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# A Study on the Growth and Formation of Single Person Households and Their Housing Decisions in Taiwan

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The number of single person households has dramatically increased in Taiwan in the past several decades as it has elsewhere in the world, but this phenomenon has been largely neglected in the literature. This research explores the factors that affect the formation of single person households and their housing decisions. Taiwan's population census data for 1980, 1990 and 2000 are used.

Some interesting trends can be found. First of all, people who are married or cohabiting have exhibited an increasing tendency to live alone census by census. This shows the increasing need in a modern society for the husband and wife to live separately due to employment or other reasons. Secondly, unmarried and widowed elderly persons have had an increasing probability of living alone over the decades. Thirdly, the number of female single person households has been increasing rapidly, and there is a higher probability that they are homeowners and also occupying a larger living space than their male counterparts.

To sum up, the results of this study show that the demand for housing

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among single person households will continue to increase as their numbers increase. Their demand for homeownership and living space are also increasing.

## **Keywords**

Single person household formation; Tenure choice; Living space; Binary probit model; Sample selection model

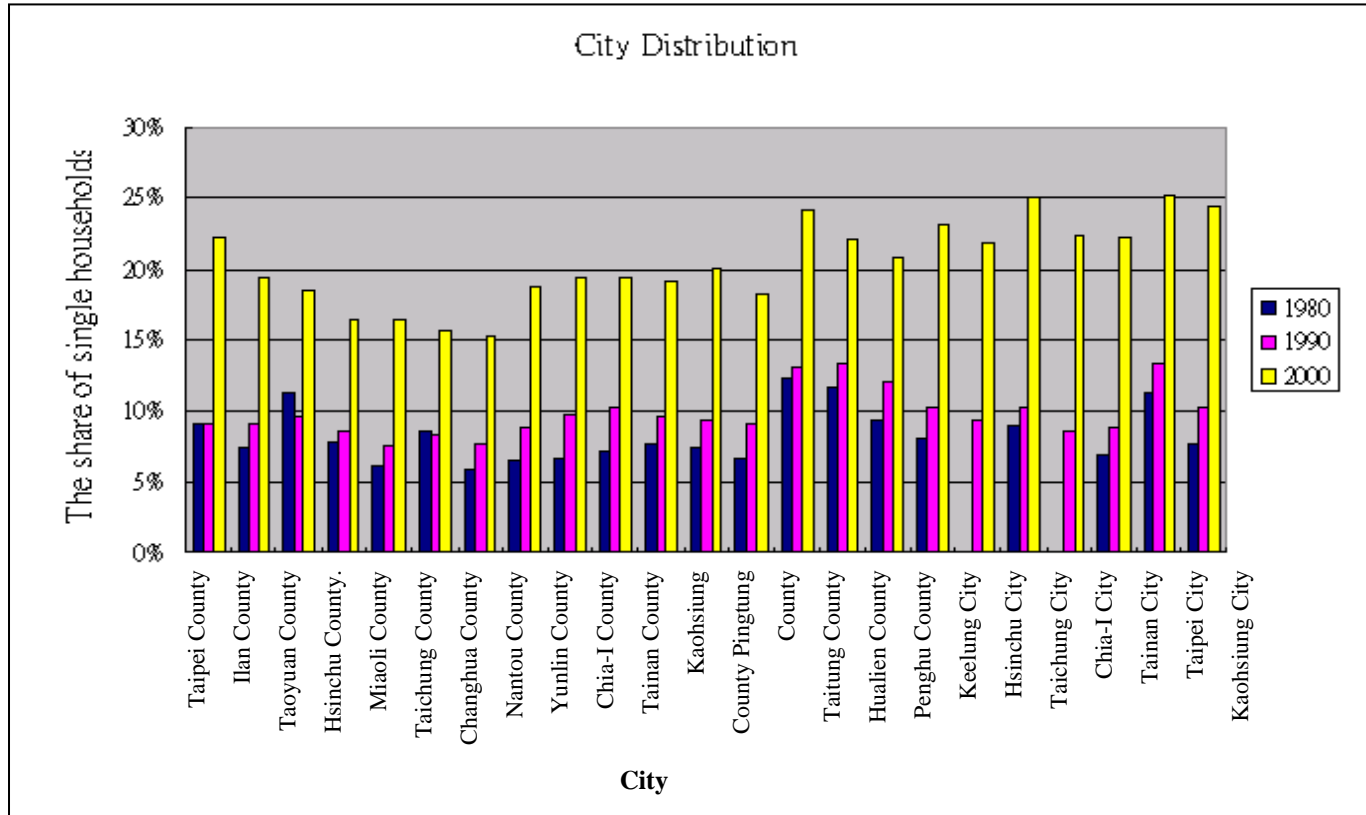
## **1. Introduction**

The family structure in Taiwan has drastically changed in recent years. In addition to the ongoing decrease in family size, we can find a phenomenal growth of single person households. A single person household can be defined as a household where one person lives alone and performs the functions needed within that household. According to the population census, the number of single person households was 8.45% of total households in 1980, and increased to 21.02% in 2000. The increase in the number of single person households is most noticeable in the big cities. Figure 1 shows the distribution of single person households in 21 administrative cities/counties in 1980, 1990 and 2000. From Figure 1, we can find that in Taipei, Kaohsiung and Taichung, the three biggest cities in Taiwan, the percentage of single person households reached about 25% in 2000.

Figure 2 shows the age distribution of single person households. From Figure 2, we can find that the distribution of single person households has two peaks, when a person is young, and when he or she is old. In the year 2000, the number of single person households increased for all age categories. However, the increases among those who were younger are more noticeable.

The increase in the number of single person households may be due to the changes in values with respect to marriage and family, which result in an increase in the number of unmarried for all ages, later marriage, and a higher divorce rate. It may also be due to the increase in studying or working away from home alone in another city which results from the process of globalization. For whatever reason, this is an important new phenomenon in social change which is not only happening in Taiwan, but can also be seen around the world.

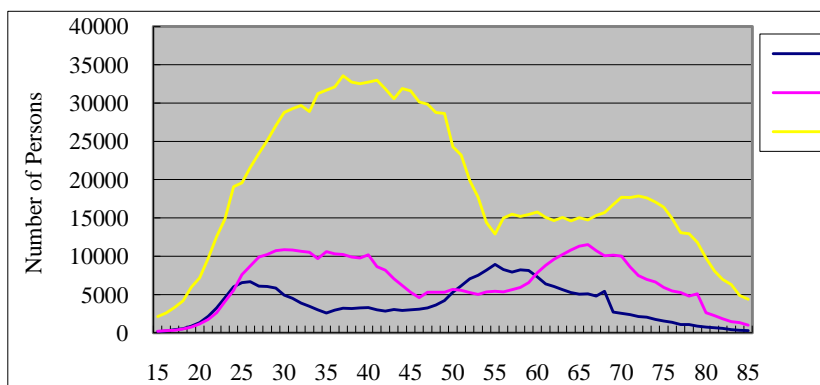
**Figure 1** Distribution of Single Person Households in 23 Administrative Cities/Counties in Taiwan



Single person households may exhibit different behavior from other people in many aspects of their living style. However, in this research, we will focus on their housing choices. Their demand for homeownership may be lower than that of regular households. Their preference for living space and location may also be different. Hence, the growth of single person households will have an important impact on the housing market in terms of the quantity and quality of housing.

However, studies on the housing choice behavior of single-person households are relatively few in Taiwan or internationally. In this research, we will perform a pioneering study on the housing decisions of single person households, including tenure choice and the demand for living space. In addition, before studying their housing decisions, we will first examine the kinds of demographic characteristics that have more influence on the formation of single person households. The original data of the Population and Housing Census in Taiwan for 1980, 1990 and 2000 will be used in this study.

**Figure 2 Age Distribution of Single Person Households in Taiwan**



The remainder of this paper is arranged as follows. Following the introduction, the next section provides the literature review. Then, a description of the data, the model specification, and a discussion of the results follow. The final section presents the conclusion.

## 2. Literature Review

The increase in the number of single person households is a new social phenomenon; hence, we rarely find academic research on their formation and housing behavior in Taiwan or around the world. In most cases, we can only find some fragmented discussions in which the single person household is examined as one type of family structure in these studies. For example, from Ogden and Schnoebelen (2005), we learn that single person households in

Paris are becoming younger in age, and also more concentrated in the metropolitan areas. This result indicates that age and urbanization are important factors that affect the formation of single person households.

