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A Female Cohort Analysis of Housing Choices in Taiwan—Comparing the Female as Head and not as Head of the Household

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In this study, we follow the female in a cohort analysis of her housing choices in Taiwan, using data from the population and housing census for 1980, 1990 and 2000. In addition to looking at the female population as a whole, we also compare the differences between females who are heads of households and those who are not. Econometric models focusing on the tenure choice of housing and living space per person are estimated simultaneously.

The age effects show that households have the highest homeownership rate and lowest amount of living space per person in their middle years. This is due to persons in their middle years having the highest accumulated wealth and also the largest household size during their life cycle. However, no clear trend can be found in the male sample with respect to the age effect in their middle years, for instance, 25-60, for both homeownership and living space. Hence, the female is probably more suitable than the male in terms of representing a household during its life-cycle.

The birth cohort effect shows that the earlier a female is born, the higher is the probability that she will become a homeowner and occupy a larger living space. This result can also be found in studies on male cohorts. These findings thus raise our concerns over the disadvantages that the younger generation faces in becoming homeowners.

In addition, we find that the age and birth cohort effects are very different for female-headed and non-female-headed households. Although on average, the female heads have more years of education and higher job participation rates, they have lower homeownership rates. They also benefit less from economic growth. Nevertheless, the gap between the female-headed and non-female-headed households has narrowed as the birth cohort has become younger.

Keywords

Cohort effect; Tenure choice; Housing demand; Female cohort; Female head

1. Introduction

The homeownership rate in Taiwan has gradually increased with the passing of time. In the 2000 census, it reached a very high level of 82.2%. Various aspects of housing behavior, such as the choice of tenure and housing demand, have been researched by many scholars in Taiwan. However, the effect of the age cohort on housing decisions has often been neglected. Age plays two roles in cross-sectional household data. It reflects both the life-cycle needs and different macro-environment of each cohort at the time of birth. Hsueh and Yen (2006) are the first to explore this issue for Taiwan. They find that earlier cohorts in Taiwan have a significant advantage in terms of becoming homeowners. This is an intergenerational equity issue that has become a focus of concern.

By using the same approach and data as Hsueh and Yen (2006), this study approaches the issue from a different angle in that it follows the female cohort. The choice of housing is typically a form of household behavior in the sense that it has to take care of the needs of every household member. In a male-dominated Chinese society, it is reasonable to believe that, in most cases, the male household head makes the decisions for all household members. Therefore, in the past, following the male household head as representing the household has been a natural choice in a cohort analysis in studying household behavior. However, as times have changed, with the improvements in female education attainment and increase in job market participation, the status of the female in family decisions has significantly increased. At the same time, the number of households with no adult male, such as single-mother or single-female households, has also significantly increased. Therefore, a cohort study which only follows the male birth cohort can not represent the welfare of the whole population. Hence, a study that follows the female in a cohort analysis of their housing choices is warranted.

In addition to observing the female as a whole, we will also divide the samples into sub-samples with the female as the head of the household and also not as the head, because the behavior of these two types of households could be very different. We thus expect that the results of the non-head part, in general, will not tend to be very different from that of male household heads with respect to the age and birth cohort distribution, since for these households, males and females both participate in the decision–making. However, the results for the housing choices of female heads could be very different. In the literature, poverty among females has been found in Taiwan (e.g., Wang and Ho, 2006) and the world (e.g., Rodgers, 1990). Therefore, we will like to find out whether female-headed households are at a disadvantage in terms of their housing decisions and housing welfare, and how such households may evolve with respect to their birth cohorts and life cycle.

Technically speaking, we will build models that take into account the effect of the census year, as well as the effect of the age and birth cohorts of a designated female in each household in order to analyze their housing tenure choice and consumption decisions. Individual household data that are obtained from the Population and Housing Census for the years 1980, 1990 and 2000 for Taiwan will be used to estimate the model.

2. Literature Review

In a survey article, Myers (1999) states that the effect of the cohort has been minimally discussed in the housing literature, and also refers to several misinterpretations of past research results using one set of cross-sectional data. For example, he notes that past research assumes that the "elderly would return from the suburbs to the cities. In fact, the elderly observed in the cities had always lived in those cities; the young families in the suburbs were located there because the suburbs were newly built." He also compares the advantages and disadvantages of using cohorts from repeated cross-sectional data and panel (or retrospective) data in the longitudinal interpretation of housing careers. He asserts that "cohorts from repeated cross-sections are better at distinguishing between age and cohorts, and at estimating cumulative changes, sample representativeness and sample size."

Myers, Megbolugbe and Lee (1998) develop a double cohort model, incorporating both birth and immigration cohorts to compare the homeownership rate over time of native-born and immigrant households. Crossley and Ostrovsky (2003) study the cohort effect of Canadian housing careers by compiling a "quasi-panel" from repeated cross-sectional surveys over the period of 1974 to 1999. They choose to follow female cohorts for different ages and attribute to each woman, the housing of her household. We follow a similar approach in this study. However, our research takes the analysis one step further in that it compares the results for females with those for males, and also compares the differences between the females when they are the household heads and when they are not.

As for the housing studies in Taiwan, tenure choice and housing demand have been very popular areas. However, the cohort effect has been neglected in the past except in Hsueh and Yen (2006). Nevertheless, the cohort effect has been analyzed in other social science fields in Taiwan, such as savings behavior (Deaton and Paxon, 1993), cross period labor substitutability (Chang and Chu, 1996), poverty (Leu, Wang and Wang, 1999), and so on.

From these articles, we can find that the income of the younger generation in Taiwan has increased very rapidly, as has consumption, while the poverty rate has been decreasing. After several decades of rapid economic growth in Taiwan, these favorable economic conditions are to be expected. These results imply that the affordability of housing for the younger generation is increasing. However, the housing price in Taiwan has also increased very rapidly. In addition, the housing markets have gone through several violent cycles that have caused large fluctuations in housing prices. These developments have resulted in earlier cohorts in Taiwan having a significant advantage in becoming homeowners (Hsueh and Yen, 2006). As for the females in Taiwan, their education levels and labor force participation rates have increased more rapidly than those of males. However, the poverty among females is still a phenomenon that can be observed just as in other countries. The effect of these different developments on the female's housing decisions is the focus of this research.

3. Data and Descriptive Statistics

3.1 Data Source and Sample Selection

Household data obtained from the Household and Housing Census 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.

Housing choice is a household decision, and for this reason, households rather than individuals are the unit of observation in this study. As mentioned earlier, a female will be chosen to represent a particular household in this study. In order to do this, we have, first of all, deleted all households that do not have any adult females. Next, one female is designated as the object to be studied in each household.

For these households, if the household head is a female as identified in the census data, then she is naturally designated; if the household head is not a female, then the eldest female in the household is designated. For households with a female head, there is a high probability that the adult male is absent in the household. Therefore, the female household head is the only, or at least, the major decision maker in the household. For households with a male head, the wife would have been the better

choice. Unfortunately, we could not distinguish the relationships between household members in the 1980 census. Consequently, it is impossible to designate the wife as the object to be studied. For the consistency of our definition, we have designated the oldest female in the household as the object for all three censuses. The eldest female could also have been the mother or the wife of the household head. Both of them usually share the responsibility for the housing decision[1]. In the more traditional Chinese family, the husband's mother usually has even higher authority than the wife in the family. We will refer to all the females who are selected in this way as the female decision-makers. We expect that having the female as the household head will result in some very different housing choices as compared to not having her as the household head.

