Life Insurance and the Value of Spouses: Labor Supply vs. Household Production*

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Abstract

To understand women's decision on labor market participation, it is crucial to correctly measure the value of household production as well as earning ability. Researchers have attempted to measure home production and other nonmarket activity by looking at the amount of time devoted to nonmarket production or the amount of household capital investment. We argue that the value of household production may not be correctly measured by looking at inputs because the value of home production can vary by individual's nonmarket productivity as well as by the stage of lifecycle of nonmarket production. In this paper we use data on life insurance holdings of married couples by age, education, and employment status to infer how much nonmarket value they produce across different demographic stages. We construct a fully specified overlapping generation model of multiperson households where individuals face mortality risk, have access to life insurance markets, and consume and save. Then we use the model to find out the profile of home production which generates employment rates, life insurance holdings, and key statistics as in the US data. We find that the profile of women's home production has a very different picture from the profile implied by hours worked at home.

Keywords: Life Insurance, Labor Supply, Life Cycle Model, Household Production

JEL Classifications: J17, J22, D91, D64, D13

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1 Introduction

It is well known that most men participate in the labor market while a significant fraction of women, specially married women do not.[1] According to the Current Population Survey(CPS) March supplement from 1987 to 1995, 42% of married women between age 20 and 65 work less than 800 hours a year. The average annual hours of work who reported less than 800 hours is 130, while the average hours of those who work more than 800 hours is 1896. This big difference shows that a large fraction of labor supply choice is accounted for by movement in and out of labor force. To explain this considerable difference of hours Benhabib, Rogerson & Wright (1991) and Greenwood, Rogerson & Wright (1995) adapt the idea of household production introduced by Becker (1965) and Gronau (1986). What derives women's labor supply decision is her reservation wage which depends on the assets of the household and earnings of the spouse and, more importantly, the ability (or productivity) of nonmarket production when she works and when she does not. In fact, non working women devote much of their disposable time to a nonmarket household activities. According to the Panel Study of Income Dynamics(PSID) of 1986-1995, nonworking women between the ages of 20 and 65 devote more than 27 hours a week on household work.[2] Similar numbers are reported at the EPA National Time Use Survey[3]: 34 hours of household work including childcare and 29 hours of household work other than childcare. Therefore, it is critical to carefully measure the *value* of nonmarket production to understand women's decision on labor force participation. Since the amount of output from nonmarket activity is unobservable, it is not easy to know how much of home production take places. However various efforts have been made to measure the size of home production.

There are two ways to measure the magnitude of home production.[4] The first one is looking at the inputs of the home production function: labor and capital. To look at labor input, one can look at data such as Michigan Time use survey, EPA Time Use Study, the PSID, and the recently begun American Time Use Survey(ATUS). These data contain information on how much time people devote to various nonmarket activities.[5] For capital input, Greenwood et al. (1995) define household capital investment as purchase of residential capital and consumer durables from the U.S. national income and product accounts (NIPA) and show that household capital investment is bigger than business capital investment. The second way of measuring nonmarket production is to look at the proxies of output. Eisner (1988) reported that the value of nonmarket production is

[1]See Killingsworth & Heckman (1986).

[2]The exact questionnaire from the PSID is "`About how much time does your (wife/"WIFE") spend on housework in an average week? I mean time spent cooking, cleaning, and doing other work around the house.`" It is not clear if the time devoted to childcare is explicitly included here.

[3]The survey conducted for the United States Environmental Protection Agency by the Survey Research Center at the University of Maryland. Data Collection began in September 1992 and was completed in October 1994. People were asked to report all the activities they did "yesterday."

[4]See Wrase (2001).

[5]See Juster & Stafford (1991) for extensive survey on literatures. Hamermesh, Frazis & Stewart (2005) documents pattern of time use from the ATUS.

between 20 percent and 50 percent of GDP.[6]

Although households devote significant amount of time and large fraction of investment on home production, the *value* of household production cannot be correctly measured by looking at these inputs because the value of home production can vary by individual's nonmarket productivity as well as by the stage of lifecycle of nonmarket production. If people differ from others in their home production ability, then the same amount of time devoted to home production can generate different values of output. It is also possible that the most required type of household work varies by lifecycle stage.

In this paper we propose a new way of measuring the value of home production. We use the information on life insurance holdings to infer the value of home production across different demographic stages. Standard life-cycle models predict that life insurance arises only in the presence of bequest motives.[7] In two-person households, life insurance can also arise because of altruism, either for each other or for their descendents. But more interestingly, life insurance can arise out of selfish concerns for lower resources in the absence of the spouse.[8] Losing a member of the household because of death can be very detrimental to the survivor. If this is the case, both spouses may want to hold a portfolio with higher yields in case one spouse dies. In this regard, life insurance is a good measure of individual's contribution to the households in terms of earnings as well as household production. Therefore, the face value of life insurance reflects agents' valuation of an individual's contribution to the household where the quality of nonmarket production is implicitly embedded.

People who stay home and focus on home production choose to do so because it is better for them to stay at home than go to the market. Roy (1951) first sketched the basic structure of describing how workers choose a career. Heckman & Honore (1990) and Sattinger (1993) show the sign of the correlation coefficient of two different skills is crucial to understand both "within-sector" inequality and "between sector" inequality. To address this self-selection issue, we follow Roy's (1951) original idea to construct a model where market productivity and nonmarket productivity are correlated and agents make a career choice between market sector and nonmarket sector. Introduction of heterogeneous productivity coupled with information of life insurance holding allow us to pin down the correlation between market and nonmarket productivity. We use an OLG model of two-sex multiperson households where agents may change their marital status due to death of spouses. Agents enjoy utility from consumption of market goods as well as nonmarket goods. Individuals in a married household solve a joint maximization problem. Agents choose how much to consume and save, as well as whether to participate in the labor market and most importantly how much life insurance to buy on each other's death. The sources of heterogeneity in our model are uncertain life time, uninsurable idiosyncratic market productivity, and different ability of nonmar-

[6]Eisner uses three different ways of valuation of nonmarket household work: "wage equals opportunity cost of time"(WOCT), "market alternative = housekeeper cost"(MAHC), and "market alternative = individual function costs"(MAIFC).

[7]See Fischer (1973), Lewis (1989), and Yaari (1965)

[8]See Cubeddu (1995) and Hong & Ríos-Rull (2004).

ket production across agents. This process allows us to estimate home production profiles across different stage of life and jointly with the weights of each spouse within the household and a shape of the utility function.

We find that nonworking women are 2 times better at home production than working women. Therefore, they choose to stay home to concentrate on home production. We also find that the profile of women's home production has a very different picture from what is implied by hours worked at home. We show that average labor productivity of household production, which is defined by nonmarket output divided by hours worked at home, varies much across agents' employment status. Our model shows that educated women produce more home goods per hour than less educated women regardless of their employment status. Consistent with findings of Heathcote (2002) and Aguiar & Hurst (2004), retired households produce a lot of home goods. The amount of nonmarket goods produced by retired households account for about 50% of nonmarket goods produced in the economy. Altogether, the value of home production is about 12% of total market output.

Among the literature that studies household production in macroeconomics, Jones, Manuelli & McGrattan (2003) study the effect of decreases in the gender wage gap on the increase in the average hours worked by married women. Heathcote (2002) uses the OLG model of a single agent with home production to explain reduction of market consumption at retirement. Rupert, Rogerson & Wright (2000) find that the introduction of home production explains a big difference in estimating the intertemporal elasticity of substitution. McGrattan, Rogerson & Wright (1997) estimate a stochastic model with home production and find a significant elasticity of substitution between home and market goods.

Several mechanisms have been developed to study the decision making of multiperson households. Chiappori (1988, 1992) developed the "collective" model where individuals in the household are characterized by their own preferences and Pareto-efficient outcomes are reached through collective decision-making processes among them.[9] Cho & Rogerson (1988) and Chang & Kim (2005) use a two-person household model where the family maximizes the expected lifetime utility. In Greenwood, Guner & Knowles (2003) and Knowles (2005), the decisions of married household are made through Nash bargaining.

With respect to work regarding labor market heterogeneity, Cho & Rogerson (1988) show labor supply depends on the relative productivity of members in the household. Castaneda, Diaz-Gimenez & Ríos-Rull (1998) study a relationship between the income distribution and unemployment spells. Chang & Kim (2005) look into the mapping from individuals' labor market participation to aggregate labor supply function.

There is a literature on how life insurance ownership varies across different household types. Auerbach & Kotlikoff (1991) document life insurance purchases for middle-aged married couples,

[9] See also Browning, Bourguignon, Chiappori & Lechene (1994), Browning (2000), Mazzocco (2003), Lise & Seitz (2004).