As to the housing behavior of single person households, there are also no systematic studies that can be found. Fragmented discussion can, however, be found in Bonvalet and Lelièvre (1997), a study on the housing behavior of households in France and Great Britain. The results of that study indicate that elderly single persons tend to change their tenure status from owning to renting their residence. Struyk (1974) provides evidence of a positive relationship between the home ownership rate and family size. This result implies that single person households, by definition having the smallest family size, are the least likely to be home owners. Hsueh and Chen (1999) provide similar results for Taiwan; however, the effect of family size is shown to decline over time. This implies that the home ownership rate of single person households should have increased over time.

In addition to academic papers, we can find some articles in trade magazines which have observed the growth of single person households and their impact on the housing market. Although these articles do not constitute serious academic research that ensures all other conditions remain equal, their direct observations from the market are still very valuable. This is all the more so at a time when the increase in single person households is still a very new social phenomenon and there is still very little academic research on this issue. Two articles of this type are discussed here.

Wickens (2000) indicates that single persons constitute the type of buyer that increased the most in the home buying market in the U.S. and points out that home builders have started to specifically provide products for this group of home buyers. Sichelman (2007) provides a discussion of the home buying behavior of single person households in the U.S., where it is observed that the number of single person households is one-third of the total number of households in the U.S. The buying behavior of male and female single persons was found to be very different. Male single home buyers are younger than their female counterparts, with the median age for males being 37 compared to 42 for females. Their preferences with regards to housing type are also different. Generally speaking, single housing is preferred to apartments. However, in percentage terms, females purchase more single housing than males. Because single females tend to treat their residence as their home, they like a bigger space to receive relatives and friends at home, and a larger space also provides a better sense of security. Such market information provided in Wickens (2000) and Sichelman (2007) can be compared with the results of this research. However, we have to keep in mind that they are merely market observations, and that controls are not in place to ensure that other things remain equal.

From these studies, we can see that age, gender, city or area lived in and so on are all important factors which may affect the formation of single person households and their housing decisions. We expect that different combinations of these variables among other variables will have different effects at different times and in different countries. In this study, we will seek to determine the important factors and how these factors affect the formation of single person households and their housing decisions in Taiwan.

### 3. Data Source and Sample Selection

Individual data obtained from the Household and Housing Censuses for the years 1980, 1990 and 2000 in Taiwan are used in this study. These censuses were conducted by the Directorate General of Budget, Accounting and Statistics (DGBAS), which is part of the Executive branch of the Taiwan government. Each census consists of data for individual households, individual persons and their respective housings.

In this paper, we will first explain how single person households are formed, and then analyze their housing decisions. In order to explain the formation of single person households, the people that are observed should be individual persons rather than households. Because we are looking at adult individual persons, it could be that some of them have decided to live alone, and form a single person household by definition, rather than have households that make decisions to have only one person in the household. To obtain appropriate observations, we removed all individuals aged below 20<sup>1</sup> or above 85<sup>2</sup> as well as those who are not in common households, e.g., in institutions from the sample, and then drew a 10 percent random sample from this modified population. The sample sizes for the census years 1980, 1990 and 2000 are 894,108, 1,242,914 and 1,474,575, respectively. With this sample selection procedure, there should be no problem in terms of representativeness. The single person householders comprised 2.98% of the total number of adult individuals in 1980. This proportion increased to 5.14% in 1990 and to 9.07% in 2000.

### 4. Model Specification and Descriptive Statistics

More and more people actively decide to live alone, which by definition means that they become single person households during a certain period in their lifetime; for example, young adults leave their parents to live alone

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<sup>1</sup> We choose age 20 because at this age, a child is considered to legally become an adult who can make his/her own decisions.

<sup>2</sup> Persons above the age of 85 are relatively few in the population. Therefore, including them in the sample will give rise to irregularities in the econometric estimation.

before entering into a marriage. However, in many situations, living alone may not be their active choice, but may be passively formed, such as in the case of a widowed person. Unfortunately, we cannot differentiate between these two kinds of persons in the census. Therefore, we will not refer to the econometric model specified in the following section as a single person household decision model, but rather, as a single person household formation model, which we can use to determine which socioeconomic factors and demographic characteristics are more influential in the formation of single person households.

The econometric models for single person household formation and their housing choices are specified as follows.

## 4.1 Econometric Model

### 4.1.1 Single person household formation model

Econometrically, a binary probit model will first be used to estimate the probability of an individual person becoming the head of a single person household. The dependent variable is concerned with whether the individual is a household head who is also the only person in the household, and denoted as SINGLE. The model can be shown as Equation (1) as follows:

$$\Pr(\text{SINGLE}=1|X)=\Phi(\alpha'X) \quad (1)$$

where  $\Pr(\text{SINGLE}=1|\bullet)$  is the conditional probability of being a single person household head.  $X$  is a vector of explanatory variables,  $\alpha$  is a vector of estimated coefficients and  $\Phi$  is the cumulative distribution function (CDF) of a standard normal distribution.

### 4.1.2 Housing choice models

Housing choices here refer to the tenure choice and the demand for living space. We specify these two choices as a recursive system, in which the tenure choice is allowed to affect the choice of living space. For example, people may want to save money to accumulate funds for their mortgage down payment, and hence may choose a smaller living space while renting. In addition, we also consider the sample selection bias issue in modeling. Because there may be some unobserved factors that affect both the forming of a single person household and the tenure choice decision, or the living space decision, not considering this issue may cause sample selection bias in estimation results.

Since tenure choice, denoted as HO, is a binary choice, a binary probit model will be used. In addition, since living space, denoted by PERA, is continuous in nature, a linear function will be used. In considering the sample selection bias issue, the HO model is a conditional probability model (Greene, 2008), and the PERA model will be a standard Heckman sample selection model. A

recursive system of models, which considers the sample selection bias issue, can be shown as Equations (2) and (3) as follows:

$$\Pr(\text{HO} = 1 | Y, \text{SINGLE} = 1) = \Phi(\beta'Y, \alpha'X, \rho) / \Phi(\alpha'X) \tag{2}^3$$

$$E(\text{PERA} | Z, \text{HO}, \text{SINGLE} = 1) = y'Z + \eta\lambda + \theta\hat{H} \tag{3}$$

$$\lambda = \phi(\alpha'X) / [\Phi(\alpha'X)]$$

where  $Y$  and  $Z$  are vectors of explanatory variables for Equations (2) and (3), respectively;  $\phi$  and  $\Phi$  are the probability density function and the cumulative density function of the standard normal distribution, respectively.  $\alpha, \beta, \gamma, \theta$  and  $\eta$  are vectors of the coefficients to be estimated.  $\rho$  is the correlation coefficient of the residuals from two binary decisions.<sup>4</sup> (Greene, 2008).  $\lambda$  is the inverse mills ratio, estimated from Equation (1) and used as an explanatory variable in Equation (3).  $\hat{H}$  is the instrumental variable for HO, which is the predicted value of HO.

## 4.2 Explanatory Variables

The socioeconomic and demographic characteristics of individual persons which are available in the census data will be used to explain the three dependent variables discussed in the three equations. We will first explain which variables will be included in each of the equations, and then provide exact definitions and descriptive statistics of these variables.

### 4.2.1 Single person household formation model

The explanatory variables included in the single person household model are marital status, gender, age, the interaction of marital status and age, as well as educational level.

Based on common sense, it is obvious that marital status is the most important factor which influences an adult person becoming the head of a single person household or not. We expect that unmarried, divorced or widowed persons will have a higher probability than those who are married but living alone which by definition constitutes a single person household.

