Life Insurance and Household Consumption *

Jay H. Hong
University of Rochester

José-Víctor Ríos-Rull
University of Pennsylvania,
CAERP, CEPR, NBER

June 2006

Abstract

We use data of life insurance holdings by age, sex, and marital status to infer how individuals value consumption in different demographic stages. Essentially, we use revealed preference to estimate equivalence scales and altruism simultaneously in the context of a fully specified model where agents face U.S. demographic features and have access to savings markets and life insurance markets. Our findings indicate that individuals are very caring for their dependents, that there are large economies of scale in consumption, that children are costly, that wives with children produce a lot of goods in the home and that while females seem to have some form of habits created by marriage, men do not. These findings contrast sharply with the implications of standard notions of equivalence scales.

Keywords: Overlapping Generations, Life Insurance, Savings, Equivalence Scales, Altruism

JEL Classifications: E21, C63, J10, D64

*We thank Luis Cubeddu, whose dissertation has the data analysis that constitutes the seeds of this work. We also thank participants at seminars at Penn, Stanford, NYU, the NBER Summer Institute, and BEMAD in Malaga. Ríos-Rull thanks the National Science Foundation (Grant SES–0079504) and the University of Pennsylvania Research Foundation.

1 Introduction

Two central pieces of modern macroeconomic models are consumption and hours worked. In recent years there has been a lot of effort to construct models of the macroeconomy with a large number of agents[1] who choose how much to work and how much to consume. Still, the data are collected by posing hours worked by individuals and consumption of the household. This inconsistency of economic unit has to be resolved, and there is exciting new work that attempts to do so. Some of this work comes from the labor economics tradition and represents a household as a multiple-agent decision-making unit, where the environment shapes the form of the joint decision, the so called collective model.[2]. Standard work in macroeconomics uses some form of equivalence scales to construct stand-in households with direct preferences rather than modeling its individual members.[3]

In this paper we estimate preferences for men and women conditional on their family composition and we use them to build general equilibrium overlapping generation models. We use information on the changing nature of the composition of the household and on life insurance purchases by households to produce our estimates. We exploit the facts that life insurance is a good that requires the death of one of the spouses to be enjoyed by the other (a great example of a purely private good), that is very widely held, and the events that

[1]The list of papers is by now very large, but we can trace this line of research to İmrohoroğlu (1989) and Díaz-Giménez, Prescott, Fitzgerald, and Alvarez (1992) as well as the theoretical developments of Huggett (1993) and Aiyagari (1994) and the technical developments of Krusell and Smith (1997).

[2]Chiappori (1988, 1992) is credit with the development of 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. Browning, Bourguignon, Chiappori, and Lechene (1994) use the collective model to show that earnings differences between members have a significant effect on the couple's consumption distribution. Browning (2000) introduces a non-cooperative model of household decisions where the members of the household have different discount factors because of differences in life expectancy. Mazzocco (2003) extends the collective model to a multiperiod framework and analyzes household intertemporal choice. Lise and Seitz (2004) use the collective model to measure consumption inequality within the household.

[3]Attanasio and Browning (1985) show the importance of household size to explain the hump-shaped consumption profiles over the life cycle. In Cubeddu and Ríos-Rull (1996) and Cubeddu and Ríos-Rull (2003), consumption expenditures are normalized with standard OECD equivalence scales. Greenwood, Guner, and Knowles (2003) use a functional form with equivalence scales which is an increasing and concave function in family size as does Chambers, Schlagenhauf, and Young (2003b). Attanasio, Low, and Sanchez-Marcos (2004) use the McClements scale (a childless couple is equivalent to 1.67 adults, a couple with one child is equivalent to 1.9 adults if the child is less than 3, to 2 adults if the child is between 3 and 7, to 2.07 adults if the child is between 8 and 12 and 2.2 adults if between 13 and 18). See Browning (1992) and Fernández-Villaverde and Krueger (2003) for a detailed survey on equivalence scales.

trigger the payments, the death of individuals, are very predictable, and, to a large extent, free of moral hazard problems. We pose two-sex overlapping generations embedded in a standard macroeconomic growth model where agents are indexed by their marital status (which includes never married, widowed, divorced, and married (specifying the age of the spouse) as well as whether the household has dependents), that evolves as it does in the U.S. In our environment, individuals in a married household solve a joint maximization problem that takes into account that, in the future, the marriage may break up because of death or divorce.[4] Crucially, we use life insurance purchases as well as aggregate restrictions to identify individual preferences in different demographic stages jointly with altruism for dependents and also jointly with the weights of each spouse within the household. In other words we use revealed preference, via life insurance purchases, to estimate a form of equivalence scales.[5]