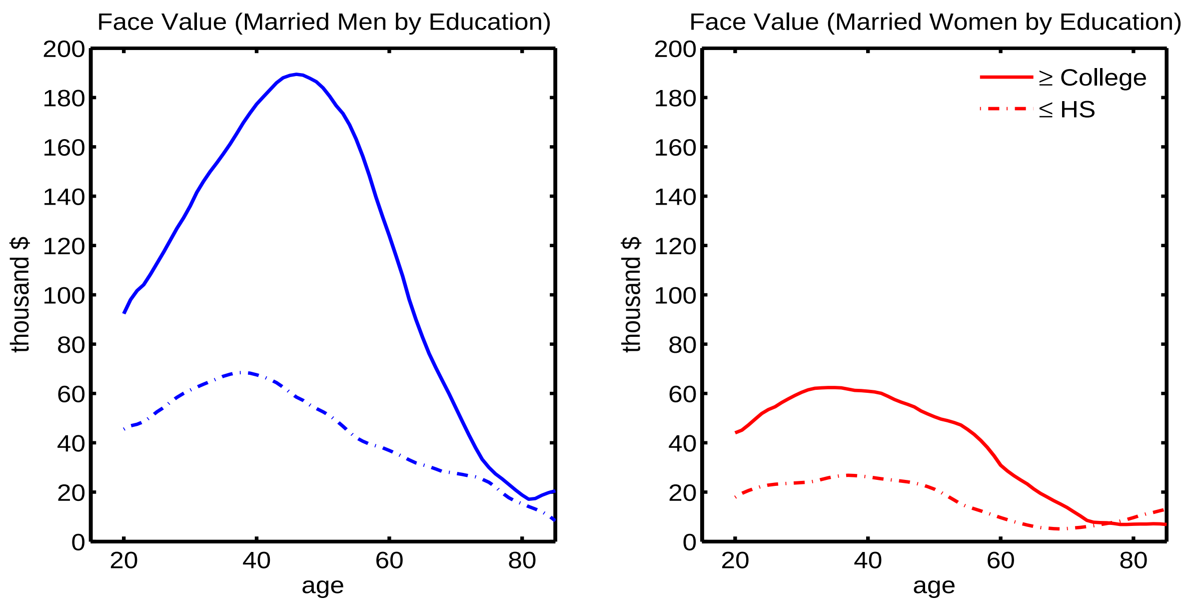

Figure 1: U.S. LIFE INSURANCE HOLDINGS (SRI-CFD 90)

while Bernheim (1991) does so for elderly married and single individuals. Bernheim, Forni, Gokhale & Kotlikoff (2003) use the Health and Retirement Study (HRS) to measure financial vulnerability for couples approaching retirement age. Chambers, Schlagenhauf & Young (2003) use a dynamic OLG model of households to estimate life insurance holdings for the purpose of smoothing family consumption and conclude that the life insurance holdings of households in their model are so large that it constitutes a puzzle. Hong & Ríos-Rull (2004) use information on life insurance holdings by age, sex, and marital status to estimate equivalence scales and altruism.

The remainder of this paper is organized as follow. Section 2 describes the pattern of life insurance purchases by the U.S. households. In section 3, we present a simple example of uncertain lifetime which illustrate the rationale of purchasing the life insurance. Section 4 explains the dynamic overlapping generation model economy in detail. In section 5 we calibrate the model parameters consistent with data and describes the quantitative targets and parameters we use in our estimation. Section 6 reports the estimation result and our main findings. Section 7 concludes with comments and future work.

2 Data

Figure 1 depicts average face value of life insurance (the amount that will be collected in the event of death) of married people in the US. The data are from the Consumer Financial Decisions (CFD) for 1990-1991. The CFD is carried out by the SRI consulting company[10], and consists of the survey responses from more than 3800 households. The data contains information on the balance sheet,

[10] http://www.sric-bi.com/CFD/

pension, life insurance, and demographic characteristics of the households. The sample is designed to oversample households with higher incomes and assets. Of the more than 3800 households surveyed, almost 1200 are with households whose annual income exceeds $75,000 or whose total assets, excluding primary residence, exceed $300,000. The main advantage of this data set relative to the Survey of Consumer Finances (SCF) data is that we have information on the division of life insurance between spouses (on whose death the payments are conditional). This is crucial because both the loss of income and the ability of the survivors to cope are very different when the husband dies than when the wife dies.

It is worth noting that, in the figures, the face value of life insurance is greater for husbands than for wives and greater for those educated than less educated for all ages. Men hold 2.6 times more insurance than women. Educated men have 2.9 times more insurance than uneducated men and 2.7 times higher for college women than non-college women. Table 2 and table 3 show that percentage of individuals holding positive amounts of life insurance policies and their average face values, respectively. Table 3 shows that working women hold twice more insurance than nonworking women and this pattern holds for all ages which is also shown in figure 2 in greater detail. We use these profiles of life insurance holdings to learn about the value of home production.

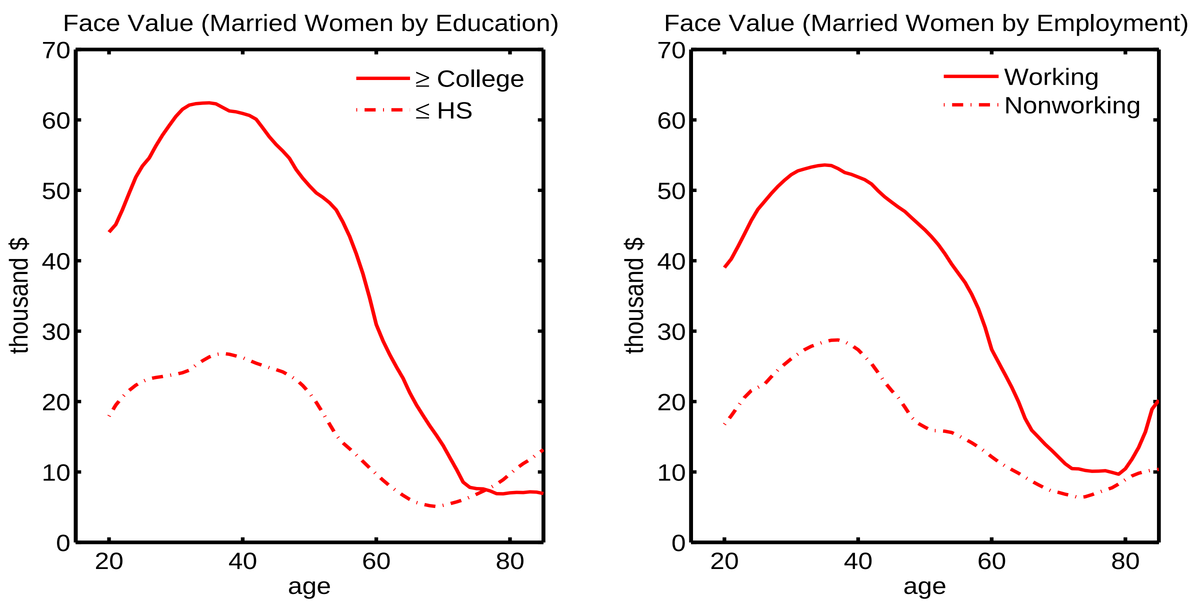

Figure 2: U.S. LIFE INSURANCE HOLDINGS OF MARRIED WOMEN (SRI-CFD 90)

2.1 Data issues about life insurance

Group Policy vs. Individual Policy Two types of life insurance policies predominate the market: group life and individual life insurance. Group life insurance is defined as "insurance obtained through your employment, membership in other organizations. (e.g. professional or fraternal organizations, church, or Veterans Insurance purchased through the U.S. Government)."

Individual life insurance is "obtained directly from a life insurance company, or a life insurance sales person/agent." According to the Life insurance factbook (1998), Americans hold $3.0 trillion of group insurance and $4.2 trillion of individual insurance as of 1987. The number of policies in effect in 1987 is 136 million of group insurance 186 million of individual insurance. It may be possible that group insurance is provided at a lower cost as a benefit package for employed workers. If this is the case, the amount of life insurance holding may be biased upward as compared to the optimal amount of insurance. However, people purchase individual life insurance policies in addition to group insurance obtained through their employer, which we view as a result of optimal decision making. As shown in table 2, more than 70 percent of men who participate in the life insurance market hold individual policy and about 60 percent of women hold individual insurance. Table 3 also shows that the average face value of individual policy exceeds that of group policy, which confirms our claim that people choose the optimal amount of life insurance by purchasing individual policies.

Term Insurance vs. Whole life Insurance While term insurance provides protection only for a specific period of time, whole life insurance can provide protection for the entire lifetime, or in certain instances, up to a specified age. In addition, permanent life insurance policies can build a cash value – money that a policy holder can borrow against. We view this cash value as a form of saving and we subtract cash value when we report face value of life insurance to get the pure insurance amount.