Age can represent the life cycle effect of a person. The effect of age may not

<sup>3</sup> The derivation of Equation (2) can be shown as follows:

$$\begin{aligned} \Pr(\text{HO} = 1 | \text{SINGLE} = 1) &= \frac{\Pr(\text{HO} = 1, \text{and } \text{SINGLE} = 1)}{\Pr(\text{SINGLE} = 1)} = \frac{\Pr(\text{HO} = 1, \text{and } \text{SINGLE} = 1) * \Pr(X, Y) / \Pr(X, Y)}{\Pr(\text{SINGLE} = 1) * \Pr(X) / \Pr(X)} \\ &= \frac{\Pr(\text{HO} = 1, \text{and } \text{SINGLE} = 1, X, \text{and } Y) / \Pr(X, Y)}{\Pr(\text{SINGLE} = 1, \text{and } X) / \Pr(X)} \\ &= \frac{\Pr(\text{HO} = 1, \text{and } \text{SINGLE} = 1 | X, Y)}{\Pr(\text{SINGLE} = 1 | X)} = \frac{\Phi(\beta'Y, \alpha'X, \rho)}{\Phi(\alpha'X)} \end{aligned}$$

(For more details see Greene, 2008, Chapter 23 & Chapter 24)

<sup>4</sup>  $\text{SINGLE}_i^* = \alpha X_i + u_i, \text{SINGLE}_i = 1$  if  $\text{SINGLE}_i^* > 0$  and 0 otherwise,  $\text{HO}_i^* = \beta'Y_i + v_i, \text{HO}_i = 1$  if  $\text{HO}_i^* > 0$  and 0 otherwise,  $(u_i, v_i) \sim \text{BVN}(0, 0, 1, \sigma_v, \rho)$



be the same at different times in life. In order to capture the different effects at different times in a life cycle, age is categorized as categorical variables by age groups of every 5 years between ages 20-85. If age is a continuous variable, the age effect is constrained which limits the possibilities in variation of age effect. However, coefficients obtained from a set of categorical variables are meant to compare the differences in effect between groups and care should be taken in their use to explain causation.

In addition, the pattern of the cycle can be different for people with different marital status. Hence, the interaction terms between age and marital status are included. For example, it is expected that an unmarried person, other things being equal, is increasingly more likely to live alone from their youth to middle age with an increasing sense of a psychological need to be independent, until old age when s/he is no longer capable of living alone.

With respect to educational level, we expect that a person with a higher educational level will more likely be able to afford to economically live alone, other things being equal. With respect to gender, based on Chinese social norms, an adult male who is not bound by a marriage obligation is expected to be much more independent than an adult female; hence, the male has a higher probability of living alone than a female.

#### **4.2.2 Homeownership decision model**

Explanatory variables included in the tenure choice model for single person households are age, educational level, gender, marital status, whether the individual is holding a job or not, and location dummies that indicate counties /cities of residence.

The homeownership decision is basically affected by the need for stability and economic affordability. All past studies on tenure choice have shown that married household heads with multi-family members usually have the highest probability of becoming a home owner compared to other types of marital status, e.g., Hsueh and Chen (1999). In the case of a single person household, we will expect widowed persons to have the highest probability of becoming home owners, as a result of their inheriting homeownership from their previous marriage. A married person who lives alone in most cases does so due to a temporary need to work away from home; hence, his/her needs to own a residence away from home are fewer than for those with other types of marital status.

With respect to age, we will expect that the probability of owning a residence increases with age due to the desire for stability. In addition, age can also reflect the amount of wealth accumulation in the life cycle.

Educational level and holding a job or not can be proxies for the economic affordability of being a homeowner. On the other hand, the educational levels

of a person can also be a proxy for his/her mobility (Hsueh et al., 2007). Higher education brings higher employability elsewhere which consequently gives rise to less need for homeownership. Hence, the effect of education levels on homeownership is uncertain. Location dummies can be used to control for housing price differences in different regions in Taiwan.

With respect to gender, from the market observation of Sichelman (2007), we can tentatively expect that female single person households will have a higher probability of owning their residence, other things being equal, because they will derive a stronger sense of stability and security from homeownership.

#### **4.2.3 Living space decision model**

The explanatory variables included in the living space decision model of single person households are age, educational level, gender, whether or not a job is being held, whether the individual concerned is a homeowner or not and location dummies that indicate the counties/cities of residence.

Home ownership is considered to also affect the decision with regards to living space. Because the cost of owning a residence is much higher than that of renting in Taiwan, especially in the inner city areas, owners may have to sacrifice living space. On the other hand, due to the high transaction costs associated with owning, the decision to own reflects a willingness to stay in that residence for a longer period of time; hence, the individual concerned may decide to have a larger living space to enjoy a better living quality. By combining two opposite effects, the effect of ownership on living space is uncertain.

Educational level, age and whether a job is being held or not are included as proxies for economic affordability. With respect to gender, from the market observation of Sichelman (2007), we can tentatively expect that female single person households will prefer larger living spaces, because they may stay at home longer in their spare time, and also receive their friends at home more frequently.

As mentioned before, the predicted probability of homeownership is used as an instrumental variable in this model to solve for the endogenous nature of this variable. As a consequence, we have to take care of the identification problem between Equations (2) and (3). Among all the available variables, marital status is considered to be less related to the decision with regards to living space, and so it is not included in Equation (3) for identification purposes.

The notation and definitions of the variables for these three models are summarized in Table 1. The descriptive statistics for these variables according to the census year for the whole sample and for single person household heads and the rest of the individuals are presented in Tables 2, 3 and 4.

**Table 1 Notation and Definitions of Variables**

<b>Marital Status</b>	M1	=1 if Unmarried	<b>Living City</b>	C1	=1 if Taipei County
	M2	=1 if Married or Cohabiting		C2	=1 if Ilan County
	M3	=1 if Divorced or Separated (control)		C3	=1 if Taoyuan County
	M4	=1 if Widowed		C4	=1 if Hsinchu
				C5	=1 if Miaoli County
<b>Education Level</b>	E1	=1 if Primary School Level (6 or less years of education)		C6	=1 if Taichung County
	E2	=1 if High School Level (control) (7-12 years or less of education)		C7	=1 if Changhua County
	E3	=1 if College Level and above (more than 12 years of education )		C8	=1 if Nantou County
<b>Age</b>	Age1	=1 if age is 20~25		C9	=1 if Yunlin County
	Age2	=1 if age is 26~30		C10	=1 if Chia-I
	Age3	=1 if age is 31~35		C11	=1 if Tainan County
	Age4	=1 if age is 36~40(control)		C12	=1 if Kaohsiung County
	Age5	=1 if age is 41~45		C13	=1 if Pingtung County
	Age6	=1 if age is 46~50		C14	=1 if Taitung County
	Age7	=1 if age is 51~55		C15	=1 if Hualien County
	Age8	=1 if age is 56~60		C16	=1 if Penghu County
	Age9	=1 if age is 61~65		C17	=1 if Keelung City
	Age10	=1 if age is 66~70		C18	=1 if Taichung City
	Age11	=1 if age is 71~75		C19	=1 if Tainan City
	Age12	=1 if age is 76~80		C20	=1 if Taipei City (control)
	Age13	=1 if age is 81~85		C21	=1 if Kaohsiung City
	Age14	=1 if age is 86~90		<b>Gender</b>	MALE =1 if male
	Age15	=1 if age is 91~95		<b>At work or not</b>	WITHJOB =1 if the individual currently holds a job

#### 4.2.4 Descriptive Statistics

From Table 2, we can find that the ratio of single person households for all independent variables has increased over the years. Most noticeably, the ratio of females who became single person households increased from 1.8% to 8.3% from 1980 to 2000, while for males, the ratio only increased from 4.0% to 9.8% over the same period of time. Divorced or separated persons have the highest ratio among the four types of marital status of being single person households, namely, 20.3%, 24.0% and 26.4% respectively, for the three census years, while the ratios for being a single person household for the other three types of marital status all markedly increased. The ratio for widowed persons increased from 8.3% to 23.4% from 1980 to 2000, while that for unmarried persons increased from 6.4% to 13.3%, and that for married persons increased from 1.1% to 5.4% over the same period of time. With respect to educational level, high school level had a slightly higher ratio in terms of being a single person household than the other educational levels.