We choose females between the ages of 15 and 84 for our analysis. The age of 15 is chosen because it is the lower bound included in the labor force survey. With the choices of age range and census years to be studied, the birth years of objects are determined concurrently as lying between 1896 and 1985. After the selection, there are a total of 2,873,451, 3,706,218 and 5,314,770 households with female decision-makers, respectively, based on the 1980, 1990 and 2000 census data. Ten percent of them are randomly chosen as samples for the subsequent econometric analysis.

Before performing the econometric analysis, we will first briefly describe our data based on the overall population of female decision-makers.

3.2. Descriptive Statistics

Here, in order to understand the demographic changes that have taken place in the past 20 years, we will first describe the age distribution of the female decision-makers as a whole, and the share of female household heads in the three census years. Then, the homeownership rate and living space per person in households based on age distribution and birth cohort for the female decision-makers will also be discussed.

3.2.1. The increase in the female decision-making population

The numbers of female decision-makers increased greatly from 2,873,451 to 5,314,770 persons between 1980 and 2000. They also accounted for 15.11% of the total population of Taiwan in 1980 and 24.91% of the population in 2000. The age profile of female decision-makers is shown in Figure 1[2]. From Figure 1, we can see that the number of females between the ages of 35 and 55 increases sharply in the 2000 census.

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[1] From the census data for 1990 and 2000, we found that 17.11% of designated female decision makers are the mothers of the household heads in 1990, and 16.61% in 2000.

[2] The age distribution is shown at 5-yearly intervals using the data at that point in time.

3.2.2. The increase in female household heads

As mentioned in the previous section, there are two types of households in the population of female decision-makers, i.e., the one with the oldest female in the household and the one with the female household head. In the male-dominated Chinese culture, a female head implies that she is the only or the most important source of income in the household. There is a very high probability that she is a single parent or the only person in the household.

Figure 1 Age Distribution of Female Decision-makers

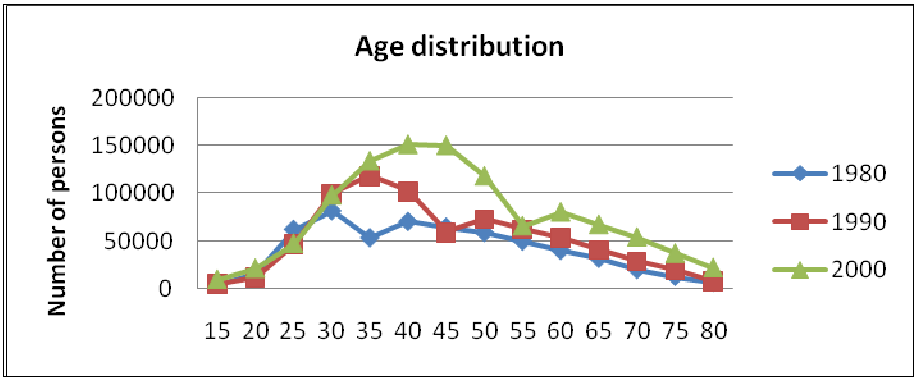


Figure 2 shows the age distribution of the share of female household heads among the female decision-makers. From Figure 2, we can find that the shape of the curves is rather similar for 1980 and 1990; in both years, the shares of female heads are the lowest in the younger age groups of around 25-30; and the shares increase with age until the age groups around 65-75, after which the shares decline. However, the age distribution of the share of female heads is very different in 2000. The shares are much higher than those of the two previous census years for all ages, and they remain at about 40 percent from age 20 to 80. This shows the relative importance of female heads as the number of female decision-makers increase significantly in the last 20 years.

3.2.3. The age and birth cohort distribution of the homeownership rate

The age-period-cohort cross table with home ownership is shown in Table 1. To gain a better understanding of the table, the age profile of the homeownership rate is shown in Figure 3, and the birth cohort profile is shown in Figure 4. From the age profile, we can find that for female decision-makers between the ages of 15 and 20, their ownership rate decreases, while between the ages of 20 and 50, their ownership rate increases. The homeownership rate for females between the ages of 20 and 65 in the 1980 census is lower than that for the other two censuses for the same age range.

Figure 2 The Share of Female Heads of Female Decision-makers by Age Distribution

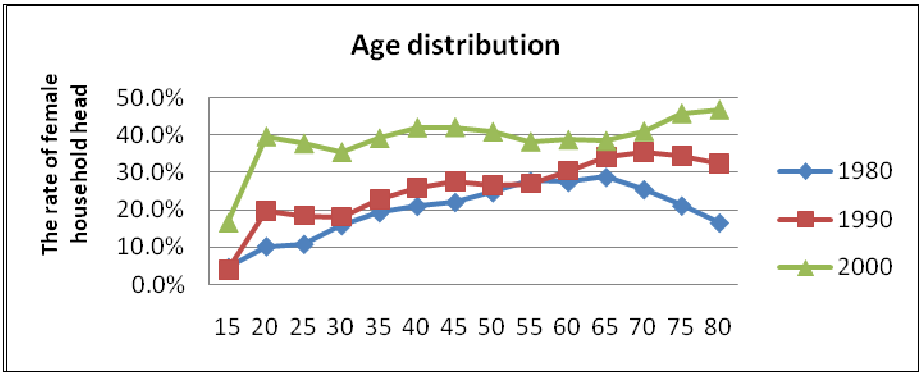
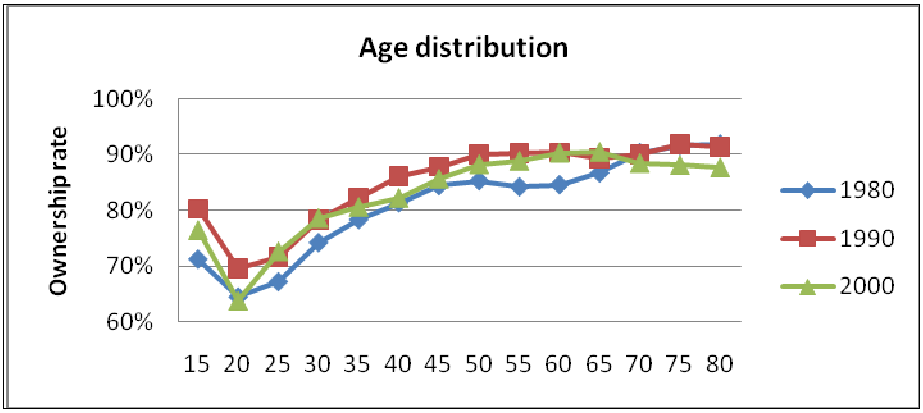