Life insurance can be held for various reasons. Standard life-cycle models, models that identify households with agents, predict that only death insurance, i.e., annuities will be willingly held. Life insurance arises only in the presence of bequest motives.[6] In two-person households, life insurance can also arise because of altruism, either for each other or for their descendents. But more interestingly, perhaps, life insurance can arise out of selfish concerns for lower resources in the absence of the spouse. The prevalence across space and time of marriage indicates that such form of organization is an efficient one, and losing its members because of the 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 our paper, we abstract from altruism between spouses, and we allow for altruism for dependents (there is a lot of information about this in the life insurance held by singles). In our model, the household composition affects the utility of agents, not only because of altruism toward descendents but also because it affects how consumption expenditures translate into consumption enjoyed (equivalence scales). Household composition also matters for earnings. The specificity with which the household composition affects agents changes over time, as the number of dependents evolves and as earnings vary. These changes translate into different amounts of life insurance being purchased, and these varying amounts contain a lot of information about how agents' utility changes. This is the effective information of the data that inform our findings.

[4]In Greenwood, Guner, and Knowles (2003), the decisions of married household are made through Nash bargaining following Manser and Brown (1980) and McElroy and Horney (1981).

[5]While we model individuals and their preferences directly, ours is not in a strict sense a collective model since the decisions are made by using a state invariant set of within household Pareto weights and all household consumption is public.

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

Our estimates of how utility is affected by household composition have some interesting features: *i)* Individuals are very caring for their dependents. While there are no well-defined units to measure this issue, our estimates indicate that a single male in the last period of his life will choose to leave more than 50 percent of his resources as a bequest. *ii)* There are large economies of scale in consumption when a couple lives together: People living in a two person household that spends $1.07 have the same marginal utility than those living alone and spending one dollar. *iii)* Children are quite expensive. A single man with one child has to spend more than $3.39 to get the same marginal utility that he would have had alone. *iv)* Women are much better at providing for children than men. Children who live with either single women or married couples require 20 percent less expenditures to keep marginal utility constant than children who live with single men. *v)* Adult dependents seem to be costless. *vi)* Men have the upper hand in the marriage decision as the weight they carry in the household's maximization problem is higher. These findings contrast sharply with the standard notions of equivalence scales.

We use our estimates to explore the implications of eliminating Survivor's Benefits from the Social Security program. This policy change implies that a retired widow is entitled only to her Social Security and not to any component of her deceased husband's. This amounts to a 24 percent reduction in widow's pensions and it is effectively a policy change that favors men and hurts women. In our environment, widows want to spend an amount similar to that of couples, and hence the elimination of Survivor's Benefits implies a reduction of income but not necessarily of consumption upon the husband's death. However, it turns out that the effects of the policy change are relative minor: married couples can easily cope with the elimination of Survivor's Benefits by purchasing additional life insurance. Still, abolishing Survivor's Benefits improves the welfare of men (by .008% of their consumption) and reduces that of women (by .024%) of their consumpiton.

There is an empirical literature on how life insurance ownership varies across different household types. Auerbach and Kotlikoff (1991) document life insurance purchases for middle-aged married couples, while Bernheim (1991) does so for elderly married and single individuals. Bernheim, Forni, Gokhale, and Kotlikoff (2003) use the Health and Retirement Study (HRS) to measure financial vulnerability for couples approaching retirement age. Of special relevance is the independent work of Chambers, Schlagenhauf, and Young (2003a), which carefully documents life insurance holding patterns from the Survey of Consumer Finances. Chambers, Schlagenhauf, and Young (2003b) 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 holding of households in their model is so large that it constitutes a puzzle.[7]

We proceed as follows. Section 2 reports U.S. data on life insurance ownership patterns in various respects. Section 3 illustrates the logic of how life insurance holdings may shed light on preferences across different demographic configurations of the household. Section 4 poses the model we use and describes it in detail. Section 5 describes the quantitative targets and the parameter restrictions we impose in our estimation. Section 6 carries the estimation and includes the main findings. In Section 7 we explore various alternative (and simpler) specifications and make the case for the choices we had made. Section 8 explores Social Security policy change in our environment and Section 9 concludes. In various appendices we describe some details of life insurance in the U.S. and some details of the computation and estimation of the model.

2 Life Insurance Holdings of U.S. Households

Figure 1 shows the face value of life insurance (the amount that will be collected in the event of death) by age, sex, and marital status. The data are from Stanford Research Institute (SRI), a consulting company, called the International Survey of Consumer Financial Decisions for 1990. 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.