**Table 2 Ratios of Single Person Households among All Individuals**

Variables (Notation)	ALL					
	1980 (n=894108)		1990 (n=1242914)		2000 (n=1474575)	
	Mean	Std.	Mean	Std.	Mean	Std.
<b>Dependent Variables</b>						
Homeownership(HO)						
HO=1	0.0517	0.2215	0.105	0.3065	0.1664	0.3724
HO=0	0.025	0.156	0.0401	0.1962	0.0775	0.2674
<b>Independent Variables</b>						
Gender (MALE)						
MALE=1	0.0401	0.1962	0.0634	0.2436	0.0979	0.2972
MALE=0	0.0184	0.1345	0.0389	0.1933	0.0825	0.2751
Marital Status						
Unmarried (M1)	0.0644	0.2454	0.0949	0.2931	0.1330	0.3396
Married or Cohabiting (M2)	0.0113	0.1057	0.0216	0.1453	0.0544	0.2269
Divorced or Separated (M3)	0.2027	0.4020	0.2407	0.4275	0.2643	0.4409
Widowed (M4)	0.0825	0.2752	0.1681	0.3740	0.2343	0.4236
Education Level						
Primary School Level (E1)	0.0302	0.1713	0.0467	0.211	0.0859	0.2802
High School Level (E2)	0.0303	0.1715	0.0552	0.2283	0.0972	0.2963
College Level and above (E3)	0.0289	0.1675	0.0504	0.2188	0.0881	0.2834
At Work or not (WITHJOB)						
WITHJOB=1	0.0287	0.167	0.0565	0.2308	0.099	0.2987
WITHJOB=0	0.0304	0.1716	0.0475	0.2127	0.0852	0.2791

Individuals who held a job had a slightly higher ratio of living alone compared with those who had no job in the 1990 and 2000 censuses. In addition, students compared with those who were not students had a higher ratio of living alone in all three censuses.

From Table 3, we can find that both the home ownership rate and living spaces of single person households are increasing from 1980 to 2000. By comparing Table 3 with Table 4, we can find that the home ownership rates of single person households are much lower than those of the remaining adult individuals.<sup>5</sup> However, their living space per person is much larger. The number of females as the heads of single person households has significantly increased over the years. Females accounted for 30% of all single person household heads in 1980, and increased to 46% in 2000.

**Table 3 Descriptive Statistics of Single Person Households**

Variables (Notation)	Unit	Single Person Households					
		1980 (n=26544)		1990 (n= 63689)		2000 (n= 132900)	
		Mean	Std.	Mean	Std.	Mean	Std.
<b>Dependent Variables</b>							
Homeownership (HO)	(0,1)	0.6928	0.4613	0.6478	0.4776	0.7380	0.4397
Living Space per Person (PERA)	ping <sup>+</sup>	17.1338	14.9019	18.6714	16.3764	23.0339	18.4784
<b>Independent Variables</b>							
Gender (Male)	(0,1)	0.7023	0.4572	0.6244	0.4843	0.5379	0.4986
Age (Year old)	year	48.86	15.70	49.19	17.21	47.78	16.53
<b>Marital Status*</b>							
Unmarried (M1)		0.4891	0.4999	0.4171	0.4931	0.3503	0.4771
Married or Cohabiting (M2)		0.2685	0.4432	0.2930	0.4551	0.4066	0.4912
Divorced or Separated (M3)		0.0873	0.2823	0.1075	0.3098	0.0974	0.2965
Widowed (M4)		0.1551	0.3620	0.1823	0.3861	0.1457	0.3528
<b>Education Level*</b>							
Primary School Level (E1)		0.7114	0.4531	0.6298	0.4829	0.4797	0.4996
High School Level (E2)		0.1565	0.3633	0.2810	0.4495	0.3778	0.4848
College Level and Above (E3)		0.1321	0.3386	0.0892	0.2851	0.1425	0.3496
At Work or not (WITHJOB )	(0,1)	0.5995	0.4900	0.5414	0.4983	0.6057	0.4887

**Note:** \* The ratios of the four types of marital status add to 1, as do the ratios for the three levels of education; +One ping equals 3.3 square meters.

The average age of the remaining adult individuals increased from 38.6 in 1980 to 42.4 in 2000 which reflects the overall aging of the population. However, the ages of the single person household heads remain about the same, 49 to 48, for the three census years.

<sup>5</sup> The homeownership rate for the rest of the adults is calculated by individuals and not by households. Because on average there are more adults in those households with homeownership than those without, the homeownership rate calculated based on individuals (87%) is higher than the homeownership rate calculated based on households (82.2%).

The distribution of the marital status of the heads of single person households also changed drastically from one census to the next. In 1980, 49% of them were unmarried and 27% were married. However, in 2000, the share of those unmarried decreased to 35%, while that of those married increased to 41%. This reveals that there was a drastic increase in the number of married couples who had to live separately in different cities due to work or for other reasons. The share of those widowed in single person households remained rather stable, namely, ranging from 15% to 18% for the three census years. These figures were much higher than those for the rest of the population which remained at about 5% for the three censuses.

The distribution of educational level between single person households and the rest of the households is not very different, with a slightly higher proportion for the college level and above and a slightly lower proportion for the high school level for the single person households than for the rest of the population.

**Table 4 Descriptive Statistics of the Rest of the Adult Individuals**

Variables (Notation)	Unit	The Rest of the Adult Individuals					
		1980 (n= 867564)		1990 (n=1179225)		2000 (n=1341675)	
		Mean	Std.	Mean	Std.	Mean	Std.
<b>Dependent Variables</b>							
Homeownership (HO)	(0,1)	0.8277	0.3776	0.8378	0.3686	0.8700	0.3363
Living Space per Person (PERA)	ping <sup>+</sup>	4.8464	3.7523	7.8682	5.6585	9.0159	6.3043
<b>Independent Variables</b>							
Gender (MALE)	(0,1)	0.5153	0.4998	0.4985	0.5000	0.4907	0.4999
Age	year	38.55	14.86	40.27	14.92	42.35	15.26
<b>Marital Status*</b>							
Unmarried (M1)		0.2175	0.4125	0.2149	0.4108	0.2262	0.4184
Married or Cohabiting (M2)		0.7193	0.4494	0.7180	0.4500	0.6997	0.4584
Divorced or Separated (M3)		0.0105	0.1020	0.0183	0.1341	0.0269	0.1617
Widowed (M4)		0.0528	0.2236	0.0487	0.2153	0.0472	0.2120
<b>Education Level*</b>							
Primary School Level (E1)		0.7169	0.4505	0.5919	0.4915	0.4516	0.4977
High School Level (E2)		0.1752	0.3801	0.3349	0.4719	0.4277	0.4948
College Level and Above (E3)		0.1079	0.3103	0.0733	0.2606	0.1206	0.3257
At Work or not (WITHJOB)	(0,1)	0.5853	0.4927	0.5861	0.4925	0.6445	0.4787
Number of Family Members	persons	6.2926	2.9547	5.1081	2.3796	4.5367	2.1940

**Notes:** \* The ratios for the four types of marital status add up to 1, and similarly, for the ratios of the three levels of education.

+One ping equals 3.3 square meters.

## 5. Discussion of the Estimation Results

The three models are separately estimated by census years, due to the fact that the variances of the residuals for Equation (1) from each census year are significantly different.<sup>6</sup> This result reveals an obvious structural change with respect to single person household formation among the population for the three census years. Therefore, it is not appropriate to pool data together. In addition, the marginal effects<sup>7</sup> rather than the original estimated coefficients of the independent variables are presented for the probit models in Equations (1) and (2). The estimated results are discussed in turn in the following section.

### 5.1 Single Person Household Formation Model

The estimated results are presented in Table 5 and Figures 3 and 4. From Table 5 and Figure 3, we can find that among the four types of marital status, it is the divorced or separated persons that are most likely to become single person households. On the contrary, married or cohabiting persons are the least likely to become single person households, with the widowed being the next least likely. However, for those who are unmarried, the probability of living alone increases from one census to the next.

Figure 5 shows the cross effect between marital status and age<sup>8</sup>. The probability of unmarried persons becoming single person households increases with age until a peak and then declines. The peak shifts by about 10 years from age 55 to age 65 and to age 75 for the three census years. This reveals an obvious cohort effect, meaning that the peaking phenomenon is

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<sup>6</sup> An F test is performed based on the variance of the residuals of Equation (1) between 1980 and 1990 as well as between 1990 and 2000. The P values are 0.0067 and 0.0000, respectively, which means the variances are significantly different in these two years.

<sup>7</sup> The definition of the marginal effects for any categorical explanatory variable  $X_i$  in Equation (1) is  $F(X=1)-F(X=0)$ , where  $F(X)$  is  $\Phi(\alpha'X)$ ; the definition of the marginal effects for any categorical explanatory variable  $Y$  in Equation (2) is  $F(Y=1)-F(Y=0)$ , where  $F(Y)$  is  $\Phi(\beta'Y, \alpha'X, \rho)$ . The way to calculate them can be found in Greene (2008).

