.36, than the whole population. This means that single person households increase their housing demand less than the population when their income rises. However, the income elasticity of single parent households is higher than other types of family structures. Their income elasticity is 0.56. Single parent households are more likely to increase housing consumption with an increase of income, and it also appears like that they have a strong preference for spacious housing. The income elasticity of couples with children, 0.44, is higher than the single person households. Other households have similar income elasticity to whole population.

Table 14 shows that each family structure has different price elasticity from the whole population. Single person households adjust housing consumption more responsively to the change of price. Their price elasticity is -0.44, which is the highest of all the family structures. That is, if the unit price of housing service rises by 1 percent they decrease their demand of housing services by 0.44 percent. The higher responsiveness of single person households may be the result of having no family members. Rapaport (1997) shows that the community choice of a household depends on school quality as well as price and property tax. Consequently, single person households

do not care about the school situation of their children, which might make them more apt to move. In contrast, single parent households are less responsive to price changes. Their price elasticity, about -0.14, is the lowest level of all family structures. The couples with children have a small price elasticity compared to single person and other households. The price elasticity of couples with children is -0.27, while the price elasticity of other households is -0.42. In summary, the households without children are more price-elastic than the households with children.

<Table 14> Income and Price Elasticities for Subgroups based on Family Structure

Groups	Income Elasticity	Price Elasticity
Whole Population	0.398345	-0.293247
Single Person Household	0.361575	-0.443182
Single Parent Household	0.556699	-0.136508
Couple with Children	0.440682	-0.267341
Others	0.398685	-0.416233

Chapter 5

Summary and Conclusions

This paper attempts to analyze the effects of family structure and residential areas on housing demand and tenure choice, using U.S. household level data from the Panel Study of Income Dynamics (PSID). Many previous studies for housing have used a variety of factors to derive the correct housing demand equation. These studies have tried to present the estimates of price and income elasticities for housing demand over the whole population. To derive accurate income and price elasticities, they have used various demographic factors, as well as income and price. That is, they have focused on analyzing the housing demand preference for the whole population. However, they have overlooked that there might exist meaningful differences in housing demand between the whole population and subgroups of the population. These differences might help to provide some implications for developing and executing housing policy.

A few previous papers introduced variables related to family structure and residential areas in their housing models. Based on these studies, I include the subgroup variables for family structure and residential area to analyze the housing demand pattern of the subgroups within the whole population.

The framework of this empirical paper consists of three main parts. As a preliminary step, the hedonic house price equation is run to get a house price index in each housing market. The hedonic equations are estimated for the states that have enough owner-occupied households to regress the hedonic price equation. The regional house price indices from the hedonic equation are used to construct the quantity of housing

demanded and the unit price of housing services in the housing model.

The first part of this paper presents the impacts of family structure and residential area on tenure choice. The impacts of other demographic factors are also analyzed on tenure choice, and then compared to the results of previous studies. The regression model is constructed for this purpose based on Ermisch (1996) and Coulson et al. (2003). For this purpose the variables for family structure and residential areas are included in the model with income, price, and other demographic factors. About 4,700 households are used to estimate the tenure choice equation.

The second part examines the effects of family structure and other factors on housing demand with owner-occupied household level micro data. Housing demand is modeled as a continuous quantity that represents the flow of housing services, while tenure choice is a discrete dependent variable. Thus, more aspects of family structure can be analyzed in this part. The regression model constructed for this purpose is based on Goodman (1988), Rapaport (1997), Ras et al (2005), and Cho et al (2005). The variables related to family structure and residential areas are included, along with some demographic factors that have been used as independent variables in previous studies.

The third part analyzes and quantifies the responsiveness of subpopulations to changes in income and price by using interaction terms between income and price, and variables for subgroups in the housing model. Other previous studies have tried to derive accurate income and price elasticities of housing demand over the whole population. However, this paper focuses on analyzing the income and price elalsticites of the meaningful subgroups within the population.