Some of the key features displayed in the figure are that the face value of life insurance is greater for males than for females for all ages and marital status. The ratio of face values for males relative to face values of females is 2.8. The face value reaches its peak at around age 45 for males, while for females the peak comes around ages 35-40. The face value of life insurance for married males (females) is on average 1.6 (1.7) times greater than that of single head of household males (females). For all ages, a greater percentage of men (76.0 percent) own life insurance than women (62.8 percent). Ownership is less common for younger and older age groups than for middle-aged people. Married men and women are more likely to own life insurance than single men and women. The percentage of men owning life insurance is 77.4 percent, 71.1 percent, and 70.1 percent for married men, single men with dependents, and single men without dependents, respectively. The percentage of women owning life

[7] They also introduce the innovative trick of having both agents in a household not know their own sex, which solves a few technical problems.

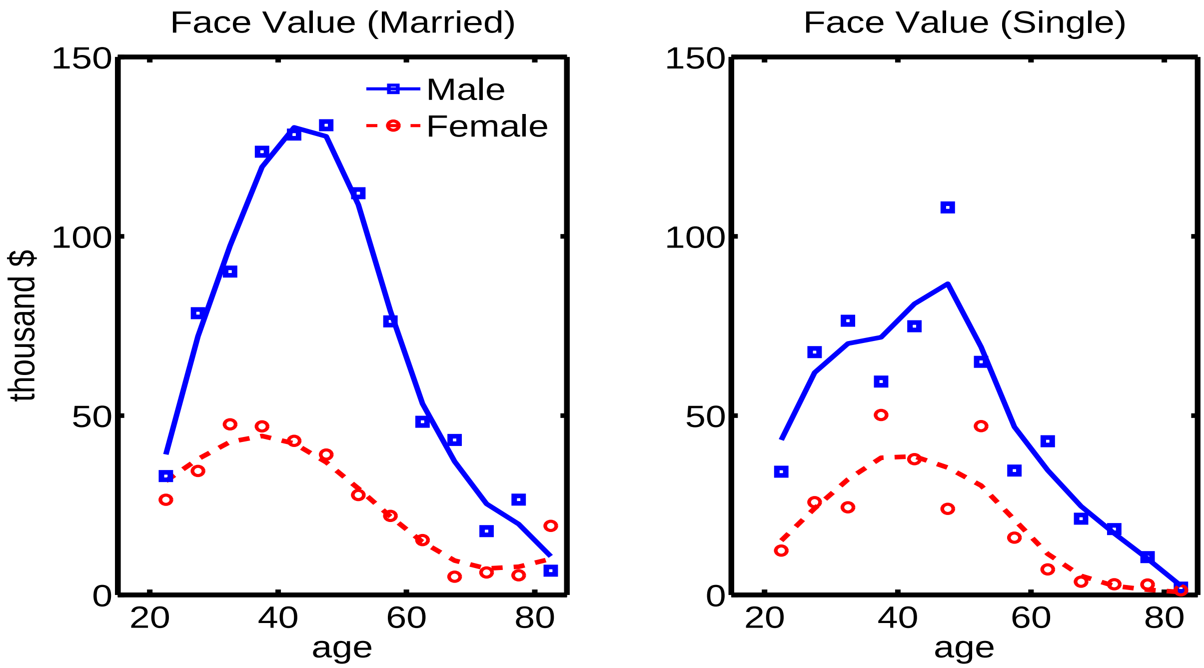

Figure 1: U.S. life insurance holdings by age, sex, and marital status

insurance is 65.7 percent, 59.0 percent, and 55.4 percent for married women, single women with dependents, and single women without dependents, respectively. We use these profiles to learn about how preferences depend on family structure.

2.1 Data issues about life insurance

There are two issues about life insurance that we have to address: first, what type of life insurance products are we referring to (Section 2.1.1), and second, whether SRI data are consistent with other available sources, in particular, SCF data (Section 2.1.2).