<sup>8</sup> The data used to construct the graphs in Figure 4 are described as follows: the set of estimated marginal effects for Age (Age1-Age13) consists of the effects for the married persons (M2) (the omitted group). The set of estimated marginal effects for M1 \*Age represents the differences in the effects between married and unmarried persons for respective age groups. Therefore, in order to obtain the total marginal effect on those who are unmarried aged 20-25, the marginal effects of Age1 and M1 need to be added to the marginal effect of MA11. (For example, the total marginal effect for those unmarried, aged 20-25, for the 1980 sample is  $-0.0184+(-0.0136)+0.0663=0.0663$ .) All other age groups in M1 and all other marriage types are similarly calculated.

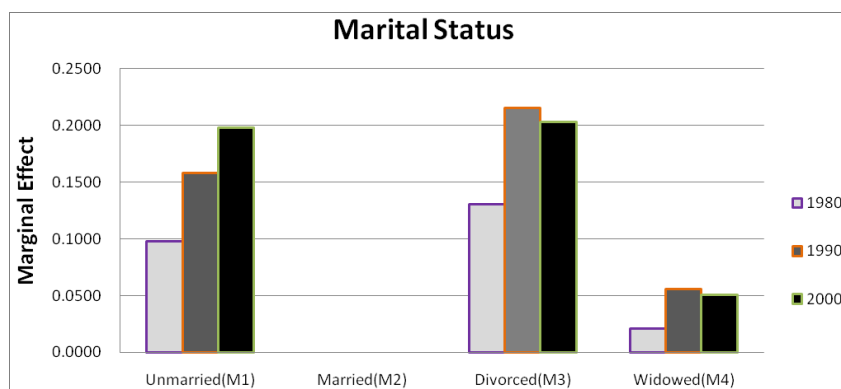
caused by the same group of people who had aged 10 years from one census to the next. A large portion of this group of people may have been unmarried veterans who came from mainland China in 1949 with the government. Although the government initiated consecutive programs in the 1970s to accommodate a large number of them in institutions, the effect of this group of people can still be seen in the census.<sup>9</sup>

The effect of those married or cohabiting with respect to age reveals that the probability of living alone has been near zero for all ages and in all three censuses.

The effect of being widowed with respect to age reveals that the probability of becoming a single person household gradually increases after the age of 40 until the age of 65 or 70; then it declines. The decline may be due to the fact that the capacity to live alone gradually diminishes with age. Furthermore, the probability of becoming a single person household is increasing from one census to the next after the age of 40; this reveals the trend that in more recent days, middle- to old-aged widowed persons are more likely to live alone than before. The effect of being divorced with regard to age is very similar to that of being widowed with respect to age, in the sense that the probability increases with age until the mid-60s, and then declines.

With respect to education, the results show that a higher educational level means a greater likelihood for him/her to live alone. This result is as expected. Furthermore, the effect becomes stronger with time. The male is more likely to live alone than the female, which is also expected, but the effect is decreasing between 1980 and 1990 and remains about the same in 2000.

**Figure 3 Marital Status Effect on Formation of Single Person Households**



<sup>9</sup> Some 600,000 soldiers came to Taiwan in 1949 with the government. At the end of 1987, 570,000 of them had been discharged. The government implemented a ten-year program and then a five-year program consecutively to accommodate elderly, low income and mostly unmarried veterans (Shih, 1994).



Table 5 Estimation Result of the Single Person Household Model

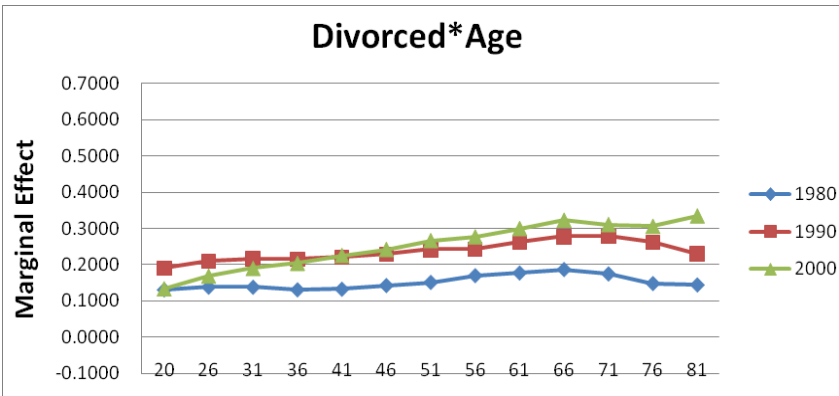
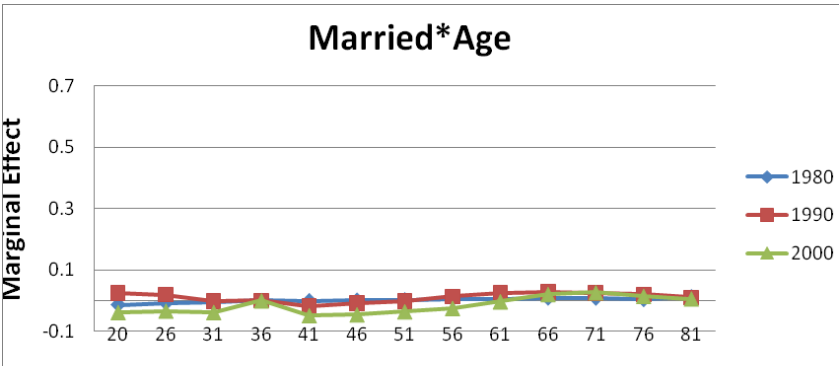
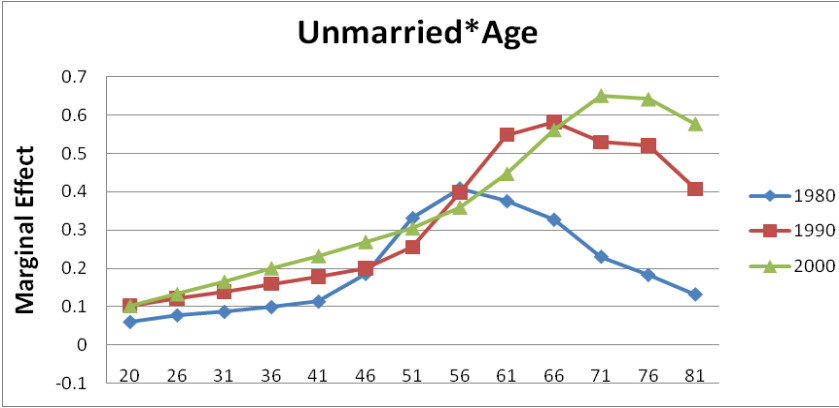
Independent Var.	1980	1990	2000	Independent Var.	1980	1990	2000
<b>Marital Status and Age Cross Item</b>				51~55 (MA47)	0.0139*	0.0202*	0.0363*
<b>M1*Age</b>				56~60 (MA48)	0.0273*	0.0424*	0.0611*
20~25 (MA11)	-0.0187*	-0.0324*	0.0361*	61~65 (MA49)	0.0361*	0.0605*	0.1055*
26~30 (MA12)	-0.0098*	-0.0188*	0.0350*	66~70 (MA410)	0.0350*	0.0648*	0.1496*
31~35 (MA13)	-0.0057*	-0.0088*	0.0358*	71~75 (MA411)	0.0358*	0.0592*	0.1594*
36~40 (MA14)	-	-	0.0331*	76~80 (MA412)	0.0331*	0.0519*	0.1389*
41~45 (MA15)	0.0158*	0.0153*	0.0171*	81~85 (MA413)	0.0171*	0.0383*	0.1232*
46~50 (MA16)	0.0796*	0.0328*	0.0445*	<b>Age</b>			
51~55 (MA17)	0.2096*	0.0795*	0.0709*	20~25 (Age1)	-0.0137*	-0.0246*	-0.0370*
56~60 (MA18)	0.2632*	0.2055*	0.1193*	26~30 (Age2)	-0.0078*	-0.0194*	-0.0280*
61~65 (MA19)	0.2219*	0.3222*	0.2001*	31~35 (Age3)	-0.0039*	-0.0104*	-0.0151*
66~70 (MA110)	0.1673*	0.3256*	0.3086*	36~40 (Age4)	-	-	-
71~75 (MA111)	0.0864*	0.2793*	0.3843*	41~45 (Age5)	-0.0006	0.0037*	0.0110*
76~80 (MA112)	0.0666*	0.2746*	0.3615*	46~50 (Age6)	0.0010	0.0051*	0.0193*
81~85 (MA113)	0.0054	0.1657*	0.2955*	51~55 (Age7)	0.0023*	0.0066*	0.0237*
<b>M3*Age</b>				56~60 (Age8)	0.0048*	0.0080*	0.0048*
20~25 (MA31)	0.0133*	-0.0003	-0.0332*	61~65 (Age9)	0.0062*	0.0143*	0.0245*
26~30 (MA32)	0.0151*	0.0127*	-0.0071	66~70 (Age10)	0.0082*	0.0215*	0.0239*
31~35 (MA33)	0.0109*	0.0111*	0.0011	71~75 (Age11)	0.0082*	0.0209*	0.0291*