Figure 3 Homeownership Rate by Age Distribution of Female Decision-makers

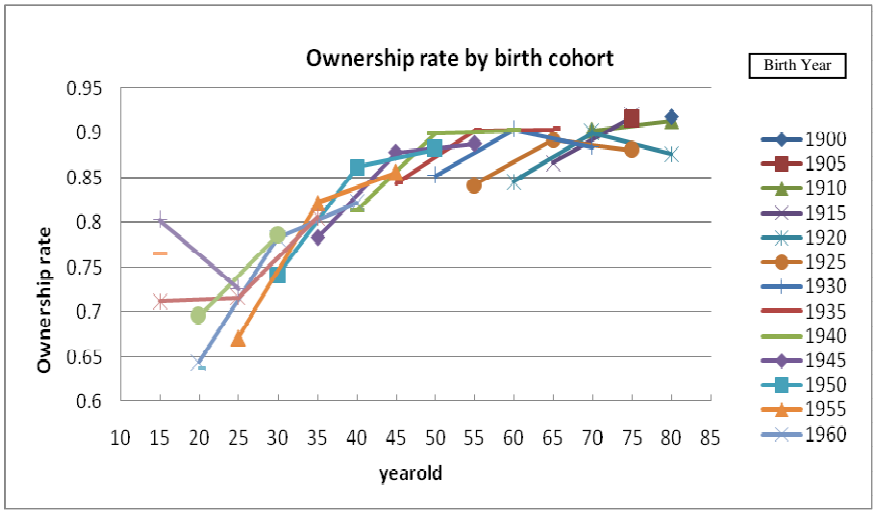


In Figure 4, each line represents one birth cohort. Each birth cohort has three points indicating the ownership rate at the age in the three census years; 1980, 1990 and 2000. From Figure 4, we can find that most of the birth cohorts exhibit a rising homeownership rate between 1980 and 2000. The younger cohorts show a steeper increase in the homeownership rate. Four birth cohorts that were born before 1935 exhibit a slight decrease in their homeownership rate between 1990 and 2000, probably due to having entered old age. In addition, we can find that the 1930 and 1935 birth cohorts show a slightly higher homeownership rate than the neighboring cohorts for all three census years.

Table 1 Age-Period-Cohort Cross Tabulation of Homeownership Rate

Cohort	Age (1980)	Age (1990)	Age (2000)	Homeownership rate %		
1985			15			76.43
1980			20			63.79
1975		15	25		80.30	72.62
1970		20	30		69.53	78.58
1965	15	25	35	71.19	71.64	80.57
1960	20	30	40	64.42	78.27	82.18
1955	25	35	45	67.15	82.19	85.62
1950	30	40	50	74.16	86.16	88.23
1945	35	45	55	78.28	87.85	88.84
1940	40	50	60	81.32	89.97	90.29
1935	45	55	65	84.38	90.30	90.44
1930	50	60	70	85.26	90.42	88.44
1925	55	65	75	84.17	89.28	88.07
1920	60	70	80	84.55	90.08	87.65
1915	65	75		86.67	91.91	
1910	70	80		90.31	91.42	
1905	75			91.56		
1900	80			91.84		

Figure 4 Homeownership Rate by Birth Cohort of Female Decision-makers



Birth Year

3.2.4 The age and birth cohort distribution of living space per person

The decision of a household regarding homeownership is based on two considerations; namely, consumption and investment. It is difficult to disentangle the implications of these two considerations. Therefore, living space is a better measurement of the housing-related welfare of a household. To control for the effect of household size, we decided to use living space per person as the measurement of living space. It is defined as the total floor space divided by the number of persons in the household. However, the effect of household size will still partially remain because of the effect of economies of scale in the living arrangements[3].

Table 2 presents living space per person data crossed with the age-period-cohort. Figure 5 shows the age profile and Figure 7 shows the birth cohort profile of living space per person, respectively.

Table 2 Age-Period-Cohort Cross Tabulation of Living Space per Person

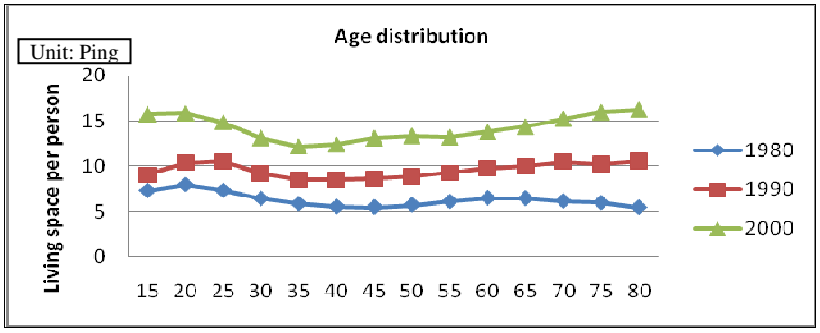
Cohort	Age(1980)	Age(1990)	Age(2000)	Living space per person (ping*)		
1985			15			15.78
1980			20			15.90
1975		15	25		9.03	14.90
1970		20	30		10.44	13.17
1965	15	25	35	7.34	10.56	12.21
1960	20	30	40	7.98	9.24	12.43
1955	25	35	45	7.35	8.54	13.15
1950	30	40	50	6.44	8.49	13.40
1945	35	45	55	5.86	8.65	13.26
1940	40	50	60	5.52	8.86	13.83
1935	45	55	65	5.47	9.26	14.38
1930	50	60	70	5.73	9.81	15.28
1925	55	65	75	6.12	10.01	15.99
1920	60	70	80	6.50	10.52	16.28
1915	65	75		6.46	10.24	
1910	70	80		6.17	10.62	
1905	75			5.98		
1900	80			5.44		

* 1 ping = 3.3057 square meters

[3] Larger household size means that more people share the common living spaces, e.g., living room, kitchen, etc. Therefore, living space per person as defined in this study will be smaller when the household size is larger, other things being equal.

Figure 5 shows three rather parallel curves for the three census years, which indicates that the living space increases census by census. It has a mild U-shaped age distribution between the ages of 20 and 75. This reflects the changes in household size in the life cycle. The lowest point is around ages 45, 40 and 35 respectively for the 1980, 1990 and 2000 censuses. This change is interesting, and probably caused by the fact that the younger generations are raising fewer offspring than the older generations. Hence, they reach the lowest points of living space per person at a younger age.

Figure 5 Living Space per Person by the Age Distribution of the Female Decision-makers



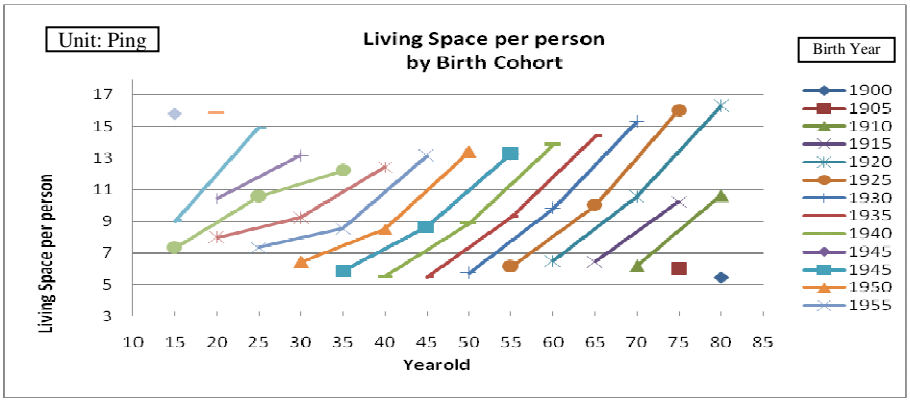
* 1 ping = 3.3057 square meters

Figure 6 shows the living space per person by birth cohort. It shows that for most of the birth cohorts, the curves are almost straight and parallel to each other. This means that the increases in the rates are about the same between 1980 and 1990, as they are between 1990 and 2000. At the same time, the birth cohort does not make a difference to the increases in living space over the period of 1980 to 2000. However, for several younger cohorts, the rate of increase is more rapid between 1980 and 1990 than between 1990 and 2000.