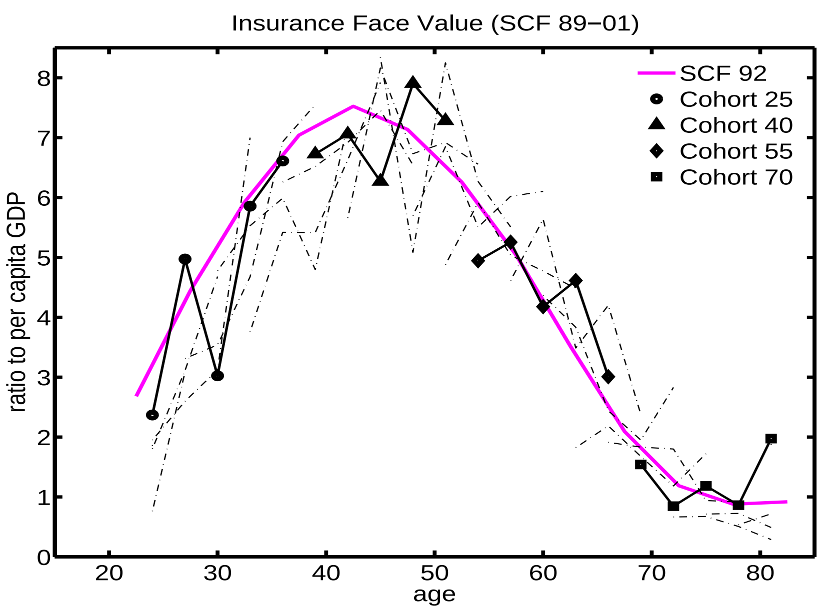

Figure 3: U.S. LIFE INSURANCE HOLDINGS (SCF 1989-2001)

Comparison with the SCF The SRI-CFD data is a cross-section survey of 1990 and we make sure there is no cohort effect in insurance data from the CFD. Hong & Ríos-Rull (2004) compare the SRI-CFD with the SCF in greater detail. We construct synthetic cohorts by using five waves of the SCF (1989-2001) and figure 3 shows that there is no cohort effect in life insurance holding from the SCF.

3 Simple Example

In this section, we present a simple model of married couples which provides an insight into life insurance purchases as a solution to the joint utility maximization problem. Basic ingredients of this simple model are the following: (a) uncertain lifetime, (b) household production, and (c) labor supply decision. Consider a married couple which lives one period. For simplicity, we assume the wife may die at the beginning of the period with probability $1-\gamma$ while the husband lives for one period with certainty. The wife can either work at the market or produce home goods, if she survives.

Members enjoy utility from market goods and nonmarket goods, where nonmarket goods can be produced by the wife's household work.

Value of wife to husband First, consider the case when the wife stays at home and produces nonmarket goods. Suppose the husband is a decision -maker in the household. From husband's point of view, wife's sudden death is a loss of nonmarket goods for him to enjoy. Therefore, he wants to insure himself by purchasing life insurance against her death. The problem of the husband can be written as

$$\max_{b} \left\{ \begin{array}{l} \gamma u(a-(1-\gamma)b+w^m+c_h)+ \\ (1-\gamma)u(a-(1-\gamma)b+b+w^m) \end{array} \right\}$$

where γ is the survival probability of a wife, a is the assets of couples at the beginning of the period, b is the face value of life insurance paid upon the death of the wife, w^m is labor income of husband from the market, and c_h is nonmarket goods produced by a wife when she is alive. The solution to this problem is $b = c_h$. This means that the husband wants to buy a life insurance for his wife which protects his loss of nonmarket goods by delivering exact same amount of market goods. The amount of life insurance, therefore, is a good proxy of husband's valuation of wife's contribution to the households.

Now consider the case where the wife can choose whether to participate in the labor market or to stay at home. She produces c_h when she chooses to stay at home, while she can make her labor earning w^f if she goes to the market. Wife's labor market participation is determined by comparing the value of her nonmarket production and the value of her earnings.

The optimal choice for the wife is to stay at home if her nonmarket value exceeds earnings from employment. Therefore the amount of life insurance for wife in this case also determined by comparing values from market and nonmarket work. $b = \max\{c_h, w^f\}$. Life insurance provides a protection from future income loss or loss of future home goods.

Altruism toward other members If she cares for the well-being of other members in the household after her death, she would want to hold life insurance against her own death. Her problem can be written as

$$\max_{b} \left\{ \begin{array}{l} \gamma u(a-(1-\gamma)b+w^m+w^f+c_h)+ \\ (1-\gamma)\chi(a-(1-\gamma)b+b) \end{array} \right\}$$

where χ is a function of her altruistic bequest. The first order condition of this problem gives $u'(c_m+c_h)=\chi'(a+\gamma b)$. This logic can apply to single persons who may want to leave a bequest to their dependents or relatives.

We show that life insurance could provide protection from loss of income or loss of nonmarket production; and the amount of life insurance holdings is a good measure of one's contribution to the households. The husband needs life insurance for his wife to protect himself against possible losses while the wife wants to hold life insurance for herself because of her warm glow motive. When husband and wife make a decision on their own life insurance these two effects are combined and the size of the two effects depends on their relative power in making a joint decision.

When it comes to a more realistic model, there are many features to be considered. People lives many periods, earnings vary across lifecycle stages, husbands may die, and the size of family changes over the lifecycle.

In the next section we present a fully specified general equilibrium overlapping generation model which provides us a more realistic picture of life-cycle behavior of married couples.

4 The Model

4.1 Environments

The economy is populated by overlapping generation agents who face life-time uncertainty over the life cycle. In each period, a new generation of adult married couple of measure one enters the economy. When they enter the economy, there is a random draw of the education level and nonmarket productivity of couples which do not evolve throughout their lives. Couples stay married until a spouse dies, in which case the survivor becomes a widow(er) and stays single throughout his/her lifetime. For simplicity, no divorce nor remarriage is allowed. At any point in time, agents are indexed by age $i, \in \{1,2,\cdots,I\}$, sex, $g\in\{m,f\}$, marital status, $z\in\{M,S\}$ (where all singles in the model are widows or widowers), own level of education, $e\in\{\underline{e},\overline{e}\}$, and individual market productivity, x, and nonmarket productivity, h. Agents are also indexed by the assets that belong to the household to which the agent belongs: $a\in\mathcal{A}$.

We denote agents' state with $s=\{i,g,e,x,h\}$. If we denote next period's values with primes, we have $s'=\{i',g',e',x',h'\}$ where $i'=i+1$, $g'=g$, $e'=e$, $h=h'$, and the probability of an agent of type $\{i,g,e,x,h\}$ today moving to x' is $\Gamma_{igeh}(x'|x)$. For married couple ($z=M$), we use s^* to denote state of the spouse. Marriage dissolves only when spouses die. The probability of changing

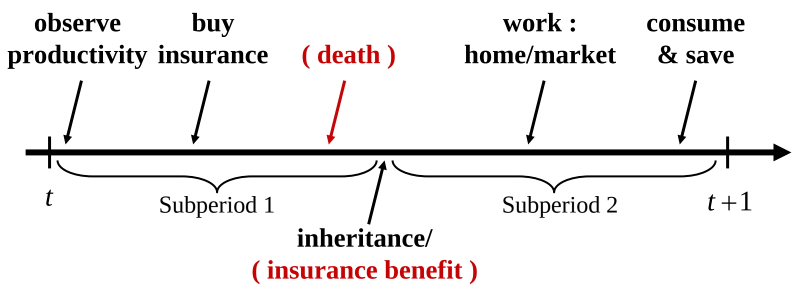

Figure 4: Timing of Events

marital status from married to single is determined by a mortality risk of the spouse which is specified below. Assets vary both because of savings and because of changes in the composition of the household.

In each period of their lives, agents have opportunities of working in the market, or staying home to produce nonmarket goods. In addition to this labor market participation choice, agents make other decisions: how much to save, how much to consume, and how much life insurance to buy against either spouse's death.

Timing of Events At the beginning of the period agents observe their own productivity for current period. Each period is divided into two subperiods. Figure 4 shows when each event takes place in every period. In the first subperiod agents make a choice of how much life insurance they purchase for themselves and their spouses for married couples. Agents may die at the end of the first subperiod in which case the remaining spouse receive insurance benefit. Agents also may inherit assets from their parent's generation which adds to their existing assets.

In the second subperiod agents make a labor supply decision as well as a consumption/saving decision, if they are alive. They consume market goods and nonmarket goods produced in that period. Nonmarket production is assumed nonstorable. Their saving will be carried over to the next period which earns interest and agents start a new period.

Demographics While agents can live a maximum of I periods, they face mortality risk. Survival probabilities of agents depend on age, sex, and their own education level. The probability of surviving between age i and age $i+1$, for an agent of gender g with education e is γ_{ige}, and the unconditional probability of being alive at age i with education e can be written $\gamma^i_{ge} = \Pi^{i-1}_{j=1}\gamma_{jge}$. Since agents can live at most I periods, we assume that $\gamma_{I..} = 0$. Population grows at rate λ_μ. The measure of agents of age $i+1$ is given by

$$\mu_{i+1ge} = \frac{\gamma_{ige}}{1+\lambda_\mu}\mu_{ige}.$$

For simplicity, husband and wife are assumed to be same age.