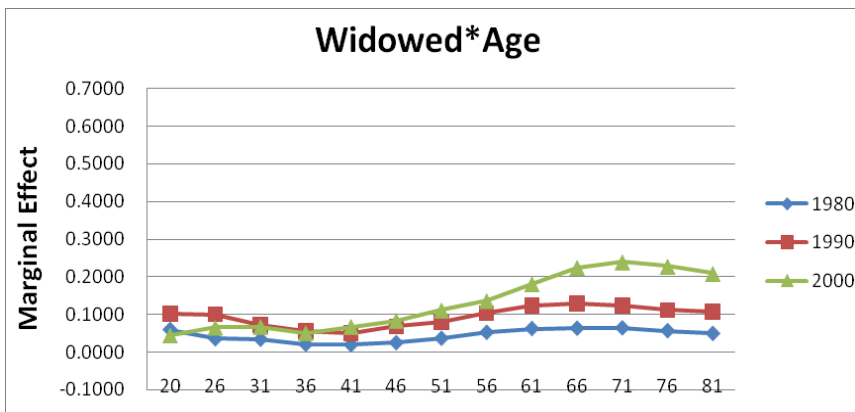
Independent Var.	1980	1990	2000	Independent Var.	1980	1990	2000
36~40 (MA34)	-	-	-	76~80 (Age12)	0.0034	0.0211*	0.0379*
41~45 (MA35)	0.0021	0.0007	0.0104*	81~85 (Age13)	0.0121*	0.0216*	0.0345*
46~50 (MA36)	0.0107*	0.0090*	0.0188*	<b>Marital Status</b>			
51~55 (MA37)	0.0181*	0.0193*	0.0387*	Unmarried(M1)	0.0981*	0.1582*	0.1982*
56~60 (MA38)	0.0342*	0.0193*	0.0487*	Married(M2)	-	-	-
61~65 (MA39)	0.0402*	0.0318*	0.0707*	Divorced(M3)	0.1301*	0.2151*	0.2032*
66~70 (MA310)	0.0478*	0.0401*	0.0944*	Widowed(M4)	0.0209*	0.0559*	0.0507*
71~75 (MA311)	0.0358*	0.0420*	0.0775*	<b>Education Level</b>			
76~80 (MA312)	0.0138**	0.0261*	0.0635*	Primary School (E1)	-0.0083*	-0.0111*	-0.0182*
81~85 (MA313)	0.0013*	-0.0070	0.0957*	High School (E2)	-	-	-
<b>M4*Age</b>				College Level and above (E3)	0.0044*	0.0086*	0.0199*
20~25 (MA41)	0.0531*	0.0595*	0.0304	<b>Other Variables</b>			
26~30 (MA42)	0.0227*	0.0519*	0.0421*	MALE	0.0055*	0.0106*	0.0106*
31~35 (MA43)	0.0175*	0.0193*	0.0314*	Wald Chi-square	57803	95144	100000
36~40 (MA44)	-	-	-	Pseudo R-Square	0.2732	0.2136	0.1179
41~45 (MA45)	-0.0006	-0.0059	0.0052	Number of observations.	894108	1242914	1474575
46~50 (MA46)	0.0032	0.0107*	0.0131**				

**Notes:** \* means that the coefficients are statistically significant at the 5% level.

\*\* means that the coefficients are statistically significant at the 10% level.

**Figure 4 Cross Effect between Age and Marital Status on Formation of Single Person Households**





*Note:* The lower ends of the age groups are shown on the horizontal axis.

## 5.2 Homeownership Model of Single Person Households

The estimation results are presented in Table 6 and Figures 5 and 6. The effect of age on the homeownership rate is quite different in each of the three census years. For 1980, the homeownership rate peaked around age 36-40 and drastically declined until age 61-65 and increased again until old age. The middle-aged persons who lived alone in the 1980s were very probably relatively disadvantaged persons, including large numbers of veterans who could not afford to own their residence. The increasing trend toward homeownership in old age may have been due to the increase in widowhood in old age, with the surviving spouse inheriting the home from the former marriage. For 1990, the homeownership rate continued to increase with age until old age, being only slightly lower around age 56-65. For 2000, the homeownership rate increased with age until age 61-65 and then gradually declined. The shape of the curve for different ages for 2000 is more in conformity with the life cycle theory which predicts that the homeownership rate increases with the accumulation of wealth from a young age until retirement. This shape indicates that the life cycle of a person who lives alone has become similar to that of the rest of the population (Hsueh et al., 2009). This result for 2000 is also similar to those from the research by Bonvalet and Lelièvre (1997). They find that elderly single persons tend to change their tenure status from owning to renting in France and Great Britain.

The effect of marital status on the homeownership rate shows that widowed single person household heads have the highest probability of owning through inheritance from their former marriage, which is as expected. The unmarried are the next highest. The increases in the homeownership rate for unmarried persons from one census to the next reflects an important social change in Taiwan in that more and more unmarried persons consider the status of being

unmarried to be permanent, and hence choose a longer-term living arrangement, i.e., by owning their residence.

Divorced persons usually go through a property split and restructuring, and this is reflected in the lowest or the second lowest homeownership rate among the four types of marital status. The effect for 1980 is the lowest, and the effect for 1990 is slightly higher than that of married persons (the benchmark group) and significant at the 10% level. The effect for 2000 is not, however, significantly different from that of married persons. In sum, divorced single persons were the least likely to own a home in 1980, but their homeownership rate status was improving over time. This is probably due to the divorce rate increasing over time in Taiwan, and that society as a whole and Civil Law has become more supportive in terms of the wife sharing in the ownership of household property<sup>10</sup>.

The married or cohabiting persons who live alone away from home usually do so on the basis of a temporary arrangement due to work relocation or other reasons; hence, it is less necessary to own the residence.

Female single person household heads have a higher probability of owning their residence than males which conforms to our expectations. We speculate that homeownership can give rise to more utility for females than males. This result supports the market observation reported by Sichelman (2007) in the U.S. housing market.

As for the effect of educational level, in 1980, the results show that persons with a primary school education level have the highest probability of being a homeowner; however, in 1990 and 2000, persons with higher education have a higher probability of being a homeowner.

Persons who hold a job had a lower probability of owning their residence in 1980, but the probability was higher in 1990 and 2000. From the estimated results based on educational level and holding a job, with both serving as a proxy for income, we can see that in 1980, the relationship between income and homeownership may have not been as close as that in 1990 and 2000. This may be due to the fact that in the 1980s, Taiwan was not as urbanized as in 1990 and 2000; hence, the price of housing with respect to income was relatively lower.