(1) The Effects of Family Structure and Residential Area on Tenure Choice

In this part the estimation results are summarized into three conclusions. First, each family structure has a different pattern of tenure choice. The existence of a spouse increases the probability of owning. Single person households and single parent households have less probability of owning their house. The couples with children own their house about 19% more often than couple alone households. Other multi-person households without spouse and children are also less likely to own their house. This result is similar to the estimation results of Ermisch (1996) and Ras et al. (2005).

Second, as expected, the households have different probabilities of owning according to residential areas. Ownership probabilities are highest in rural areas, but the estimate is insignificant. In contrast, the households in the center of a big city are less likely to own their house. Other areas have slightly higher ownership probabilities, but the estimates are insignificant. Coulson et al (2003) propose conclusions similar to this result.

Third, most of the other demographic variables have the expected effects on tenure choice. Income is a very significant variable in tenure choice. Price affects tenure choice negatively, but age has a positive correlation with tenure choice, even if its effect is small. Education has a significantly positive effect on tenure choice; thus, households with heads who have beyond a high school degree are more likely to own their house. This result is similar to that of Coulson et al (2003). The households who recently moved have less ownership probabilities, and the households with white heads have higher probabilities of owning.

(2) The Effects of Family Structure and Other Factors on Housing Demand

This part is summarized into three conclusions. First, according to the papers of Ermisch (1996) and Ras et al. (2005), the couples with children seem to have more housing demand than other households. The parameters of the related variables to family structure have the expected signs. The couples with children have a positive relationship with housing consumption. Single person households consume relatively little housing demand as shown in the studies of Ermishch (1996) and Ras et al. (2005). Single parent households also have less housing demand than other types of households. Other households are also shown as the family structure with relatively small housing consumption. However, Ras et al. (2005) have different results; they show that other households have more housing demand than other types of households

Second, other demographic factors also affect housing demand significantly. As expected, income elasticity is about 0.40 and price elasticity is about -0.29. Ermisch (1996) presents a range of values between 0.49 and 0.52 for income elasticity and between -0.39 and -0.41 for price elasticity. Zabel (2004) shows that income elasticity ranges from 0.27 to 0.43 and price elasticity ranges between -0.05 and -0.50. The coefficient of the age variable is slightly positive and significant. The coefficient of education is also positive, implying that households with high education consume more housing than other households. Zabel (2004) has the same conclusion. White household head has a positive relationship with housing demand. Harmon (1988) and Goodman (1988) show that the coefficient for the black household head is negative. The recent movers usually consume more housing than non-movers. Ioannides et al. (2003) find that migration is positively correlated with housing consumption.

(3) Income and Price Elasticities between the Population and Subgroups

This part presents the meaningful differences between the whole population and subgroups within the population.

First, single person households have smaller income elasticity, 0.36, than whole population, 0.40. The income elasticity of single parent households is higher than those of other types of family structures. Single parent households are more likely to increase housing consumption with an increase in income. Their income elasticity is 0.56. The income elasticity of couples with children is higher than single person households, and other households have similar income elasticities to the whole population.

Second, each family structure has very different price elasticities than the whole population. The households without children are more price-elastic than the households with children. The price elasticity of single person households is about -0.44, the highest of all family structures. Higher responsiveness of single person households might be due to no family members. Rapaport (1997) implies that single person households do not have to care about the school quality for children, which is the crucial factor for community choice. On the contrary, the price elasticity of single parent households is about -0.14, which is the lowest of all family structures. The price elasticity of the couples with children is about -0.27, and the price elasticity of other households is -0.42.

This study needs to be improved in the following points. First, this paper uses about 5,000 household samples to analyze the effects of various subgroups. More efficient studies can be executed by using the survey data with larger household samples. In this case comparison for more various subgroups can be attempted. Second, the use of

panel data might make it possible to analyze the housing demand of each subgroup in a detailed way.

In conclusion, this paper tries to study the notable differences in housing demand between the whole population and subgroups within the population.

I hope these results can be helpful in developing and executing housing policy.

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