2.1.1 Term insurance versus whole life insurance

There are different types of life insurance products, but they can be divided into two main categories: *term insurance* and *whole life insurance*. Term insurance protects a policyholder's life only until its expiration date, after which it expires. Renewal of the policy typically involves an increase in the premium because the policy-holder's mortality is increasing with age. Even the life insurance contracts labeled as term insurance may be have some front

	Face Value (US $)		Participation (Percent)	
	Males	Females	Males	Females
All	80,374	28,110	76.0	62.8
Married	85,350	32,197	77.4	65.7
Single	54,930	18,718	70.5	57.2
Single /w dep	58,081	25,777	71.1	59.0
Single w/o dep	51,893	13,673	70.1	55.4

Table 1: Life Insurance Statistics from SRI (1990)

loading (see Hendel and Lizzeri (2003)).[8] Whole life insurance doesn't have any expiration date. When signing the contract, the insurance company and the policyholders agree to set a face value (amount of money benefit in case of death) and a premium (monthly payment). The annual premium remains constant throughout the life of the policy. Therefore, the premium charged in earlier years is higher than the actual cost of protection. This excess amount is reserved as the policy's *cash value*. When a policyholder decides to surrender the policy, she receives the cash value at the time of surrender. There are tax considerations to this type of insurance, since it can be used to reduce a tax bill. Since whole life insurance offers a combination of insurance and savings, we have to subtract this saving component from the face value to get the pure insurance amount.

The SRI data have the information on how insurance policy has been obtained. Group life insurance policy is obtained through an employment or membership in organizations while individual insurance policy is obtained directly from a life insurance company. Since some of group policies are provided by an employer, the amount of insurance covered by these group policies may not be a result of policy holders' optimal choice.[9] This is not an issue if policy holders are able to purchase an individual policy on top of their group policies to make their total insurance optimal. Among those who hold positive am mount of life insurance, 72.1% of men and 68.8% of women hold some individual insurance. The facevalue of men's group policy is $ 33,152 while average facevalue of individual insurance is $ 48,792.

[8]They compare annual renewable term insurance with level term contracts which offers premium increase only every n years. They found that premiums for level term policies have some front loading compared with annual renewable contract.

[9]In fact this may be what accounts for the fact that up to 70% of single males without dependents own life insurance. We abstract from the holdings of this group.

2.1.2 Life insurance data in the SRI and in the SCF

The SRI data are not very explicit about what type of insurance it refers to. What we do is compare the 1990 SRI with the 1992 SCF. The SCF documents the face values of term insurance and whole insurance separately as well as their cash values, which allows us to compute the amount of pure insurance in each household. We compile the SCF data by subtracting the cash value from the sum of the face values of term insurance and whole life insurance by age, sex, and marital status of the head of household. Note that the SCF collects information on life insurance for the whole household and we cannot distinguish between life insurance for the husband or for the wife in a married couple. To see whether the amounts reported in the SRI are similar to those in the SCF, we combine the insurance face value for married men and for married women to get the face value of married households in the SRI.

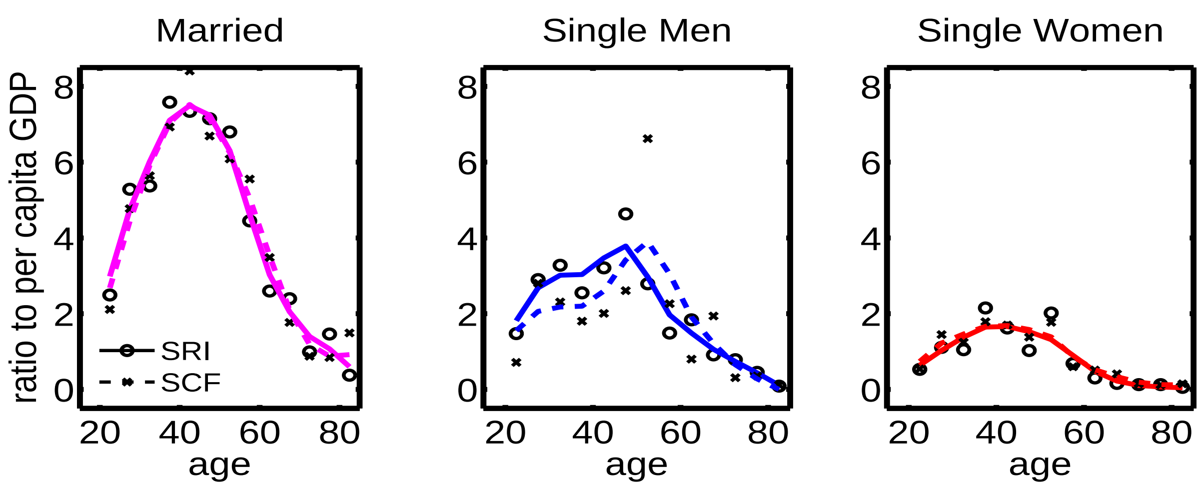

Figure 2: U.S. life insurance holdings: SRI vs. SCF

Figure 2 shows life insurance face values by household types from the 1990 SRI and the 1992 SCF. The dots are the average face value in each age group, while the lines are profiles smoothed with splines. As we see, the amounts are extremely similar. Hence, we conclude that the SRI data are a good measure of the amount of pure life insurance held by American households.