Preferences, Bequest and Inheritance Individuals derive utility from consumption of market goods, c_m, from consumption of nonmarket goods, c_h, and from a warm glow bequest transferred to the other members of household (including spouse) upon death, which we denote with $\chi(\cdot)$. We assume that preferences are time-separable with discount factor β and are indexed by age, sex, education, and marital status, and written as $u_s(c_m, c_h)$. Household share consumption goods between members and it is assumed that all consumption are public. If we denote with $V_s(a)$ the value function of single agent in state (s, a), we can have the following relationship:

$$V_s(a) = \gamma_s u_s(c_m, c_h) + \beta\gamma_s \mathbb{E}(V_{s'}(a')|s) + (1 - \gamma_s)\chi(y)$$

where y is the amount of bequest she leaves. The first term is current period utility when alive, the second term is the discounted value function for next period, and the third term is the utility from leaving bequests.

For a married couple, a similar relationship holds but it is a little more complicated because there is the possibility of changing marital status from married to widowed in case spouse dies. If we denote the value function of married agents of state s, spouse's state s^* and asset a with $V_{ss^*}(a)$, the relationship can be written as

$$\begin{aligned} V_{ss^*}(a) &= \gamma_s\gamma_{s^*} u_{ss^*}(c_m, c_h) + \beta\gamma_s\gamma_{s^*}\mathbb{E}(V_{s's^{*\prime}}(a')|ss^*) \\ &+ \gamma_s(1-\gamma_{s^*})u_s(c_m, c_h) + \beta\gamma_s(1-\gamma_{s^*})\mathbb{E}(V_{s'}(a')|s) \\ &+ (1-\gamma_s)\chi(y). \end{aligned}$$

The first two terms are the value of staying married, while the next two terms are the value of being widowed. The last term is the utility agent gets from the bequest upon death.

This bequest is transferred to the next generation when single head dies or both husband and wife die at the same time. We assume that all the assets of households that die at age i are inherited by households of next generation of age $i - G$ where G denotes the generation length or by the generation of age 1 if $i \leq G$.

Labor Supply Decision & Productivity In this economy agents of the same age, sex, and education level face the same exogenous age-sex-education specific efficiency profile ϵ_{ige}. In addition to this average age-sex-education profile, agents differ from each other in their idiosyncratic productivity. The stochastic shocks to their productivity level are characterized by a transition function $\Gamma_{ge}(x'|x)$. This Markov process is same for all agents with same sex and education level. Therefore, the total market productivity of a worker of age i, sex g with education e is given by the product of the worker's stochastic productivity in that period and the worker's deterministic efficiency profile : $x_{ge}\epsilon_{ige}$.

We abstract from an intensive margin and assume that labor supply is indivisible. Agents can choose to participate in the labor market until they reach their mandatory retirement age[11]

[11]Since agents are required to retire at age R, we assume $\epsilon_{ige} = 0$ for all $i \geq R$.

R. If agents choose to work, which we denote with $E = 1$, they make $(1 - \tau)wx\epsilon$ where τ is the Social Security tax rate and w is economy-wide wage rate. After their retirement, agents can receive their Social Security payment T_{gexz} which depends on recipients' sex, education level, market productivity, and marital status.

Home Productivity Every agent in this economy is able to produce nonmarket goods which are non-storable and agents with same age, sex, and education share common age-sex-education specific profile of nonmarket production $\bar{h}^E_{ige}$, where E stands for the employment status. Note that there are two different profiles for each group: one for workers and the other for nonworkers. Agents who work at the market also produce nonmarket goods but amount of home production might be smaller than what produced by stay home agents, that is $\bar{h}^0_{ige} \geq \bar{h}^1_{ige}$. This is to capture the difference of hours in homework between worker and nonworker.

In addition to this average profile, agents can differ from each other in their idiosyncratic nonmarket productivity, h^E_{ge} which is assumed to be correlated with market productivity x. lifetime. We want to look at if productive worker is also productive in nonmarket production or market productivity is negatively correlated with nonmarket productivity. One can view this nonmarket productivity as a relative ability of nonmarket production within $\{i, g, e, x\}$ group. Thus, total home goods produced by agents with age i, sex g, and education e can be written as:

$$H^E_{ige}(x) = \bar{h}^E_{ige} + h^E_{ge}(x), \qquad E \in \{0, 1\}.$$

Technology There is an aggregate neoclassical production function that uses efficient units of labor and aggregate capital, $Y = f(K, L)$. Capital depreciates with rate δ.

Markets There are spot markets for labor and capital with a price of an efficiency unit of labor w and the rate of return of capital r, respectively. There is a life insurance market which we assume under perfect competition. Therefore life insurance companies charge actuarially fair price for any life insurance policy.

Government Government collects payroll taxes of tax rate τ to finance social security benefit payment T to those who retired ($i \geq R$).

In the following sections we describe the decision-making process.

4.1.1 Problem of Single Men

We abstract from men's labor supply decision by assuming that men always work at the market until they retire. Therefore, single men's problem is relatively simple. He decides how much to save/consume and how much life insurance to buy which is inherited by the next generation's household in case of his death. The present value of single men with state s and asset a denoted by $V_s(a)$ can be expressed as:

$$V_s(a) = \max_{b} \Big[\gamma_s \Omega_s(y_a) + (1-\gamma_s)\chi(y_d)\Big] \tag{1}$$

where

$$\begin{aligned} y_a &= a - (1-\gamma_s)b + \mathcal{I} \quad \text{if alive,} \\ y_d &= a + \gamma_s b - d \qquad\quad\ \ \text{if dead.} \end{aligned}$$

We denote by $\Omega_s(y)$ the value of being survived for single men of state s with asset y. He chooses the optimal amount of life insurance b to maximize his expected value. Note that $\mathcal{I}$ denotes the amount of inheritance he receives from his parent's generation at the end of the first subperiod if he survives and d denotes a fixed amount of cost of death.

In the second subperiod, single men, if survive, choose how much to save and consume.

$$\Omega_s(y) = \max_{a'} u_s(c_m, c_h) + \beta \mathbb{E}[V_{s'}(a')|s]$$

$$\begin{aligned} \text{subject to} \qquad c_m + \frac{a'}{1+r} &= y + (1-\tau)wx\epsilon_s + T_s \\ c_h &= H(s) \end{aligned}$$

4.1.2 Problem of Single Women

The problem of single women is similar to the problem of single men, but in addition to her consumption/saving and insurance decision, she also makes her own labor supply decision. In the first subperiod she makes insurance holding decision as in equation (1). Let Ω_s^1 be the present value of being single women who work in the market and Ω_s^0 be that of nonworker. The value function in the second subperiod can be defined as:

$$\Omega_s(y) = \max\left\{\Omega_s^0\ ,\ \Omega_s^1\right\}$$

where

$$\Omega_s^E(y) = \max_{a'} u_s(c_m^E, c_h^E) + \beta \mathbb{E}[V_{s'}(a')|s]$$

$$\begin{aligned} \text{subject to} \qquad c_m^E + \frac{a'}{1+r} &= y + (1-\tau)wx\epsilon_s \mathbf{1}_{E=1} + T_s \\ c_h^E &= H^E(s) \\ \text{for} \quad E &\in \{0,1\} \end{aligned}$$

4.1.3 Problem of Married Couples

Married couples solve a joint maximization problem to decide how much life insurance to buy upon one of their deaths in the first subperiod, and whether the wife goes to work or not and how much to consume and save in each case in the following subperiod.

The problem of a married couple in the first subperiod can be written as:

$$\xi V_{ss^*}(a)+\xi^* V_{s^*s}(a) = \max_{b,b^*}\left\{\begin{array}{cc} & \xi\left[\begin{array}{c}\gamma_s\gamma_{s^*}\Omega_{ss^*}(y_{ss^*})+\gamma_s(1-\gamma_{s^*})\Omega_s(y_s)+\\ (1-\gamma_s)\gamma_{s^*}\chi(y_{s^*})+(1-\gamma_s)(1-\gamma_{s^*})\chi(y_0)\end{array}\right] \\ + & \xi^*\left[\begin{array}{c}\gamma_s\gamma_{s^*}\Omega_{s^*s}(y_{ss^*})+\gamma_s^*(1-\gamma_s)\Omega_{s^*}(y_{s^*})+\\ (1-\gamma_{s^*})\gamma_s\chi(y_s)+(1-\gamma_{s^*})(1-\gamma_s)\chi(y_0)\end{array}\right]\end{array}\right\}$$

where

$$\begin{array}{rcll} y_{ss^*} & = & a-(1-\gamma_s)b-(1-\gamma_{s^*})b^*+\mathcal{I} & \text{if both alive} \\ y_s & = & a-(1-\gamma_s)b+\gamma_{s^*}b^*-d+\mathcal{I} & \text{if husband alive} \\ y_{s^*} & = & a+\gamma_s b-(1-\gamma_{s^*})b^*-d+\mathcal{I} & \text{if wife alive} \\ y_0 & = & a+\gamma_s b+\gamma_{s^*}b^*-2d & \text{if both dead.} \end{array}$$

We denote the wife's variables with star($*$) and ξ is the weight of husband in the joint maximization problem. Note that Ω_{ss^*} is the value function of a husband with state s whose wife's state is s^*. It is worth noting that $\Omega_{ss^*}(y)$ and $\Omega_{s^*s}(y)$ have different value because husband and wife face different mortality risks which affect their future values.