For location dummies, we can find that only Taichung city has a lower effect than Taipei for all three censuses. The effects of Tainan and Kaohsiung are

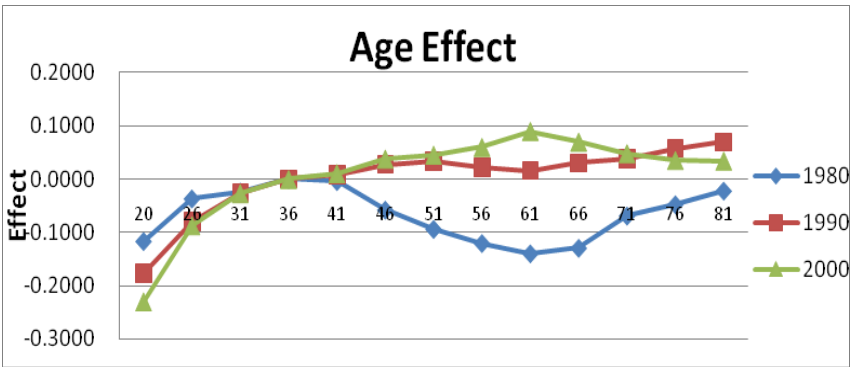
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<sup>10</sup> In 1984, the Civil Law in Taiwan underwent a major revision in household property sharing arrangements between spouses. Before the revision, the wife basically could not share any of the property when the marriage was dissolved.

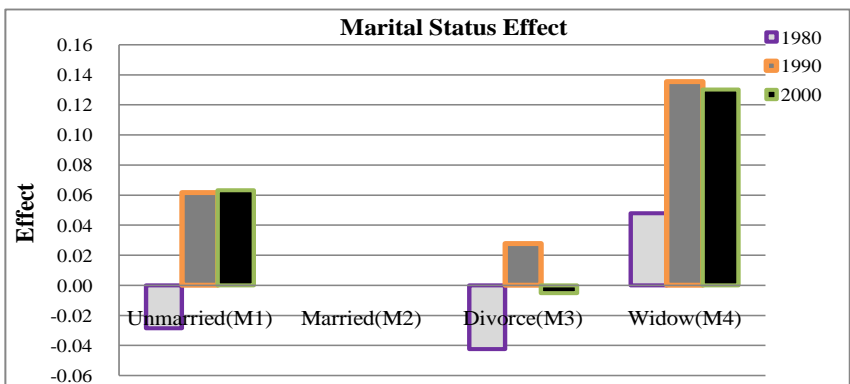
smaller than for other cities/counties. This reflects the higher housing prices in big cities.

Lastly, the estimated  $\rho$  is significant and positive in all three censuses, which indicates that some unobserved factors which positively affect the formation of single person households also positively affect the homeownership decision (Greene, 2008).

**Figure 5 Effect of Age on the Homeownership of Single Person Households**



**Figure 6 Effect of Marital Status on the Homeownership of Single Person Households**



**Table 6 The Estimation Result of the Homeownership Model for Single Person Households**

Independent Var.		1980	1990	2000	Independent Var.	1980	1990	2000	
<b>Age</b>					<b>City/County</b>				
20~25	(Age1)	-0.1196*	-0.1787*	-0.2311*	Taipei County	(C1)	0.1192*	0.0662*	0.1090*
26~30	(Age2)	-0.0379**	-0.0808*	-0.0882*	Ilan County	(C2)	0.1084*	0.0963*	0.1371*
31~35	(Age3)	-0.0241	-0.0272*	-0.0270*	Taoyuan County	(C3)	0.1547*	0.0711*	0.0662*
36~40	(Age4)	-	-	-	Hsinchu	(C4)	0.0999*	0.0424*	0.0429*
41~45	(Age5)	-0.0038	0.0077	0.0113	Miaoli County	(C5)	0.1079*	0.1846*	0.1564*
46~50	(Age6)	-0.0574*	0.0274*	0.0387*	Taichung County	(C6)	0.1528*	0.1022*	-0.0045
51~55	(Age7)	-0.0931*	0.0342*	0.0462*	Changhua County	(C7)	0.1702*	0.2612*	0.2013*
56~60	(Age8)	-0.1195*	0.0217*	0.0606*	Nantou County	(C8)	0.1126*	0.1255*	0.1163*
61~65	(Age9)	-0.1390*	0.0164	0.0907*	Yunlin County	(C9)	0.2033*	0.3278*	0.2360*
66~70	(Age10)	-0.1287*	0.0304*	0.0709*	Chia-I	(C10)	0.1534*	0.1343*	0.1077*
71~75	(Age11)	-0.0682*	0.0378*	0.0496*	Tainan County	(C11)	0.1478*	0.2101*	0.1426*
76~80	(Age12)	-0.0469	0.0574*	0.0371*	Kaohsiung County	(C12)	0.1222*	0.0899*	0.0796*
81~85	(Age13)	-0.0213	0.0695*	0.0356*	Pingtung County	(C13)	0.1108*	0.1381*	0.1112*
					Taitung County	(C14)	0.1799*	0.1065*	0.0955*
					Hualien County	(C15)	0.1691*	0.1154*	0.0753*
<b>Education Level</b>					Penghu County	(C16)	0.0329	0.0331	0.0402*
Primary School(E1)		0.0455*	-0.0296*	-0.0435*	Keelung City	(C17)	0.0818*	0.0708*	0.0825*
High School(E2)		-	-	-	Taichung City	(C18)	-0.0071	-0.0528*	-0.0358*
College Level and above(E3)		0.0245*	0.0179*	-0.0005	Tainan City	(C19)	0.0003	0.0374*	-0.0387
					Taipei City	(C20)	-	-	-
					Kaohsiung City	(C21)	0.0448*	-0.0019	0.0140*
<b>Marital Status</b>					<b>Other Variables</b>				
Unmarried(M1)		-0.0286	0.0617*	0.0632*	MALE		-0.0517*	-0.0261*	-0.0294*
Married(M2)		-	-	-	WITHJOB		-0.0497*	0.0152*	0.0295*
Divorce(M3)		-0.0425*	0.0278**	-0.0053	Wald Chi-square		1129	3262.9	5237.4
Widow(M4)		0.0480*	0.1355*	0.1302*	Number of observations in the second stage		26544	63689	132900
ρ		0.1214*	0.3016*	0.3766*					

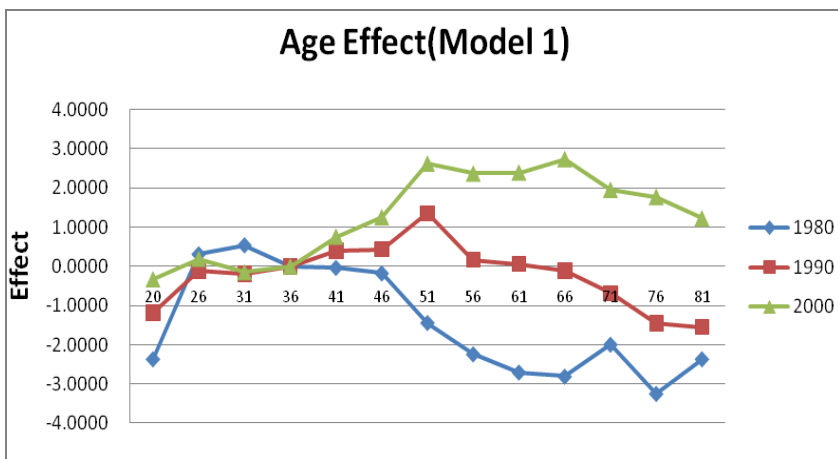
*Note:* \* means that the coefficients are statistically significant at the 5% level. \*\* means that the coefficients are statistically significant at the 10% level.

### 5.3 Living Space Model of Single Person Households

The estimation results of the living space model are shown in Table 7 and Figure 7. For this model, we have also estimated a specification (Model 2) in which the actual homeownership status is used to contrast with the other model (Model 1) where the endogenous nature of the homeownership was considered, i.e., the predicted probability of homeownership was used. The estimated results show that homeownership (HOhat and HO, respectively) has a positive effect on living space in both Models 1 and 2, except in Model 1 for 1980; nevertheless, the effects are greater in Model 1 for 1990 and 2000. This result largely indicates that when a single person decides to own his/her residence, s/he treats the place as home, and so s/he will choose a larger living space at the same time. Meanwhile, the estimated coefficients of other variables between Models 1 and 2 are not very different in sign and magnitude.

The coefficients of the  $\lambda$ s are all significant for all models which indicate that there will exist sample selection bias in estimation if we fail to take account of the effect of single household formation.

**Figure 7 Age Effect of Living Space per Person Decision of Single Person Households**



*Note:* The lower ends of the age groups are shown on the horizontal axis.