The SRI data are from a cross section. Therefore, to identify the age profile of insurance face value from the SRI as a *life cycle* profile, we have to make sure that there are no cohort effects for life insurance holdings. Although the absence of cohorts effects cannot be directly checked from the SRI, we can use the SCF from 1989-2001 to see if there exists cohort effects for average life insurance holding at the household level. Figure 3 shows life insurance face values for various cohorts (indexed by age in 1990) from the SCF. See that the life cycle profile of face values of these cohorts is very similar to the age profile across cohorts in 1992 and, consequently we assume that there are no cohort effects.

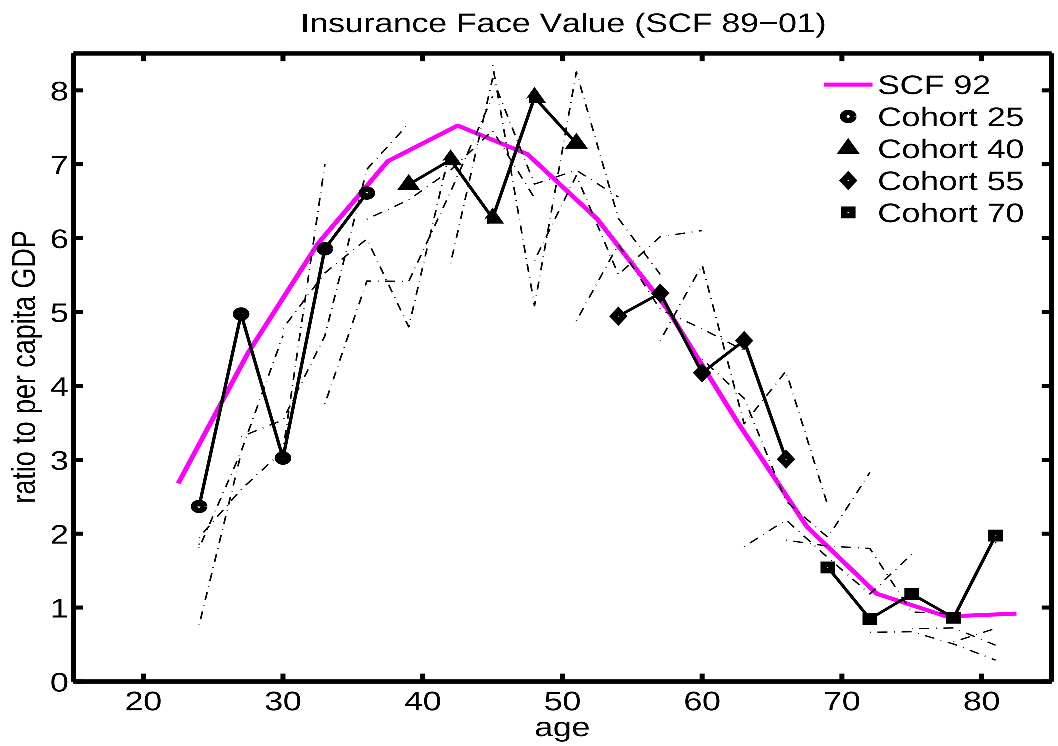

Figure 3: U.S. life insurance holdings SCF

3 Retrieving Information from Life Insurance Holdings

In this section we briefly describe how life insurance holdings carry information both about altruism or, more precisely, the joy of giving (Section 3.1) and about how consumption expenditures translate into utilities across different types of marital status (Section 3.2).

3.1 Life insurance and altruism

Consider a single agent with dependents. With probability γ the agent may live another period. Its preferences are given by utility function $u(\cdot)$ if alive, which includes care for the dependents. If the agent is dead, it has an altruistic concern for its dependents that is given by function $\chi(\cdot)$. Under perfectly fair insurance markets and zero interest rate, the agent could exchange $1-\gamma$ units of the good today for one unit of the good tomorrow if it dies and γ units today for one unit tomorrow if it survives. The problem of this agent is:

$$\max_{c,c',b} \quad u(c) \ + \ \gamma \, u(c') \ + \ (1-\gamma) \, \chi(b) \tag{1}$$

$$\text{s.t.} \qquad c + \gamma \, c' + (1-\gamma) \, b = y \tag{2}$$

where c and c' are current and future consumption, b is the life insurance purchase, and y is its income. The first-order conditions of this problem imply that $c = c'$ and

$$u_c(c) = \chi_b(b). \tag{3}$$

Notice that if we had data on consumption and life insurance holdings for many households we could recover the relation of the utility function u and the altruism function χ from the estimation of equation (3).