In the second subperiod couples solve the following problem to decide wife's labor supply.

$$E^* = \arg\max\left\{\xi\Omega^0_{ss^*}+\xi^*\Omega^0_{s^*s}\ ,\ \xi\Omega^1_{ss^*}+\xi^*\Omega^1_{s^*s}\right\}.$$

The joint maximization problem of couples can be defined as:

$$\xi\Omega^E_{ss^*}(y)+\xi^*\Omega^E_{s^*s}(y) = \max_{a'}\left\{\begin{array}{cc} & \xi\Big[u_{ss^*}(c^E_m,c^E_h)+\beta\mathbb{E}[V_{s's^{*\prime}}(a')|ss^*]\Big] \\ + & \xi^*\Big[u_{ss^*}(c^E_m,c^E_h)+\beta\mathbb{E}V_{s^{*\prime}s'}(a')|s^*s]\Big]\end{array}\right\}$$

$$\text{subject to}\quad \begin{array}{rcl} c^E_m+\dfrac{a'}{1+r} & = & y+(1-\tau)w\{x\epsilon_s+x^*\epsilon_{s^*}\mathbf{1}_{E=1}\}+T_s+T_{s^*} \\ c^E_h & = & H(s)+H^E(s^*) \end{array}$$

for each $E\in\{0,1\}$. Note that consumption and savings are shared between couples and the optimal decision on consumption and savings are same for husband and wife.

4.2 Equilibrium

A steady-state equilibrium consists of a set of value functions, a set of decision rules, aggregate inputs, factor prices, and a law of motion for the distribution $\mu' = \mathbf{T}(\mu)$ and satisfies the following conditions:

1. Let $\mu_{s,s^*}(a)$ be the distribution of households.
2. Agents solve their problem given factor prices w and r.
3. Factor prices are consistent with the aggregate quantities of capital and labor and the production function.
4. Distribution μ is consistent with agents action.

$$\mu_{s's'^*}(B) = \sum_{s,s^*} \pi(\{s', s'^*\}|\{s, s^*\}) \int_{a\in\mathcal{A}} \mathbf{1}_{a'_{ss^*}(a)\in B} \;\; \mu_{ss^*}(da)$$

5 Quantitative Specification of the Model

We now turn to the quantitative specification of the model.

Demographics Agents enter into the economy at age 20 and live up to age 90. The model period is 5 years. Agents retire at age 65 (R) and receive their Social Security benefit. Population growth rate is set to 1.2 percent which is the average US rate for the last 30 years. The survival probability by age and sex, γ_{ig}, are from the US Life Tables of 1990[12] from the National Center for Health Statistics. Since the life table does not provide information on the mortality risk by education level, we use estimated life expectancy from Rogot, Sorlie & Johnson (1992) to construct the survival probability by age,sex, and education. Rogot et al. use data from the National Longitudinal Mortality Study (NLMS) and estimate that the difference in life expectancy between the highest grade completed and the lowest is about 6 years at age 25, 5 years at age 45 , and 3.3 years at age 65 for men. For women, these differences are slightly smaller, 5 years at age 25, 4.4 years at age 45, and 2.4 years at age 65. We adjust the survival probability from the life table to match these estimated life expectancy differential for each education group. Table 4 shows the adjusted survival probability by sex, age, and education group.

We use two different groups of education level: people who have at least some college education ($\overline{e}$) and people who do not ($\underline{e}$). The measure of people by education group are from the CPS of year 1989-1991. Assortive matching is a prevailing feature of marriage in the US as in Becker (1973) and is well captured in table 5 which shows the measure of married couple by education level of husband and wife from the CPS.

Family size changes over the lifecycle. Table 6 shows average number of children by mother's age and education which is compiled from the CPS 1989-1991. Educated women tend to have less children and their peak comes later than less educated women.

[12] http://www.cdc.gov/nchs/data/lifetables/life90_2acc.pdf

Preferences We assume a standard constant relative risk aversion per period utility function with a risk aversion parameter σ as

$$u_s(c_m, c_h) = \frac{C_s(c_m, c_h)^{1-\sigma} - 1}{1-\sigma}.$$

We choose $C_s(c_m, c_h) = \frac{1}{\eta_s}\{\lambda(c_m)^{\varphi} + (1-\lambda)(c_h)^{\varphi}\}^{1/\varphi}$, where φ governs the substitutability between market and home consumption[13] and λ is the relative weight between market and nonmarket consumptions. Family size η is the number of persons in the household including children reported in table 6. According to Heathcote (2002), λ is in the range between 0.54 and 0.58, while range from Jones et al. (2003) are from 0.62 to 0.76 and a point estimate from McGrattan et al. (1997) is 0.414. For φ, various papers use values ranging from 0.429 to 0.8. benchmark case, We set σ to be 3 and estimate λ and φ.

The warm glow bequest function is specified as in De Nardi (2004):

$$\chi(a) = \chi_a \frac{(a + \chi_b)^{1-\sigma}}{1-\sigma}$$

where χ_a reflects the strength of bequest motive while χ_b determines the curvature of bequest function. We choose bequest function parameters to match bequest to output ratio 3 % and distribution of bequest. The bequest distribution is from Hurd & Smith (2001) who use the Asset and Health Dynamics Among the Oldest Old (AHEAD) of 1993-1995 and report that the average bequest left by single at the lowest 20th percentile is \$2,000, \$50,000 for 60th percentile, and \$125,000 for 80th percentile.[14]

Earnings and Productivity Age-sex-education specific efficiency profile ϵ_{ige} are compiled from the Current Population Survey (CPS) March Supplements of 1987-1995. We use the variable of "annual earnings from wage and salary". We use annual earning instead of hourly wage because we believe that earning variable can capture age,sex- and education specific intensive margin. Average annual hours of worked vary along workers' age and also by sex and education. Among the workers who reported more than 800 hours a year, men tend to work more than women, educated workers supply more time in the market than under-educated workers, and younger or older workers work less hours than middle-age workers. We believe these variations of working hours reflect working ability of workers with certain characteristic and argue that this is more plausible measure of efficiency profile for the presented model which abstracts from the intensive margin. Annual earnings from different years are adjusted using GDP deflator. Table 7 reports average earnings from the March CPS. Since we assume a mandatory retirement at age 65, $\epsilon_i = 0$ for all $i > R$.

The employment rate, which we define as a fraction of people who work more than 800 hours annually, is from the March CPS and reported in table 8.

[13]The elasticity of substitution is $1/(1-\varphi)$.

[14]We do not consider estate taxes. The threshold of estate taxes exemption is high enough that we neglect it. The exemption thresholds is \$600,000 for singles and \$1.2 million for married and widowed households in 1991.

Individual productivity x, which is the temporary component of earning ability which cannot be predicted by individual's characteristics, is assumed to follow an AR(1) process in logs:

$$\ln x' = \rho_x \ln x + \varepsilon_x, \qquad \varepsilon_x \sim N(0, \sigma_x^2). \tag{2}$$

We use the annual earnings from the PSID for the period of 1986-1992 to estimate ρ_x, σ_x for each sex and education group. We use Heckman's (1979) Maximum-Likelihood estimator to correct for sample-selection bias after individual characteristics such as sex and education are controlled for. Table 9 presents the ML estimators in 5 year value.

Home Production Amount of nonmarket goods produced by an agent is determined by average profile of home production of age, sex, education, and employment status $\bar{h}_{ige}^E$ and agents specific idiosyncratic home production ability $h_{ge}^E(x)$. As noted above, this idiosyncratic nonmarket productivity can be interpreted as a *relative* ability of home production within the group. We assume that h^E follows a normal distribution with mean 0 and variance $\sigma_{h,E}^2$: $h^E \sim N(0, \sigma_{h,E}^2)$. Since we are interested in the correlation between market productivity and nonmarket productivity, we also assume that market productivity $\ln x$ and nonmarket productivity h follow a joint normal distribution with correlation ρ_{xh}.[15] We use the information on life insurance holdings to pin down the age-,sex-,education specific profile of home production: $H_{ige}^E(x) = \bar{h}_{ige}^E + h_{ge}^E(x)$.

Other Features We assume the aggregate production function has a Cobb-Douglas form

$$f(K, L) = K^\alpha L^{1-\alpha}$$

with capital share α is 1/3. The discount rate β is chosen so that capital-output ratio from the model is 3.

According to Hurd & Smith (2001) total out-of-pocket cost of death is \$9,400 from the AHEAD 1993-1995. This cost can be divided into death expenses such as funeral cost of \$4,300, while average medical expenses before death \$4,200. We set the cost of death d to be \$9,000.