4. Modeling and Variable Definitions

The housing tenure choice and housing consumption, which is measured by living space per person, are the most important housing decisions that every household has to face. We are interested in determining the extent that age and birth cohorts affect these two decisions, other things being equal. In order to answer this question, an econometric model will be built in this section.

Figure 6 Living Space per Person by the Birth Cohort of the Female Decision-makers



* 1 ping = 3.3057 square meters

The decisions regarding housing tenure choice and living space are not mutually independent. Non-homeowners may wish to save more money for the mortgage down payment, hence choosing a smaller living space. On the other hand, if a household prefers a larger living space, then it may need to choose renting, because the expenses associated with owning a residence, including interest payments, maintenance and taxes, etc. are much higher than in the case of those renting in Taiwan. On the contrary, homeowners may decide to choose a larger living space which can accommodate the future needs of the household in order to avoid the high transaction cost in moving associated with being a homeowner. Therefore, we have to estimate these two decisions simultaneously. We construct a simultaneous equation model. Equation (1) is for the home tenure choice, which is a binary choice, and so, a conditional binary probit model is used. Equation (2) is for the living space choice, which is a continuous variable, and so, a linear model is used. Equations (1) and (2) constitute a simultaneous model. The two equations can be expressed as follows:

$$\begin{cases} HO = \Pr(ho = 1 \mid y, a, c) = f(y, a, c, HEAD, X_1, PerA) \text{.....(1)} \\ PerA = g(y, a, c, HEAD, X_2, HO) \text{.....(2)} \end{cases}$$

where in Equation (1), *ho=1* means the household owns its own residence. $\Pr(ho = 1 \mid \bullet)$ shows the conditional probability of owning a residence. *PerA* stands for the living space per person. *y, a,* and *c* are vectors which stand for the census year, age and birth cohort respectively. *HEAD* stands for whether the female decision maker is a household head. This variable is important because it can differentiate between two different types of female decision-makers. X1 and X2 are vectors which

contain other control variables. *f* is a cumulative probability function, and g is a linear function.

The vectors y, a, c are all dummy variables. The y vector has 2 variables; y0 and y2, which stand for the 1980 and 2000 census years, respectively[4]. The *a* vector has 13 variables; *a0, and a2 to a13,* representing 13 age groups[5]. Each group consists of 5 years in terms of age, so that the 13 age groups cover the ages of 15 to 85. The *c* vector has 17 variables; *c0 to c13* and *c15 to c17,* which represent 17 birth cohort groups[6]. Each group consists of 5 years in terms of birth years, covering the period from 1896 to 1986. We use the fixed effects model to evaluate the year, age, and cohort effects. The regression coefficients represent the differences in terms of the intercept.

As individual household data are used in the estimation, there is a need to control for the differences among households that might also have an effect on the housing decisions. For Equation (1), X_1 includes a vector of variables for marital status (*MARRIED, DIVORCE and WIDOW*), participation in the job market or not (*WORK*), and household size (*MEMBER*). Marital status can be a proxy for whether there is a spouse in the household to share the financial responsibility in housing decisions. WORK can be a proxy for the income of the female decision-makers.

For Equation (2), X_2 includes years of education (*EDU, EDU_SQUARE*), *MEMBER*, and *WORK*. The education level can be a proxy for the income of the female decision-makers. *EDU* is not included in Equation (1) and marital status is not included in Equation (2) for identification purposes.

The notation and definitions for all variables are presented in Table 3. The descriptive statistics of the variables other than the year-age-cohort variables according to the female and non-female heads are shown in Table 4. The descriptive statistics of variables according to homeowners and non-homeowners are shown in Table 5. From Table 4, we can find that the homeownership rate is lower for the female-head households (80%) compared with the non-female-head households (85%). The living space in the case of the female-head households is also smaller in terms of floor area per household (32.71 vs. 33.94 pings), but larger in terms of floor area per person (10.00 vs. 7.12 pings). The female heads have higher average education levels and job market participation rates. The family size is much smaller for the female-headed households. As for the marital status, the female heads have higher rates in the categories of unmarried, divorced and widowed, and lower rates in terms of those married.

From Table 5, we can find that female decision-makers who are not homeowners are more likely to participate in the job market and have higher education. The living

[4] y*1* which stands for 1990 is omitted to be the control group.
[5] *a1* which stands for the 20-24 year-old age group is omitted.
[6] *c14* which is for those born in 1971-1975 is omitted.

space per person for the non-homeowners is slightly smaller than that for the homeowners. The family size of the homeowners is on average, 0.6 persons larger than that of non-owners. As for marital status, homeowners have higher rates of those who are married and widowed, and lower rates of those who are unmarried and divorced than non-owners.

Table 3 Variable Notation and Definitions

Notation	Definition	Notation	Definition
Year Group		**Cohort Group**	
y0	=1 if in 1980 census	*c0*	=1 if born in 1896~1900
y1	=1 if in 1990 census (control group)	*c1*	=1 if born in 1901~1905
y2	=1 if in 2000 census	*c2*	=1 if born in 1906~1910
Age Group		*c3*	=1 if born in 1911~1915
a0	=1 if age is 15~19	*c4*	=1 if born in 1916~1920
a1	=1 if age is 20~24 (control group)	*c5*	=1 if born in 1921~1925
a2	=1 if age is 25~29	*c6*	=1 if born in 1926~1930
a3	=1 if age is 30~34	*c7*	=1 if born in 1931~1935
a4	=1 if age is 35~39	*c8*	=1 if born in 1936~1940
a5	=1 if age is 40~44	*c9*	=1 if born in 1941~1945
a6	=1 if age is 45~49	*c10*	=1 if born in 1946~1950
a7	=1 if age is 50~54	*c11*	=1 if born in 1951~1955
a8	=1 if age is 55~59	*c12*	=1 if born in 1956~1960
a9	=1 if age is 60~64	*c13*	=1 if born in 1961~1965
a10	=1 if age is 65~69	*c14*	=1 if born in 1966~1970 (control group)
a11	=1 if age is 70~74	*c15*	=1 if born in 1971~1975
a12	=1 if age is 75~79	*c16*	=1 if born in 1976~1980
a13	=1 if age is 80~84	*c17*	=1 if born in 1981~1985
Others			
HO	probability of homeownership	*HEAD*	=1, if the female decision-maker is a household head
PerA	Predicted value of living space per	*MARRIED*	=1 if the female decision-maker is married
MEMBER	Number of household members	*WIDOW*	=1 if the female decision-maker is widowed
EDU	Years of education of the female	*UNMARRIED*	=1 if the female decision-maker is
EDU_ SQUARE	Square of EDU	*DIVORCE*	=1 if the female decision-maker is divorced
WORK	=1, if the female decision-maker is at work		