3.2 Life insurance and the differential utility while married and while single

Consider now a married couple where one of the agents is the sole decision-maker. In addition, this agent lives for two periods. The other agent may live a second period with probability γ. Let $u^m(c)$ be the utility of the decision-maker when consumption expenditures are c and when there are two persons in the household, while $u^w(c)$ is the utility when she is a widow and lives alone. Under fair insurance markets and zero interest rate, the problem is:

$$\max_{c^m,c'^m,c'^w} \quad u^m(c^m) \ + \ \gamma \, u^m(c'^m) \ + \ (1-\gamma) \, u^w(c'^w) \tag{4}$$

$$\text{s.t.} \qquad c^m + \gamma \, c'^m + (1-\gamma) \, c'^w = y \tag{5}$$

The first-order conditions of this problem are $c^m = c'^m$ and

$$u^m_c(c^m) = u^w_c(c'^w). \tag{6}$$

In this simple model, having data on both consumption of married couples c^m and of widows c^w could allow us to estimate equation (7), and consequently it would tell us how to compare utilities across marital status.

While life insurance is pervasive, death insurance or annuities[10] are very rare in the data. This does not matter, since if $c'^w > c'^m$ in this example, the same allocation can be achieved

[10]What single-sex OLG models with early death with complete markets call for. See for example, Ríos-Rull (1996)

with uncontingent savings and life insurance by looking at the following problem:

$$\max_{c^m, a', b \geq 0} \quad u^m(c^m) \; + \; \gamma \, u^m(a') \; + \; (1-\gamma) \, u^w(a'+b) \qquad \text{s.t.} \tag{7}$$

$$c^m \; + a' + (1-\gamma) b = y \tag{8}$$

With first-order conditions given by $c^m = a'$ and $u^m_c(c^m) = u^w_c(a'+b)$. Here we see that life insurance holdings together with savings can be used to infer the relation between the utility functions that represent preferences when living alone with those that represent living in a two-period household.

Obviously, when confronting the data, things are much more complicated than these examples illustrate: agents live many periods, there is no dictator in marriages, both spouses can die, there are many possible family sizes, and there is divorce and remarriage, to name but a few. We next pose an OLG model with agents differing in age, sex, marital status, and asset holdings that can be confronted with the life insurance holdings data. The model is built around the structure of a growth model which allows us to use aggregate and individual variables when obtaining our estimates.

4 The Model

The economy is populated by overlapping generations of agents embedded into a standard neoclassical growth structure. At any point in time, its living agents are indexed by age, $i \in \{1, 2, \cdots, I\}$, sex, $g \in \{m, f\}$ (we also use g^* to denote the sex of the spouse if married), and marital status, $z \in \{S, M\} = \{n_o, n_w, d_o, d_w, w_o, w_w, 1_o, 1_w, 2_o, 2_w, \cdots, I_o, I_w\}$, which includes being single (never married, divorced, and widowed) without and with dependents and being married without and with dependents where the index denotes the age of the spouse. Agents are also indexed by the assets that belong to the household to which the agent belongs $a \in A$.

While agents that survive age deterministically, one period at a time, and they never change sex, their marital status evolves exogenously through marriage, divorce, widowhood, and the acquisition of dependents following a Markov process with transition $\pi_{i,g}$. If we denote next period's values with primes, we have $i' = i + 1$, $g' = g$, and the probability of an agent of type $\{i, g, z\}$ today moving to state z' is $\pi_{i,g}(z'|z)$.[11]

[11]Note that we abstract from assortative matching. Extending the model to account for this type of sorting would requite to index agents by education which would increase dramatically the computational demands of the problem. We leave this for future work.

Demographics. While agents live up to a maximum of I periods, they face mortality risk. Survival probabilities depend only on age and sex. The probability of surviving between age i and age $i+1$, for an agent of gender g is $\gamma_{i,g}$, and the unconditional probability of being alive at age i can be written $\gamma_g^i = \Pi_{j=1}^{i-1}\gamma_{j,g}$.[12] Population grows at an exogenous rate λ_μ. We use $\mu_{i,g,z}$ to denote the measure of type $\{i, g, z\}$ individuals. Therefore, the measure of the different types satisfies the following relation:

$$\mu_{i+1,g,z'} = \sum_z \gamma_{i,g} \frac{\pi_{i,g}(z'|z)}{(1+\lambda_\mu)} \mu_{i,g,z} \tag{9}$$

There is an important additional restriction on the matrices $\{\pi_{i,g}\}$ that has to be satisfied for internal consistency: the measure of age i males married to age j females equals the measure of age j females married to age i males, $\mu_{i,m,j_o} = \mu_{j,f,i_o}$ and $\mu_{i,m,j_w} = \mu_{j,f,i_w}$.