6 Estimation

Table 10 summarizes the parameters we calibrate outside model and parameters we find in the model. We use a method of simulated moments to pin down parameters. More specifically, we minimize the squared errors between specific moments generated from the model and those observed in the data.

[15] Conditional distribution of nonmarket productivity (h) given market productivity (x) can be written as

$$h|x \sim N\Big(\mu_h|x, \sigma_h^2|x\Big)$$

where $\mu_h|x = \rho_{xh} \ln x \, \sigma_h \sqrt{1-\rho_x^2}/\sigma_x$ and $\sigma_h^2|x = \sigma_h^2(1-\rho_{xh}^2)$.

Target Moments The observed moments we want to replicate from the model are:

- Employment rate of married women by age and education in table 8; $(18 = 9_i \times 2_e)$
- Mean life insurance holdings of
  men and women by age and education in figure 1; $(52 = 2_g \times 13_i \times 2_e)$
  women by employment status in figure 2; $(18 = 9_i \times 2_E)$
- Median life insurance holdings of
  men and women by age and education in figure 1; $(52 = 2_g \times 13_i \times 2_e)$
  women by employment status in figure 2; $(18 = 9_i \times 2_E)$

which give us a total of 158 moments to match. In addition to these moments, we also match a wealth to output ratio of 3, a bequest to output ratio of 3 percent and the bequest distribution from Hurd & Smith (2001).

Parameters The parameters we estimate in the model are

- Profile of average home production $(\bar{h}_s^E)$; $(74 = 2_g \times 14_i \times 2_e + 9_i \times 2_E)$
- Variance of idiosyncratic home production ability $(\sigma^2_{h,sE})$; $(6 = 2_e + 2_e \times 2_E)$
- Correlation between productivity (ρ^E_{xh}); $(6 = 2_e + 2_e \times 2_E)$
- Weight of joint decision (ξ)
- Utility parameters (λ, φ)
- Bequest function parameters (χ_a, χ_b)
- Discount rate (β)

which give us total 92 parameters to estimate. We simultaneously search for suitable parameters that provide the smallest possible residuals, that ensure that the economy is in equilibrium.

Although parameters altogether affect moments in the model, we can see which parameter has significant effect on which moments. Home production profile of nonworker H^0 corresponds to the amount of life insurance of agents who are out of labor force. Home production profile of those employed H^1 coupled with their earnings determine the level of insurance holding. The differential of average home productivity between nonworker and worker, $\bar{h}^0 - \bar{h}^1$, affect agents labor supply decision. In the extreme case where the differential is zero, everyone would choose to work since there is no gain of staying out of labor market. In the other extreme where the differential is huge, most people stay at home to produce home goods as long as market goods and nonmarket goods are substitutes. Therefore, this differential is determined by employment rate within group. The ratio of average insurance between worker and nonworker is affected not only by the ratio of $\bar{h}^0$ and $\bar{h}^1$, but also by the correlation of market and nonmarket productivity ρ^E_{xh}. The variance of home production ability σ^2_h is determined by mean and median of face value of life insurance. Table 11 reports parameter estimates of model economy.

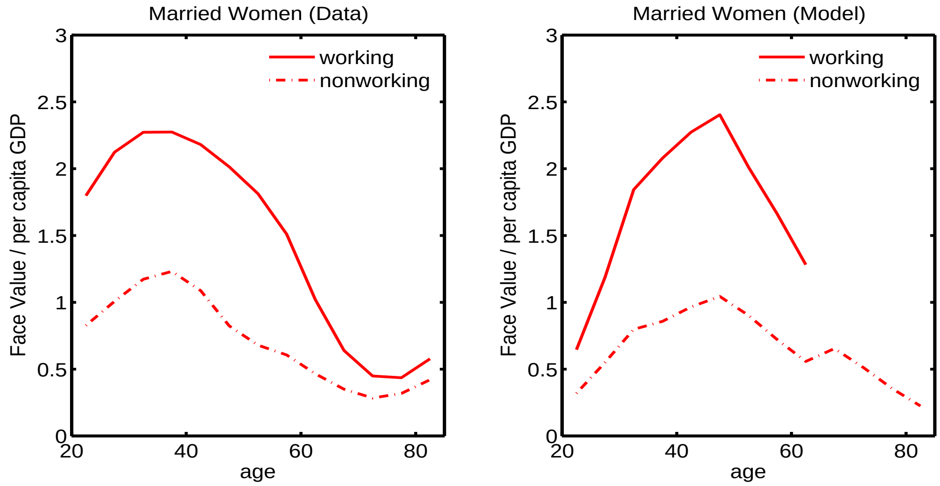

Figure 5: Women's Life Insurance by employment: Data & Model

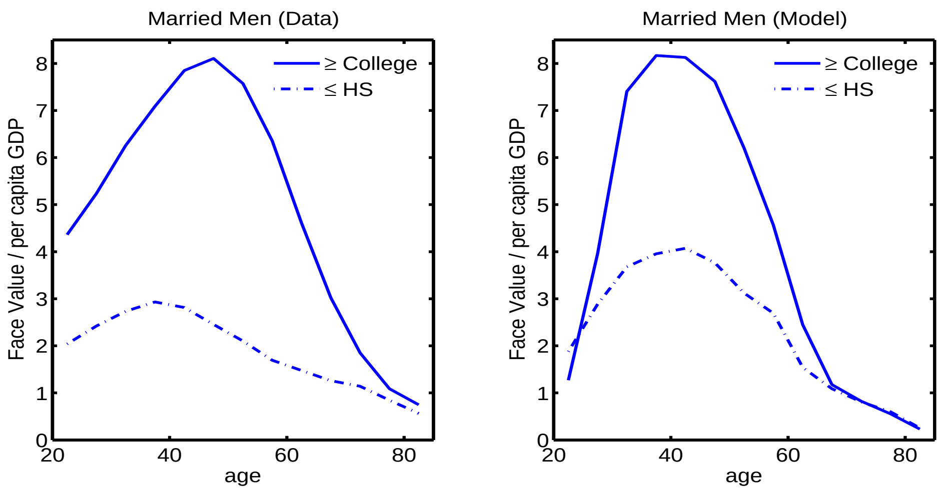

Figure 6: Men's Life Insurance : Data & Model

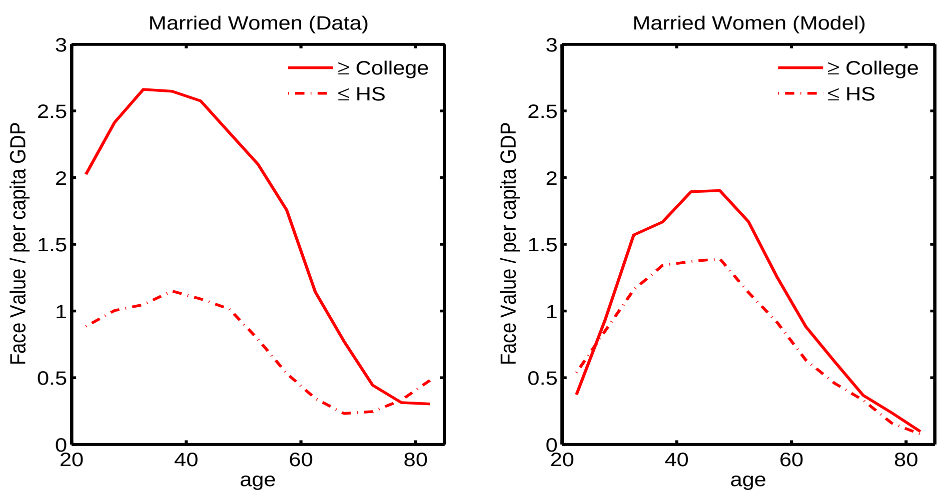

Figure 7: Women's Life Insurance : Data & Model

Figure 5, 6, and 7 show the results of the estimation by putting next to each other the values of life insurance holdings by age, sex, education, and employment both in the model and in the data. Note that while the match is not perfect, the model replicates all the main features of the data that we described in Section 2. While we did not intend to match, the fraction of people who hold positive life insurance is similar to the number reported in table 2. According to the model, 74% of married men and 51% of married women hold life insurance, while 77% of married men and 66% of married women hold life insurance in the data. The model also replicates the fact that participation is more common for the middle-age group regardless of sex.

Self-Selection & Labor Supply We present simulated data from the model in table 1 which shows how married women make their labor supply decision. We adjust the units such that the per capita output of the model matches US per capital GDP in 1990, $23,330. Top panel shows the values of possible home production for women who decide to work. She can make 10,949 dollar of earnings and 354 dollar of home production if she decide to work, while she can produce 2,910 dollar of home goods if she stays at home. Since the gain of staying home is small for her, she decides to work at the market. For those who decide to stay at home, however, their are better at home sector which is shown at the bottom panel. They can make 2,254 dollar on average if they participate in the labor market, while they can produce additional 4,135 dollar of home goods if stay. People who decide to stay at home choose to do so not only because they are offered lower earnings but also they are better at home production than people who choose to work. The third column of the table clearly shows that women who choose to stay home are better at home production than those who choose to work. This implies that nonworking women have an absolute advantage in home production compared to working women. The home productivity of nonworking women are 1.7 times better than that of working women ($4,831 vs. $2,910).