Table 4 Descriptive Statistics Based on Female and Non-female Household Heads

		ALL (n=1,187,987)		Female Head (n=364,078)		Non-female Head (n=823,909)	
Variables	**Unit**	**Mean**	**Std.**	**Mean**	**Std.**	**Mean**	**Std.**
Dependent Variables							
HOMEOWNERSHIP	**(0,1)**	0.8354	0.3709	0.7979	0.4016	0.8519	0.3552
Living space per person	**ping***	10.391	9.855422	14.9364	14.05464	8.382	6.292941
Living space per household	**ping***	33.5671	19.6207	32.7141	18.8295	33.9441	19.9488
Independent Variables							
UNMARRIED	**(0,1)**	0.0606	0.2386	0.1100	0.3129	0.0388	0.1930
MARRIED	**(0,1)**	0.7983	0.4013	0.5628	0.4960	0.9024	0.2968
DIVORCE	**(0,1)**	0.0280	0.1650	0.0795	0.2705	0.0053	0.0725
WIDOW	**(0,1)**	0.1131	0.3167	0.2477	0.4317	0.0536	0.2252
WORK	**(0,1)**	0.3708	0.4830	0.4594	0.4983	0.3317	0.4708
MEMBER	**person**	4.3080	2.1917	3.2707	2.0999	4.7663	2.0718
EDU	**year**	7.4041	4.7048	8.0101	4.8362	7.1363	4.6203

∗ 1 ping = 3.3057 square meters

Table 5 Descriptive Statistics by Homeownership

		Non-homeowner (n=195,586)		Homeowner (n=992,401)	
Variables	**Unit**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
UNMARRIED	**(0,1)**	0.1009	0.3012	0.0527	0.2234
MARRIED	**(0,1)**	0.7619	0.4259	0.8055	0.3958
DIVORCE	**(0,1)**	0.0500	0.2180	0.0237	0.1521
WIDOW	**(0,1)**	0.0872	0.2822	0.1182	0.3228
WORK	**(0,1)**	0.3825	0.4860	0.3685	0.4824
MEMBER	**person**	3.8241	1.9032	4.4033	2.2319
EDU	**year**	8.4170	4.3707	7.2045	4.7425
PerA	**ping**	10.1980	10.6224	10.4296	9.6967
HEAD	**(0,1)**	0.3762	0.4844	0.2927	0.4550

5. Model Estimation

Equations (1) and (2) constitute a simultaneous equation system, in which Equation (1) is a binary probit model and Equation (2) is a linear model. For this type of simultaneous system, the reader can refer to Maddala's model 3 on page 245 (Maddala, 1983). We follow Greene's suggestion in the handbook for LIMDEP version 8.0 to estimate it (Greene, 2002). The steps in the estimation involve fitting the two equations of the reduced form using all exogenous variables first[7]. The fitted values for *HO* and *PerA* from the reduced form are then inserted into the structural forms to estimate the coefficients of all variables in the structural models. Finally, the corrected asymptotic covariance matrices are estimated.

Before proceeding with the model's estimation, two more issues have to be clarified. First, in the cohort analysis literature, the collinearity of age, birth year and census year is a well-known problem. Although Deaton (1997), and Fienberg and Mason (1978) have developed different approaches to solve this problem, in this research, we will solve it by constraining the discretion of choosing the control group in the dummy variable sets. In the usual case, for a set of dummy variables, any variable in the set can be chosen as the control group to be omitted. Three sets of dummy variables; namely, age, birth year and census year, need three omitted variables. However, because age, cohort and the census year are mutually interdependent, when omitted variables from any two sets of variables, for instance, age and census year, are chosen, then the omitted variable for the third set, i.e., the birth year, is automatically determined. This means that we lose the discretion of choosing any one of the cohort groups as the control group. For example, any female in the sample aged 21 in 1990 must have been born in 1969.

Secondly, instead of using semi-panel data which are compiled from the group means of each year-age-cohort combination, individual household data are used to estimate the model. This will greatly increase the sample size used in the estimation, and hence avoid the problem of an insufficient sample size in the tail of the birth cohorts. In this research, due to the restrictions associated with selecting sample observations between the ages of 15 and 84, eight out of the eighteen birth cohorts are not observed in any of the three censuses, i.e., 1980, 1990 and 2000. Four cohorts, i.e., *c0, c1, c16 and c17*, are observed only once, and four cohorts, i.e., *c2, c3, c14 and c15*, are observed only twice.

6. Discussion of the Estimation Results

We estimate the simultaneous models expressed in Equations (1) and (2) in two specifications. In Model 1, the full sample is used with *HEAD* (whether the female

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[7] The reduced form is $\begin{cases} H = f(y, a, c,\ HEAD, X) \\ PerA = g(y, a, c,\ HEAD, X) \end{cases}$, where X is the union of X_1 and X_2.

decision-maker is the household head or not) being included as an explanatory variable. In Model 2, the female head and non-head samples are estimated separately. In the meantime, by using the joint tests with the dummy variable (*HEAD*) and the interactive term of *HEAD* with all other variables, we can tell whether the effects of the same variable in the two sub-samples are significantly different or not.[8] The estimation results of the homeownership rate model will be discussed first, to be followed by those of the living space per person model.

6.1. Homeownership Rate Model

The results of estimating Equation (1) are shown in Table 6[9,10]. The census year, age and cohort effect are also drawn into curves as shown in Figure 7.

From Table 6, we can find that the coefficient of $\hat{P}erA$ is significant; and from Table 7, the coefficient of $\hat{HO}$ is also significant. This verifies our hypothesis that home ownership and living space are simultaneously determined housing choices. The coefficient of $\hat{P}erA$ is positive, which means that by choosing a larger living space, a household shows its intention to stay in that place longer, and hence chooses to own that residence. On the other hand, $\hat{HO}$ has a negative coefficient. This shows that to own a residence involves sacrificing living space, other things being equal. This may be attributed to the fact that the expenses associated with owning a residence are much higher than the cost of renting over a long period of time in Taiwan.

The variable *MEMBER* has a positive effect which means that a larger household size has a higher probability of becoming a homeowner. The *WORK* variable has a positive effect which indicates that the female decision-makers who are employed are more able to afford homeownership. From the full sample, we find that the female as the household head has a negative effect on the homeownership rate. This finding conforms to that of other research (Leu, Wang and Wang, 1999) in the sense that female heads have a higher probability of poverty. As for the marital status, the

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[8] In order to compare the estimated coefficients between the female-head households and non female-head households , Equations (1) and (2) in the simultaneous equation model are adjusted to Equations (3) and (4) as follows:

$$HO = f(y, a, c, X_1, PerA, HEAD, HEAD*y, HEAD*a, HEAD*c, HEAD*X_1, HEAD*PerA) \quad (3)$$

$$PerA = g(y, a, c, X_2, HO, HEAD, HEAD*y, HEAD*a, HEAD*c, HEAD*X_2, HEAD*HO) \quad (4)$$

Equations (3) and (4) are estimated using the full sample. If the coefficient of the interaction term of *HEAD* and other explanatory variables, for instance, *HEAD*y0*, is significantly different from 0, then it means that the effect of *y0* is significantly different between the head and non-head samples.

[9] The marginal effects of the variables are shown in Table 6. Since the constant term has no marginal effect, it is not listed.

[10] To control for the effect of regional differences, the county/city dummies that indicate where the household lives are also included as control variables in the equation. However, they are not reported in the table in order to save space.

unmarried, divorced or widowed female-headed households have a significantly lower probability of owning their residence than those of households without female heads.