Preferences. We index preferences over per period household consumption expenditures by age, sex, and marital status $u_{i,g,z}(c)$. We also consider a form of altruism. Upon death, a single agent with dependents gets utility from a warm glow motive from leaving its dependents with a certain amount of resources $\chi(b)$. A married agent with dependents that dies gets expected utility from the consumption of the dependents while they stay in the household of her spouse. Upon the death of the spouse, the bequest motive becomes operational again. Note that we make the extreme assumption of no altruism between the spouses. The reason for this is that we need an identifying assumption that allows us to separate what is given because of altruism from what is the result of the interactive process between the spouses. This is a direction where more work would be very welcome.

If we denote with $v_{i,g,z}(a)$ the value function of a single agent and if we (temporarily) ignore the choice problem and the budget constraints, in the case where the agent has dependents we have the following relation:

$$v_{i,g,z}(a) = u_{i,g,z}(c) + \beta\, \gamma_{i,g}\, E\{v_{i+1,g,z'}(a')|z\} + \beta\, (1-\gamma_{i,g})\, \chi(a') \tag{10}$$

while if the agent does not have dependents, the last term is absent.

The case of a married household is slightly more complicated because of the additional term that represents the utility obtained from the dependents' consumption while under the care of the former spouse. Again, using $v_{i,g,j}(a)$ to denote the value function of an age i

[12] Here we abstract from differential mortality based on marital status. We also leave this extension for future work.

agent of sex g married to a sex g^* of age j and ignoring the decision-making process and the budget constraints, we have the following relation:

$$
\begin{aligned}
v_{i,g,j}(a) = u_{i,g,j}(c) + \beta\, \gamma_{i,g}\ E\{v_{i+1,g,z'}(a')|z\} \\
+\ \beta\ (1-\gamma_{i,g})\ (1-\gamma_{j,g^*})\ \chi(a')\ + \\
\beta\ (1-\gamma_{i,g})\ \gamma_{j,g^*}\ \ E\{\Omega_{j+1,g^*,z'_{g^*}}(a'_{g^*})\}
\end{aligned} \tag{11}
$$

where the first and second terms of the right-hand side are standard, the third term represents the utility that the agent gets from the warm glow motive that happens if both members of the couple die, and where the fourth term with function Ω represents the well being of the dependents when the spouse survives and they are under its supervision. Function $\Omega_{i,g,z}$ is given by

$$
\Omega_{i,g,z}(a) = \widehat{u}_{i,g,z}(c) + \beta\, \gamma_{i,g}\ E\{\Omega_{i+1,g,z'}(a'|z)\} + \beta\, (1-\gamma_{i,g})\ \chi(a') \tag{12}
$$

where $\widehat{u}_{i,g,z}(c)$ is the utility obtained from dependents under the care of a former spouse that now has type $\{i, g, z\}$ and expenditures c. Note that function Ω does not involve decision-making. It does, however, involve the forecasting of what the former spouse will do.

Endowments. Every period, agents are endowed with $\varepsilon_{i,g,z}$ units of efficient labor. Note that in addition to age and sex, we are indexing this endowment by marital status, and this term includes labor earnings and also alimony and child support. All idiosyncratic uncertainty is thus related to marital status and survival.

Technology. There is an aggregate neoclassical production function that uses aggregate capital, the only form of wealth holding, and efficient units of labor. Capital depreciates geometrically.[13]

Markets. There are spot markets for labor and for capital with the price of an efficiency unit of labor denoted w and with the rate of return of capital denoted r, respectively. There are also markets to insure in the event of early death of the agents. While, for the most part, these markets are for standard life insurance policies that pay when an agent dies, in some cases (singles and couples without dependents), these markets can be used for payments in case agents survive, or annuities. We assume that the insurance industry operates at zero costs without cross-subsidization across age and sex.

[13]This is not really important, and it only plays the role of closing the model. What is important is to impose restrictions on the wealth to income ratio and on the labor income to capital income ratio of the agents, and we do this in the estimation stage.

We do not allow for the existence of insurance for marital risk other than death; that is, there are no insurance possibilities for divorce or for changes in the number of dependents. This assumption should not be controversial. These markets are not available in all likelihood for moral hazard considerations. We also do not allow agents to borrow.