Relation between Market and Nonmarket Productivity People who were offered high earnings tend to choose to work, while a higher fraction of people choose to stay home when they have higher nonmarket production. Table 16 reports fraction of people employed by their ability in nonmarket production. We can see that the employment rate is decreasing in home ability. This is because higher ability in home production increases one's reservation wage. decision. The correlation coefficient of earnings and home production is 0.03. The correlation is higher for college women (0.07) than non-college women (0.01). While the sign of the correlation is positive, it is not far from zero, which is no correlation. For people with higher nonmarket ability, their reservation wage is higher than average. However, near zero correlation implies that they are most likely to get an average wage offer, which makes the employment rate of that group is lower than average.

Home Hours vs. Home Value Although we do not use information on time spent in the nonmarket activity, we can compare the value of nonmarket production and time spent in the nonmarket activity reported in the EPA Time Use Survey. Table 12 compares home hours from

Table 1: Labor Supply Decision of Married Women

	Differential of Home Production $H^0 - H^1$	Home Production When work H^1	Home Production When do not work H^0	Offered Earnings
Working				
HS	2,471.80	353.10	2,824.90	9,423.96
College	2,656.28	354.24	3,010.53	12,743.61
Total	2,556.53	353.62	2,910.15	10,948.55
Nonworking				
HS	4,063.70	699.09	4,762.79	2,174.18
College	4,288.28	688.77	4,977.06	2,427.00
Total	4,134.79	695.83	4,830.62	2,254.22

Note: Simulated Data for Married Women (Age 20-65). Converted to 1990 US Dollar.

the data and the value of home production from the model. The first row reports the share of married women from the model which successfully replicates two facts from the data as shown in table 8: (1) 60% of married women choose to work and (2) employment rate of college women is higher than that of less educated women. The second row shows the estimated value of home production of married women from the model. The third row is the average home hours of married women between 20 and 65 taken from the EPA Time Use Survey. We construct a measure of average labor productivity of home production which is defined as the value of home goods produced per hour worked at home, and report this on the fourth row. It is striking that the labor productivity of home production for nonworking women is more than 8 times higher than that of working women. Educated women produce more home goods per hour than less educated women regardless of their employment status. The average productivity of home work of less educated women is 1 and 8.72 for workers and nonworkers, respectively. For educated women, the average productivity is 1.12 and 9.11 – higher than less educated women. Given the fact that college women have higher earnings on average than non-college women, this tells us that market productivity and nonmarket productivity are positively correlated.

The face value of life insurance can be thought of as a present value of individual's contribution to the household. Working women are more likely to stay at the market tomorrow. We observe from the data fairly high persistence of women's labor supply.[16] As stated in section 2 working women hold twice more life insurance than nonworking women. This fact implies that the value of home production of nonworking women is fairly large. Without big nonmarket value of nonworker, we cannot explain the two facts: that significant fraction of women stay out of labor force, and

[16] From the PSID of 1986-1995, 64 percent of women who work less than 800 hours a year keep working less than 800 hours after 5 years while 82 percent of full-time women continue to work fulltime next 5 year.

that the ratio of life insurance holding of working and nonworking women is 2 while the differential of earnings are more than 5 times.

Home Production after Retirement As well documented in Aguiar-Hurst, the retired household reduce market consumption and increase nonmarket hours. Our estimates indicate that the retired households produce significant amount of nonmarket goods. Home goods produced by the retired households are almost 50 percent of total nonmarket goods produced in the economy. While men devote most of his time on market works before retirement, their home hours increase after the retirement. According to the EPA Time Use data, men's home hours are 10-12 hours per week before retirement but increase to 22-25 hours after retirement. Women's home hour, however, slightly drop after the retirement. Women reduce their home hours by 5 hours from 34 hours to work 25-29 hours after retirement. This reduction of gender gap in home hours after retirement is well captured in our model. Men's contribution to total home production of retired household is more than 3/4. Retired men whose only income is Social Security transfer hold significant amount of life insurance even after retirement, and to make sense of significant insurance holding of men the model predicts that men produce a lot of nonmarket goods after retirement.

Total Value of Home Production The total value of home production is about 12% of market output. As noted above, retired households produce about 50 percent of total nonmarket goods and the remaining half are produced by women who do not work at the market.

Summary of Findings:

- **Nonworking women are better at home production than working women.** Nonworking women are 2 times better at home production than working women. Therefore, they choose to stay home to concentrate on home production.
- **The value of home production is very different from what implied by home hours.** The value of nonmarket output produced per hour is 8 times greater for those who stay home.
- **Educated women have higher productivity of home production than those who less educated.** Educated women produce more home goods per hour than less educated women regardless of their employment status.
- **The value of home production is about 12% of Market output.**
- **Retired men produce significant amount of home goods.** Retired households produce a lot of home goods. The amount of nonmarket goods produced by retired households account about 50% of nonmarket goods produced in the economy.

Utility Parameters If market goods and home goods are complements, married couples are better off when wife stays home. The reasoning is the following: given the earnings process where the husband's earnings usually exceed the wife's earnings, the wife chooses to work at the market only when her ability of nonmarket production H^1 is exceptionally high. Additional income she makes from the market increases consumption of market goods as long as market goods is normal goods, which requires more nonmarket consumption because of complementarity. This cannot be reconciled with the fact that average employment rate of women is 60 percent and men hold more life insurance than women. Women will choose to work if she can produce enough home goods or if the husband cannot make enough income. However, none of these can explain why men hold more insurance than women. Therefore, to be able to explain employment rate of women and differential of insurance holding between men and women, market goods and home goods should be substitute. Our estimate φ which governs substitutability between market goods and home goods is 0.681, which implies the elasticity of substitution of 3.1. Table 13 compares our estimates of utility parameters with other literatures.

The weight on husband's utility ξ_m is determined by the ratio of insurance holding by men and women. Our estimate is 0.705.

Wealth Distribution Table 14 reports the Gini coefficients of family earnings and wealth from data and the model. The wealth Gini is 0.76 in the PSID, while 0.65 from the model. Wealth is more concentrated in the data. We summarize the more detailed information on wealth distribution in table 15. Although we cannot capture high concentration of wealth for the top 1 or 5 percent of the population, the model economy has a reasonably similar heterogeneity.

7 Conclusion

Nonmarket production which was first pioneered by Becker (1965) has been explicitly incorporated into macroeconomic models (e.g., Benhabib et al. (1991) and Greenwood & Hercowitz (1991)) to better explain economic behaviors in the market. The big huddle in incorporating nonmarket production into the model is that nonmarket output is unobservable. This paper is the first attempt to measure the value of nonmarket output produced in the household by using data on life insurance holdings.

We study the relationship between household production and labor force participation of married women. Women who are good at home production tend to choose to stay out of labor force so that they can concentrate their nonmarket activities. We argue that the value of household production may not be correctly measured by looking at inputs because the value of home production can vary by individual's nonmarket productivity as well as by the stage of lifecycle of nonmarket production. We use data on life insurance holdings of married couples by age, education, and employment status to infer how much nonmarket value they produce across different demographic stages. We construct a fully specified overlapping generation model of multiperson households where individuals face mortality risk, have access to life insurance markets, and consume and save. Individuals face shocks on market productivity and nonmarket productivity and make labor supply decision accordingly. By doing this, we can explicitly take care of self selection issue. Then we use the model to find out the profile of home production which generates employment rates, life insurance holdings, and key statistics as in the US data.

We find that the profile of women's home production has a very different picture from what is implied by hours worked at home. We show that average labor productivity of household production, which is defined by nonmarket output divided by hours worked at home, varies much across agents' employment status. Working women, on average, produce 360 dollars of nonmarket output, while nonworking women produce 4,830 dollars of nonmarket output. Nonworking women stay out of labor market because they are better at home production compared to working women. They can produce 4,830 dollars of nonmarket output while those who choose to work only produce 2,910 dollars of nonmarket output if they stay at home. We also find that educated women produce more home goods per hour than less educated women regardless of their employment status. Consistent with findings of Heathcote (2002) and Aguiar & Hurst (2004), retired households produce a lot of home goods. The amount of nonmarket goods produced by retired households account for about 50% of nonmarket goods produced in the economy. Altogether, the value of home production is about 12% of total market output.

We show that the value of nonmarket output is very different from what can be inferred by the total time spent on home production. We also show that there is a big difference in the value of home goods produced by working women and by nonworking women. An immediate step is to take a more detailed look at time use, such as secondary work or tertiary work as well as time allocation of worker and nonworker between various activities.

In this paper we abstract from some important issues. The presented model does not have a fertility decision. Incorporating heterogeneity in the number of children will give us better understanding of the value of home production.