Figure 7 shows that the home ownership rate exhibits an increasing trend from 1980 to 1990, regardless of whether the full sample or female or non-female-head samples are used. This indicates that with the 8.76% annual growth of the economy in this period, the affordability in relation to becoming a homeowner is increasing for all households. From 1990 to 2000, with a slower annual economic growth rate of 6.51%, for the non-female-head sample, an increasing trend toward becoming a homeowner is still maintained. However, for the female head sample, there is a slightly (statistically insignificant) decreasing trend. This result shows that the female-headed households benefit less from the economic growth in becoming homeowners.

The curve of the age effect in Figure 7 shows that the probability of becoming a homeowner increases from the young age and reaches its highest point in middle age before declining for both the full sample and non-female-head sample. This can be explained by the life-cycle theory, which means that the probability of becoming a homeowner corresponds to a person's accumulation of wealth over the life cycle. However, we can not find this clear pattern in the results for the male sample, in which the probability of homeownership remains about the same between the ages of 20 and 60 (Hsueh and Yen, 2006).

The effect of the birth cohort shows that the earlier a female decision-maker is born, the higher the probability that she is a homeowner. This result may be attributed to the fact that the competition for space has been very strong in Taiwan in recent decades. In other words, the price of land and housing in Taiwan has increased at a faster rate than income. This result can also be found in the male sample (Hsueh and Yen, 2006).

To compare the age-cohort-year effect between heads and non-heads, first, for the age effect, we find that the homeownership rate of female-headed households reaches the highest point at about age 30-35, which is much younger than that of the non-female-head households, at age 45-49. Meanwhile, throughout the life-cycle, the ownership rate of the female-headed households is lower than that of the non-female-headed households; and when the age increases, the gap in terms of the home ownership probability becomes larger. This phenomenon may reflect the fact that at a younger age, for instance, younger than the 30-35 age groups, the female heads are mostly unmarried single person households, and their economic status is improving with age. However, when they get older, they marry and no longer head the households. For those who remain as head of the household, they are most likely to be divorced or widowed and single mothers. In other words, for female heads, after the age of 35, the probability of being an unmarried single is decreasing, and the probability of becoming an economically disadvantaged single mother is increasing.

Secondly, it is shown that the birth cohort effect is stronger for the female-headed households. This means that the female-headed households are more seriously affected by the higher housing prices than the non-head households.

6.2. Living Space Per Person Model

The estimation results of the living space per person model are listed in Table 7, and the coefficients of the census years, ages and cohorts are drawn as curves and depicted in Figure 8. The coefficient of *MEMBER* is negative, which shows that when the household size is bigger, the living space per person is smaller. This is expected because of the scale effect, in the sense that larger households have more members to share public space, e.g., a living room, kitchen, etc., and this results in less living space per person.

WORK has positive coefficients for the full sample and non-female-head sample. However, it has a negative effect for the female head sample. A positive effect is expected because income from employment can increase the affordability of a larger living space. The negative effect for the female head sample can be attributed to the higher percentage of old age, and not the employed female heads in the sample, who live alone in their original residence in their old age and enjoy a large living space (see the age effect panel of Figure 8).

The coefficient of *HEAD* for the full sample is positive, indicating that after controlling for all other effects, households with female heads have larger living space per person. This finding shows that households with female heads prefer a larger living space to homeownership. However, it may also be because of the economies of scale effect that the size of the female-headed households is on average, much smaller than that of the non-female-headed households.

Figure 8 shows the year, age and cohort effects. From Figure 8, we can see that the census year effect is increasing. The growth of the economy in recent decades is reflected in the larger living space. The age effect for both the female-headed and non-female-headed households is U-shaped with the lowest point being in the 35-39 age range, which reflects the changes in household size in the life cycle. However, different effects for the female-headed and non-female-headed households can still be found. First, the effect is much stronger for the female-headed households. Secondly, after the age of 50 for the non-headed households, the effect starts to decline, while the effect continues to increase in the female-headed households. This is probably caused by the arrival of the third generation in the families in which the female is not the head of the household. However, for the female-headed families where the female head is reaching old age, it is most likely the case that the females are living alone and becoming single person households.

Table 6 The Estimation Results of the Homeownership Rate Model

Variable	All	Non-head	Head	F-value
Year				
1980(*y0*)	*-0.0777	*-0.0905	*-0.0720	#15.4449
1990(*y1*)	-	-	-	-
2000(*y2*)	-0.0017	*0.0131	-0.0081	#14.3641
Age				
15~19(*a0*)	*0.0582	*0.0536	-0.0264	#15.2881
20~24(*a1*)	-	-	-	-
25~29(*a2*)	*0.0242	*0.0248	0.0137	0.6084
30~34(*a3*)	*0.0368	*0.0359	*0.0176	#7.1824
35~39(*a4*)	*0.0508	*0.0497	0.0047	#6.8644
40~44(*a5*)	*0.0531	*0.0509	0.0050	#19.7136
45~49(*a6*)	*0.0638	*0.0602	-0.0033	#9.7344
50~54(*a7*)	*0.0618	*0.0572	-0.0034	#17.4724
55~59(*a8*)	*0.0587	*0.0539	-0.0251	#10.8900
60~64(*a9*)	*0.0536	*0.0471	-0.0262	#14.8225
65~69(*a10*)	*0.0476	*0.0410	-0.0532	#11.0889
70~74(*a11*)	*0.0368	*0.0346	*-0.0810	#21.8089
75~79(*a12*)	*0.0258	0.0213	*-0.1089	#14.5924
80~84(*a13*)	0.0007	0.0064	*-0.1612	#27.1441
Cohort				
1896~1900(*c0*)	*0.1123	*0.1158	*0.1824	#5.1076
1901~1905(*c1*)	*0.1077	*0.1113	*0.1938	#9.4249
1906~1910(*c2*)	*0.1051	*0.1092	*0.1738	#8.8804
1911~1915(*c3*)	*0.0911	*0.0988	*0.1550	#5.29
1916~1920(*c4*)	*0.0720	*0.0818	*0.1268	#5.6644
1921~1925(*c5*)	*0.0568	*0.0684	*0.1114	3.8416
1926~1930(*c6*)	*0.0507	*0.0625	*0.0949	#4.1209
1931~1935(*c7*)	*0.0580	*0.0696	*0.0995	2.2801
1936~1940(*c8*)	*0.0544	*0.0638	*0.0880	3.7249
1941~1945(*c9*)	*0.0438	*0.0509	*0.0845	#4.0804
1946~1950(*c10*)	*0.0428	*0.0471	*0.0767	#11.7649
1951~1955(*c11*)	*0.0229	*0.0271	*0.0583	#4.7089
1956~1960(*c12*)	*0.0131	*0.0165	*0.0336	#9.7969
1961~1965(*c13*)	-0.0076	-0.0065	0.0130	2.4025

(Continue…)

Table 6 Continued

Variable	All	Non-head	Head	F-value
Cohort *(Continued)*				
1966~1970(*c14*)	-	-	-	-
1971~1975(*c15*)	*-0.0185	*-0.0228	*-0.0217	0.0081
1976~1980(*c16*)	*-0.0403	*-0.0264	*-0.0798	#33.8724
1981~1985(*c17*)	*-0.0820	*-0.0688	*-0.0684	0.0004
Marriage				
MARRIED	-	-	-	-
UNMARRIED	*0.0373	0.0011	*-0.0956	#151.2900
DIVORCE	*-0.0469	*-0.0904	*-0.1718	#221.7121
WIDOW	*0.0352	-0.0008	*-0.1106	#248.6929
MEMBER	*0.0331	*0.0288	*0.0402	#24.4036
WORK	*0.0200	*0.0226	*0.0134	#33.5241
$\hat{P}erA$	*0.0101	*0.0068	*0.0160	#65.61
HEAD	*-0.0684	-	-	-
INTERCEPT				#99.0025
Wald chi-square	*65618.13	*66610.45		**3721.94
Pseudo R-square	0.064	0.0663		

Note: * means that the coefficients are significantly different from zero at the 5% level.