Table 7 Estimation Results of the Living Space Model of Single Person Households

Independent Variables		1980		1990		2000	
Age		Model(1)	Model(2)	Model(1)	Model(2)	Model(1)	Model(2)
20~25	(Age1)	-2.4396*	-0.5075*	-1.1845*	-1.4976*	-0.3206	-1.9689*
26~30	(Age2)	0.3085	0.9137*	-0.1137	-0.2678	0.2212	-0.3282
31~35	(Age3)	0.5504	0.8958**	-0.1831	-0.2382	-0.1184	-0.2553
36~40	(Age4)	-	-	-	-	-	-
41~45	(Age5)	-0.0022	0.0281	0.4010	0.4150	0.7869*	0.8141*
46~50	(Age6)	-0.1769	0.4598	0.4307	0.5252**	1.2795*	1.5575*
51~55	(Age7)	-1.4618*	-0.4910	1.3418*	1.4709	2.6474*	3.0184*
56~60	(Age8)	-2.2730*	-1.0357*	0.1619	0.2872	2.3899*	2.9942*
61~65	(Age9)	-2.7469*	-1.3482*	0.0543	0.1773	2.4083*	3.4364*
66~70	(Age10)	-2.8412*	-1.6735*	-0.1255	0.0698	2.7505*	3.6586*
71~75	(Age11)	-1.9820*	-1.6791*	-0.7008**	-0.4208	1.9689*	2.6966*
76~80	(Age12)	-3.2210*	-3.1713*	-1.4647*	-1.0449*	1.7873*	2.4655*
81~85	(Age13)	-2.3218*	-2.5870*	-1.5757*	-1.0423*	1.2363*	2.0232*
<b>Education Level</b>							
Primary School(E1)		-2.9811*	-3.5978*	-4.1747*	-4.2212*	-3.8898*	-4.2160*
High School(E2)		-	-	-	-	-	-
College Level and above (E3)		3.4285*	3.0448*	3.1529*	3.1991*	4.1526*	4.1219*
<b>City/County</b>							
Taipei County (C1)		1.7088*	-0.1647	1.3951*	8.4294*	1.9402*	3.0370*
Ilan County (C2)		-0.2959	-2.0688*	0.4199	-4.2212	8.1172*	9.5618*
Taoyuan County (C3)		3.5039*	0.9516*	2.6711*	3.1991*	9.7332*	10.3723*
Hsinchu (C4)		2.5453*	0.9326**	2.3589*	1.5841*	10.2034*	10.6597*
Miaoli County (C5)		0.4236	-1.3541*	2.9632*	0.7138*	11.3340*	13.0291*
Taichung County (C6)		1.7948**	-0.7135**	2.1968*	2.8576*	10.8727*	10.8638*

Independent Variables		1980		1990		2000	
Changhua County	(C7)	-0.9844	-3.8018*	-1.4296*	2.4782	9.4138*	11.6124*
Nantou County	(C8)	-0.4744	-2.3436*	1.2625*	3.6493*	9.2857*	10.5371*
Yunlin County	(C9)	-1.8059	-5.2126*	-3.0559*	2.5089*	1.7595*	4.3951*
Chia-I	(C10)	-1.6255**	-4.1922*	-0.8649**	-0.3358	4.2231*	5.3843*
Tainan County	(C11)	-1.0841	-3.5536*	-1.8386*	1.6935*	6.1632*	7.7032*
Kaohsiung County	(C12)	-0.0183	-2.0233*	1.2155*	-1.5565*	7.2392*	8.0607*
Pingtung County	(C13)	-1.3685**	-3.2214*	-0.0686	-0.3742	7.1242*	8.3035*
Taitung County	(C14)	0.7133	-2.3631*	-1.7324*	-1.0076*	5.1289*	6.1550*
Hualien County	(C15)	1.2995	-1.5680*	1.5698*	1.4982*	6.1048*	6.8667*
Penghu County	(C16)	1.2645	0.6328	0.6615	0.4076	7.2358*	8.6682*
Keelung City	(C17)	-1.7058*	-3.0299*	-1.0673*	-1.4129**	1.9779*	3.6911*
Taichung City	(C18)	-1.2304*	-1.1626*	2.4730*	1.9037*	6.5295*	6.2233*
Tainan City	(C19)	-1.7732*	-1.8438*	0.6707**	0.8257	9.3612*	9.4709*
Taipei City	(C20)	-	-				
Kaohsiung City	(C21)	-0.2948	-1.0060*	-0.0618	-0.8651	3.6516*	3.8083*
<b>Other Variables</b>							
MALE		-2.4833*	-1.6886*	-1.0984*	-1.2677*	-0.2641*	-0.7138*
WITHJOB		0.0265	0.7388*	1.3821*	1.4480*	0.3809*	0.6836*
HOhat		-10.7777*		11.4975*		15.7011*	
HO			3.3621*		8.4294*		6.2259*
Intercept		22.1226*	14.0926*	9.8720*	11.2205*	2.1905*	7.1373*
lambda		3.6919*	3.2331*	3.3163*	2.2353*	5.0149*	3.6297*
Wald Chi-square		4170	4496	7441	11666	8142	11308
Observation numbers the second stage		26544	26544	63689	63689	132900	132900

*Note:* \* and \*\* means that the coefficients are statistically significant at the 5% and 10% levels respectively.

From Figure 7, we can find that for the census years 1990 and 2000, the living space increased from a young age until around middle age and then declined; the turning points were at ages 51 and 66, respectively. The changes in the age effect in 1990 and 2000 can be explained by the life cycle theory, which predicts that people will improve their quality of life (by increasing their living space) with the accumulation of wealth from the time when they are young until they retire. However, for people who lived alone in the 1980 census, their living space started to decrease as early as the age of 30. This finding is quite similar to that of the homeownership model. This finding again reflects the fact that people who could not have family in the 1980s could not do so owing to their lower socioeconomic status, and the status worsened with age. In addition, we can also find that the living area increases census by census. This reflects the improved affordability for a better living quality due to the continuous economic growth in Taiwan.

As for the educational level, a higher education level means larger living space with each census. Having a job also resulted in a larger living space. Both results confirm the existence of a positive relationship between income and the living space decision among single person households.

As for gender, the results of the estimation show that males have a smaller living space than females. This result supports the market observation obtained by Sichelman (2007) in the U.S.

For the locational dummies, although housing prices are always the highest in Taipei city, the capital of Taiwan, only in 2000 did single person households in Taipei have the smallest living area. The living space elsewhere was smaller than that in Taipei city for 13 out of the 21 cities/counties in 1980 and 8 out of 21 in 1990. This may be due to the differences in housing prices not being as large in 1980 and 1990. This may also be due to the heads of single person households in Taipei city having higher socioeconomic status than those in other places<sup>11</sup>.

## 6. Conclusion

The number of single person households has dramatically increased in Taiwan in the past several decades as elsewhere in the world, but this phenomenon has been largely neglected. This study is a pioneering work in terms of exploring the factors that affect the formation of single person households and

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<sup>11</sup> Many young males in the rural areas cannot locally find a wife. Many of them have to marry a girl from countries with lower levels of economic development through marriage brokers. Hence, we can say that those who remain single in rural areas have relatively low socio-economic status.

their housing decisions. Taiwan's population census data for 1980, 1990 and 2000 are used.

Some interesting trends can be found. First of all, married or cohabiting persons exhibit an increasing trend of living alone with each census. This reflects the increasing need in modern society for the husband and wife to live separately due to employment or other reasons. However, the married single person households have the least probability of owning their residence; this indicates that living alone is basically a temporary arrangement. Secondly, elderly unmarried and widowed persons have been characterized by an increasing probability of living alone over the decades. This finding shows the increasing need for care among this group of elderly persons.

Thirdly, we can find that the number of female single person households is rapidly increasing, and that they have a higher probability of being homeowners and also occupying a larger amount of living space than single males.

In addition, a group of middle-aged persons, who are very probably veterans from mainland China when the government relocated to Taiwan in 1949, have exhibited an obvious economic disadvantage in the sense that they had a lower homeownership ratio and smaller average living space according to the 1980 census.

Generally speaking, the effects of most variables are that they become stronger with each census according to the three equations, which reflect the fact that the proportion of single person households has been increasing in the population over the last two decades and that their living standards are increasing.

To sum up, the results of this study show that the demand for housing among single person households will continue to increase as their numbers increase. Their demand for homeownership and living space are also increasing. These results should have important implications for the housing market in Taiwan.

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