Knowles (2005) uses a bargaining model of married couples and shows that the decision weight of couples varies along the relative earnings of husbands and wives and the value of their outside option; divorce. The next step is to extend the model to allow for changes in marital status such as divorce and remarriage as well as a variable decision weight of the joint maximization problem.

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Table 2: Percentage of Individuals Holding Positive Amounts of Life Insurance

		Type of Policy			Marital Status	
age	Total	Individual	Group	Both	Married	Single
men						
20-24	55.2	7.7	25.8	21.6	47.8	60.3
25-29	69.1	21.8	24.0	23.3	70.1	71.7
30-24	73.7	19.2	29.8	24.7	73.4	72.5
35-39	82.0	16.2	26.7	39.1	83.7	79.0
40-44	83.0	19.8	23.1	40.1	84.7	72.8
45-49	79.8	24.0	24.2	31.6	81.4	69.6
50-54	83.4	16.8	20.1	46.5	85.1	58.5
55-59	82.9	25.1	17.5	40.3	83.7	76.4
60-64	82.2	31.9	21.1	29.3	82.9	86.4
65-69	78.3	29.8	14.8	33.7	79.4	66.3
70-74	64.9	32.3	9.2	23.4	62.3	73.2
75-79	66.5	38.4	4.3	23.8	62.4	93.6
80-84	50.5	14.3	2.7	33.6	51.8	43.4
Total	76.2	22.2	21.3	32.6	77.4	72.0
women						
20-24	44.1	15.9	25.0	3.2	43.6	44.6
25-29	57.9	16.1	33.9	7.9	62.7	44.8
30-24	65.7	20.7	29.6	15.5	67.0	61.4
35-39	71.8	23.3	25.0	23.5	69.7	77.2
40-44	69.6	22.8	23.3	23.5	72.4	61.4
45-49	69.8	28.6	19.5	21.7	72.7	55.8
50-54	75.4	34.1	16.4	24.8	76.5	73.8
55-59	66.1	31.2	14.8	20.1	67.1	62.2
60-64	64.4	33.3	13.1	18.0	64.6	62.2
65-69	51.9	37.7	6.8	7.5	47.6	57.5
70-74	60.0	45.0	5.7	9.3	61.7	57.9
75-79	43.4	36.3	4.0	3.2	48.0	40.5
80-84	48.4	36.3	3.1	9.0	66.0	41.6
Total	63.0	27.5	19.7	15.8	65.8	56.9

Table 3: Average Face Value of Life Insurance in US $ (SRI-CFD 90)

	Total	Group	Individual
men	80,654	33,206	47,394
women	28,289	12,568	15,721
men, married	85,315	34,192	51,123
men, single	56,248	28,380	27,868
women, married	32,331	13,143	19,188
women, single	18,817	11,222	7,595
women, employed	41,628	20,947	20,682
women, nonemployed	13,004	2,968	10,036
women≤65, employed	41,651	21,310	20,341
women≤65, nonemployed	19,254	4,413	14,841
men, HS	44,374	15,939	28,435
men, College	127,917	55,824	72,092
women, HS	16,494	6,673	9,821
women, College	44,896	20,869	24,028

Table 4: Education-Adjusted Survival Probability

	Men		Women	
age	HS	College	HS	College
20-24	.9915	.9920	.9974	.9975
25-29	.9885	.9929	.9963	.9976
30-24	.9863	.9912	.9952	.9966
35-39	.9830	.9887	.9935	.9952
40-44	.9795	.9861	.9909	.9929
45-49	.9716	.9813	.9848	.9884
50-54	.9577	.9698	.9767	.9811
55-59	.9343	.9502	.9614	.9673
60-64	.8993	.9207	.9461	.9537
65-69	.8535	.8824	.9196	.9252
70-74	.7848	.8245	.8772	.8876
75-79	.6901	.7441	.8111	.8310
80-84	.5627	.6329	.6993	.7394

Table 5: Measure of Couples by Education (CPS 1989-1991)

Men	Women HS	Women College	Total
HS	.4617	.0999	.5616
College	.1423	.2916	.4384
Total	.6040	.3960	1.0

Table 6: Number of Children (CPS 1989-1991)

age of mother	Mother's Education HS	Mother's Education College
20-24	1.120	0.473
25-29	1.647	0.915
30-24	1.984	1.531
35-39	1.835	1.779
40-44	1.097	1.377
45-49	0.498	0.672
50-54	0.186	0.197
55-59	0.061	0.047
60-64	0.014	0.009
65-69	0.006	0.005
70-74	0.005	0.005
75-79	0.003	0.002
80-84	0.001	0.002

Table 7: Average Annual Earnings from CPS March 1987-1995 (1990 US $)

	Men		Women	
age	HS	College	HS	College
20-24	10,069	9,432	6,725	7,889
25-29	13,956	19,803	8,105	13,542
30-24	16,463	26,695	8,794	15,313
35-39	18,272	29,851	9,532	15,886
40-44	19,596	32,003	10,104	16,867
45-49	20,901	34,223	10,432	17,456
50-54	20,470	33,702	10,133	16,860
55-59	18,925	30,187	9,615	15,506
60-64	14,499	23,875	8,012	12,747

Table 8: Employment Rate from CPS March 1987-1995

	Men		Women	
age	HS	College	HS	College
20-24	0.9014	0.8895	0.5142	0.6997
25-29	0.9257	0.9429	0.5404	0.7215
30-24	0.9219	0.9600	0.5648	0.6603
35-39	0.9183	0.9617	0.6055	0.6635
40-44	0.8955	0.9592	0.6250	0.7085
45-49	0.8838	0.9529	0.6059	0.7306
50-54	0.8532	0.9350	0.5433	0.6913
55-59	0.7617	0.8560	0.4336	0.5593
60-64	0.5320	0.6246	0.2755	0.3674
Total	0.8480	0.9227	0.5316	0.6690

Note: Employment rate is defined as a fraction of people who work more than 800 hours.

Table 9: Evolution of Individual Productivity (PSID 1986-1995)

Education	ρ_{xm}	ρ_{xf}	$\sigma_{\varepsilon_{xm}}$	$\sigma_{\varepsilon_{xf}}$
HS	.598	.471	.763	.893
College	.630	.513	.728	.868

Table 10: Parameter Values

i, I	Model Age	age 20∼90
R	Retirement Age	65
γ	Survival Probability	see text and table 4
λ_μ	Population Growth	1.2 %
G	Generation Length	30 year
x	market productivity	see text
$\Gamma(x'\|x)$	Transition of x	AR(1) process, see table 9
ε	efficiency profile	see text
τ	Social Security tax rate	10 %
T	Social Security Transfer	see text
α	Capital Share	.33
δ	Depreciation	8 %
σ	CRRA Risk aversion	3
d	death cost	\$8,000
η	Family Size	see text and table 6

Table 11: Parameter Estimates

ξ	Weight on husband	0.70
λ	Weight on market goods	0.628
φ	Substitutability	0.681
χ_a	Bequest function	0.634
χ_b	Bequest function	\$134,081
β	Discount rate	0.975

Table 12: Home Hours vs. Home Value

	Working		Nonworking	
	HS	College	HS	College
Share (Simulation)	32%	27%	28%	13%
Value Produced (Simulation)	1.41	1.42	19.08	19.93
Home Hours (EPA Time Use)	21.89	19.64	33.95	33.97
Output/Hour (Normalized)	1.00	1.12	8.72	9.11

Table 13: Estimated Utility Parameters

	Weight on market goods λ	Substitutability φ
BRW (JPE,91)	N/A	.8 (.6 $\sim$ 1.0)
MRW (IER,97)	.414	.429
Heathcote (2002)	.578	.5 $\sim$ .75
JMM (2003)	.682	.429
This Paper	.628	.681

Table 14: Gini Indices

	PSID (84)	SCF (92)	Model
Wealth	.76	.78	.65
Earnings	.53	.63	.53

Note: The PSID and SCF statistics are from Chang & Kim (2005) and Díaz-Gimenez, Quadrini & Ríos-Rull (1997), respectively.

Table 15: Characteristics of Wealth Distribution

	Quintile					
	1st	2nd	3rd	4th	5th	Total
SCF						
Share of wealth	-.39	1.74	5.72	13.43	79.49	100
Group average/population average	-.02	.09	.29	.67	3.97	1
Share of earnings	7.05	14.50	16.48	20.76	41.21	100
Model						
Share of wealth	.05	1.79	9.10	12.81	65.25	100
Group average/population average	.00	.09	.45	1.19	3.26	1
Share of earnings	9.55	17.87	19.72	22.49	30.36	100

Note: The SCF statistics are from Díaz-Gimenez et al. (1997).

Table 16: Employment Rate by Nonmarket Ability

Education	Bottom 1/3	Middle 1/3	Top 1/3	Total
HS	0.834	0.412	0.388	0.545
College	0.908	0.620	0.563	0.697
Total	0.863	0.495	0.459	0.606