#The F-values show whether the coefficients of each variable in non-head and head are significantly different or not at the 5% level.

**The F-values show whether the overall models between the Non-head and Head sub-samples are significantly different or not.

As for the birth cohort effect, the full sample and non-female-headed households exhibit a declining effect, which means that being born earlier results in larger amount of living space per person for the household. This is also similar to the result for the male sample. This phenomenon can be explained by the fact that the housing price increased more rapidly than income over time. However, the effect for the female-headed households is very different. It shows an increasing effect for those cohorts who were born between 1898 and 1933, which then started to decline in a similar way to the non-female-headed households. This may be caused by the disadvantaged economic situation of the females in the earlier birth cohorts, whose socio-economic situation improved over time to catch up with the non-female-headed households. For cohorts born after 1933, the trend is similar to the case of the non female-headed sample.

Figure 7 Year, Age and Cohort Effects on Homeownership Decision of Female Decision-makers

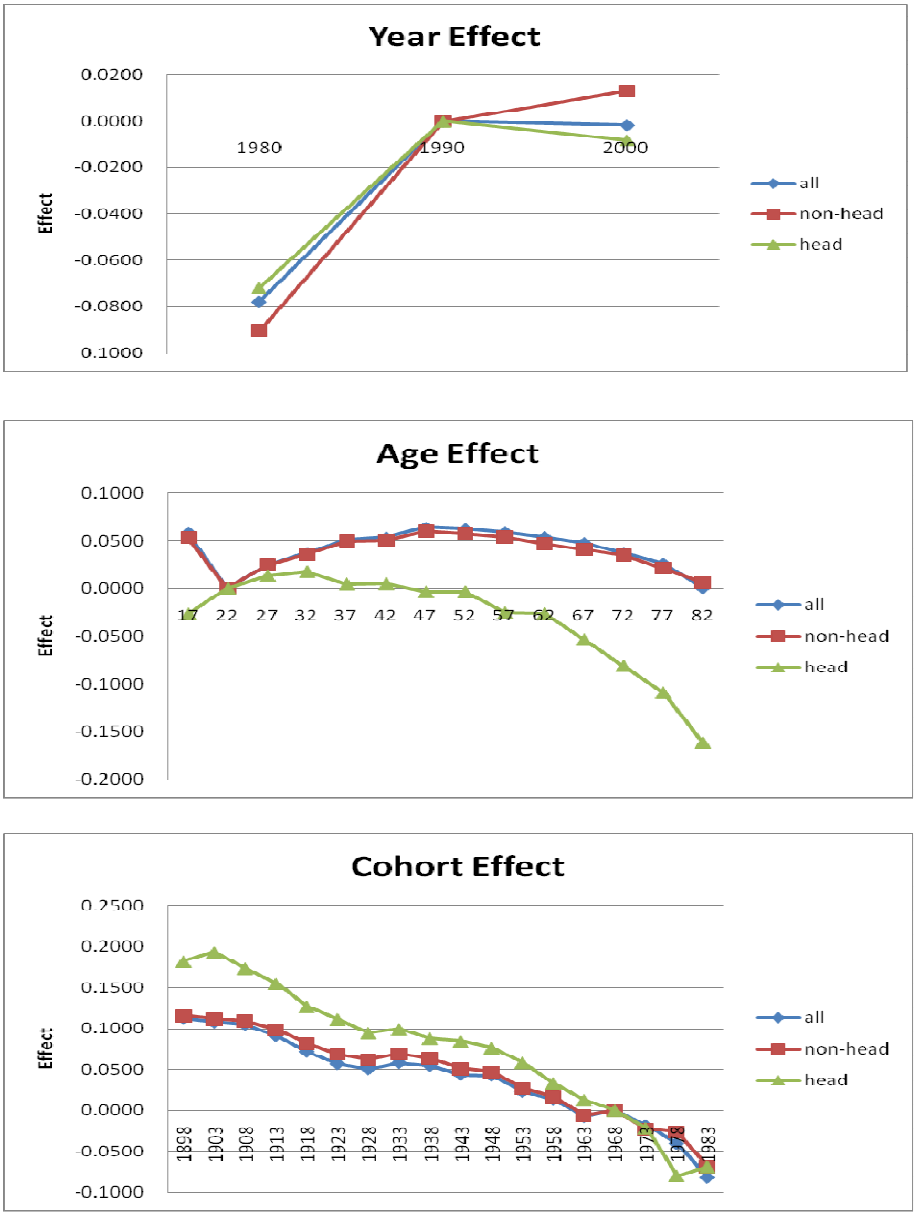


Table 7 The Estimation Results of the Living Space per Person Model

Variable	All	Non-head	Head	F-value
Year				
1980(*y0*)	*-4.4189	*-3.5091	*-2.4957	#30.0304
1990(*y1*)	-	-	-	-
2000(*y2*)	*3.4313	*2.5538	*3.0839	#11.9716
Age				
15~19(*a0*)	*1.3374	*0.7849	*0.7815	0.0001
20~24(*a1*)	-	-	-	-
25~29(*a2*)	*0.3853	0.0434	*-0.7208	3.6100
30~34(*a3*)	*1.1743	*0.2928	-0.4977	#10.2400
35~39(*a4*)	*0.7481	-0.0399	-0.9361	3.4225
40~44(*a5*)	*1.2050	*0.3071	-0.4634	#4.6656
45~49(*a6*)	*1.1685	*0.3713	-0.3364	1.4161
50~54(*a7*)	*1.5893	*0.7396	0.2990	0.8100
55~59(*a8*)	*1.1496	*0.5695	0.4480	0.0289
60~64(*a9*)	*1.1704	*0.5535	0.7929	0.1444
65~69(*a10*)	*0.5857	0.1248	0.8996	0.8464
70~74(*a11*)	*0.5648	-0.2596	1.4080	#4.6656
75~79(*a12*)	-0.0087	*-1.1247	*1.9090	#9.4864
80~84(*a13*)	0.0588	*-1.5749	*3.0416	#24.0100
Cohort				
1896~1900(*c0*)	*11.2376	*8.8172	2.1817	#28.6225
1901~1905(*c1*)	*11.2195	*8.3285	*3.8621	#13.3956
1906~1910(*c2*)	*9.9527	*7.2863	*3.9405	#12.3904

(Continued…)

Table 7 Continued

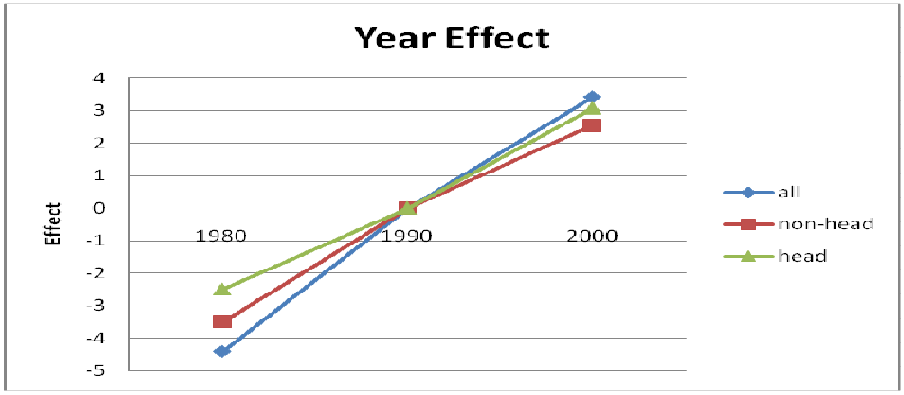
Variable	All	Non-head	Head	F-value
Cohort *(Continued)*				
1911~1915(*c3*)	*9.4570	*6.7321	*4.5735	#4.7524
1916~1920(*c4*)	*8.2644	*5.9257	*4.2065	#4.9729
1921~1925(*c5*)	*7.9647	*5.6415	*4.5090	1.8496
1926~1930(*c6*)	*7.2985	*5.1807	*4.6436	0.7569
1931~1935(*c7*)	*7.4822	*5.1361	*5.0492	0.0144
1936~1940(*c8*)	*6.4616	*4.4671	*4.4946	0.0036
1941~1945(c9)	*5.8929	*4.0777	*4.1134	0.0036
1946~1950(*c10*)	*4.6026	*3.1700	*3.2048	0.0121
1951~1955(*c11*)	*3.8298	*2.6105	*2.8880	0.3721
1956~1960(*c12*)	*2.0976	*1.4776	*1.5660	0.2304
1961~1965(*c13*)	*1.1182	*0.8219	*0.8595	0.0100
1966~1970(*c14*)	-	-	-	-
1971~1975(*c15*)	0.1780	0.1017	0.3637	0.6084
1976~1980(*c16*)	*-0.9189	*-0.6336	-0.6726	0.0144
1981~1985(*c17*)	-0.5245	-0.0044	0.8182	1.5376
EDU_SQUARE	*0.0285	*0.0183	*0.0205	#4.3264
EDU	*-0.2133	*-0.0782	*-0.0681	0.3600
MEMBER	*-1.6155	*-1.0686	*-3.2509	#5759.292
WORK	*0.2603	*0.2929	*-0.2798	#141.1344
$\hat{H}O$	*-0.30121	*-0.17615	*-0.14847	#8.4681
HEAD	*1.7173	-	-	-
INTERCEPT	*33.4116	*22.7017	*29.8809	#146.168
F-value	*5097.92	*3780.06		**456.230
R-square	0.3432	0.3894		

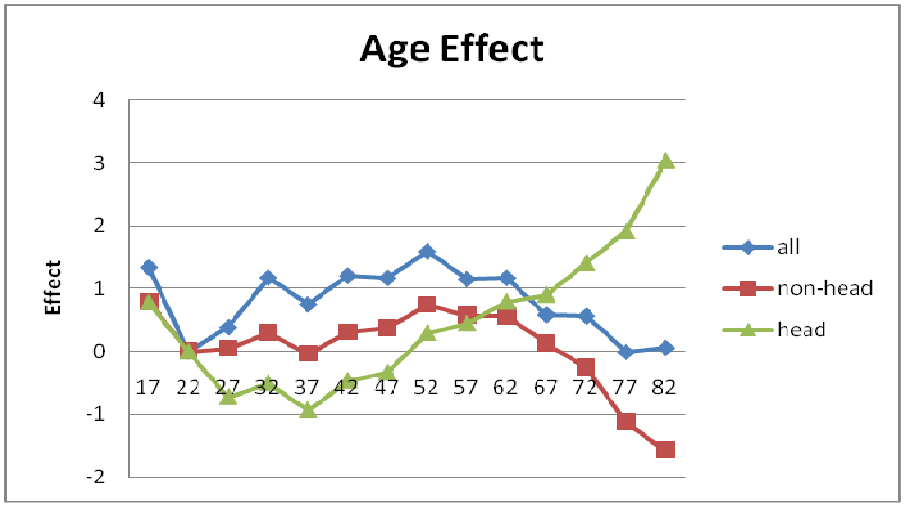
Note: * means that the coefficients are statistically significant at the 5% level.

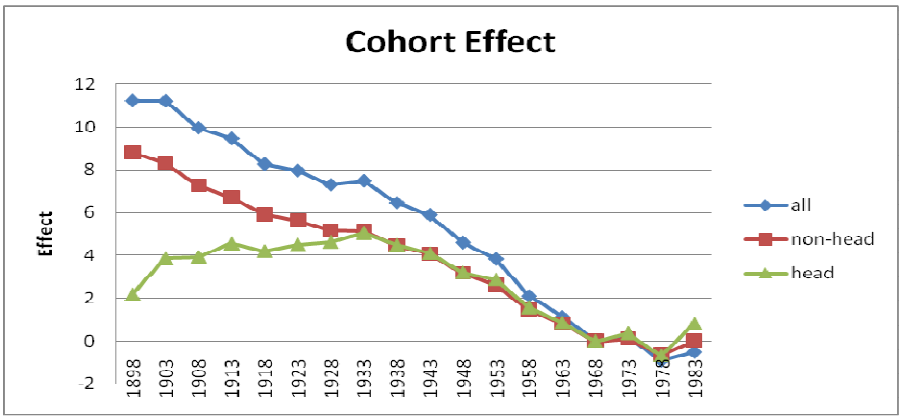
The F-values show whether the coefficients of each variable in the non-head and head sub-samples are significantly different or not at the 5% level.

** The F-values show whether the overall models between the non-head and head sub-samples are significantly different or not.

Figure 8 **Year, Age and Cohort Effects on the Living Space per Person Decision of Female Decision-makers**







7. Conclusion

In this research, we have followed the female birth cohort to analyze its effect on housing tenure choice and consumption of households. We find that the effects of age on homeownership and living space move in opposite directions to each other. The age effects show that households have the highest homeownership rate and lowest amount of living space per person in their middle years. This is due to persons in their middle years having the highest accumulated wealth and also the largest household size in the life cycle. However, there is no clear trend that can be found in the male sample with respect to the age effect in their middle years, for instance, 25-60, for both homeownership and living space. Hence, the female is probably more suitable than the male in terms of representing a household in its life-cycle.

The birth cohort effect shows that the earlier a female is born, the higher is the probability that she is a homeowner and occupies a larger living space. This phenomenon can also be found in the result of the male sample (Hsueh and Yen, 2006). This may be due to the prices of land and housing having increased more rapidly than incomes in the past few decades in Taiwan. These findings raise our concerns regarding the disadvantage that the younger generation has in becoming a homeowner. This is an issue that public policy needs to address.

In addition, we find that the age and birth cohort effects are very different for female-headed and non-female-headed households. Although on average, the female heads have more years of education and higher job participation rates, they have lower homeownership rates. They also benefit less from economic growth. Nevertheless, the gap between the female-headed and non-female-headed households has become narrower as the birth cohort has become younger.

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