Social Security. Social Security is a large annuity and the model incorporates it. There is a payroll tax with rate τ on labor income and agents receive Social Security benefits if eligible. The budget constraint of couples can be written as follows

$$\begin{aligned} c + y + (1-\gamma_{i,g})b_g + (1-\gamma_{j,g^*})b_{g^*} &= (1+r)\,a + (1-\tau)w(\varepsilon_{i,g,j} + \varepsilon_{j,g^*,i}) + T_{i,g,j,R} \\ T_{i,g,j,R} &= \begin{cases} T_g & \text{if agent is eligible} \\ T_{g^*} & \text{if only spouse is eligible} \\ T_M & \text{if both are of retirement age} \end{cases} \end{aligned}$$

where y are savings, b_g, b_{g^*} are the mounts of life insurance of the agent and its spouse, R is the retirement age, and T_g, T_{g^*} and T_M are the amounts of Social Security benefits for one and two-person households, respectively. The government has no other expenditures or revenues and runs a period-by-period balanced budget.

Distribution of assets of prospective spouses. When agents consider getting married, they have to understand what type of spouse they may get. Transition matrices $\{\pi_{i,g}\}$ have information about the age distribution of prospective spouses according to age and existence of dependents, but this is not enough. Agents have to know also the probability distribution of assets by agents' types, an endogenous object that we denote by $\phi_{i,g,z}$. Taking this into account is a much taller order than that required in standard models with no marital status changes. Consequently, we have $\mu_{i,g,z}\ \phi_{i,g,z}(B)$ as the measure of agents of type $\{i,g,z\}$ with assets in Borel set $B \subset A = [0, \overline{a}]$, where $\overline{a}$ is a nonbinding upper bound on asset holdings. Conditional on getting married to an age $j+1$ person that is currently single without dependents, the probability that an agent of age i, sex g who is single without dependents will receive assets that are less than or equal to $\widehat{a}$ from its new spouse is given by:

$$\int_A 1_{y_{j,g^*,s_o}(a) \leq \widehat{a}} \quad \phi_{j,g^*,s_o}(da) \tag{13}$$

where 1 is the indicator function and $y_{j,g^*,s_o}(a)$ is the savings of type $\{j, g^*, s_o\}$ with wealth a. If either of the two agents is currently married, the expression is more complicated because we have to distinguish the cases of keeping the same or changing spouse (see Cubeddu and Ríos-Rull (1996) for details). This discussion gives an idea of the requirements needed to solve the agents' problem.

Bequest recipients. In the model economy there are many dependents that receive a bequest from their deceased parents. We assume that the bequests are received in the first period of their lives. The size and number of recipients are those implied by the deceased, their dependents, and their choices for bequests.

We are now ready to describe the decision-making process.

The problem of a single agent without dependents. The relevant types are $z \in S_o = \{n_o, d_o, w_o\}$, and we write the problem as:

$$v_{i,g,z}(a) \quad = \quad \max_{c \geq 0, y \in A} \; u_{i,g,z}(c) \; + \beta \gamma_{i,g} \, E\{v_{i+1,g,z'}(a')|z\} \qquad \text{s.t.} \tag{14}$$

$$c + y \quad = \quad (1+r)\, a + (1-\tau) w \; \varepsilon_{i,g,z} + T_{i,g,z,R} \tag{15}$$

$$a' \quad = \quad \begin{cases} \frac{y}{\gamma_{i,g}} & \text{if } z' \in \{n_o, n_w, d_o, d_w, w_o, w_w\}, \\ \frac{y}{\gamma_{i,g}} + y_{z',g^*} & \text{if } \; z' \in \{1_o, 1_w, .., I_o, I_w\}. \end{cases} \tag{16}$$

There are several features to point out. Equation (15) is the budget constraint, and it includes consumption expenditures and savings as uses of funds and after-interest wealth and labor income as sources of funds. More interesting is equation (16), which shows the evolution of assets associated with this agent. First, if the agent remains single, its assets are its savings augmented by the fact that it set them up as annuities (they are augmented by the inverse of the survival probability). While annuities markets are not widely used, allowing agents to use them solves the problem of what to do with the assets of agents who die early. This is not, we think, an important feature. Second, if the agent marries, the assets associated with it include whatever the spouse brings to the marriage, and as we said above, this is a random variable.

The problem of a single agent with dependents. The relevant types are $z \in S_w = \{n_w, d_w, w_w\}$, and we write the problem as:

$$v_{i,g,z}(a) \quad = \quad \max_{c \geq 0, y \in A} \; u_{i,g,z}(c) \; + \beta \gamma_{i,g} \, E\{v_{i+1,g,z'}(a')|z\} + \beta \; (1-\gamma_{i,g}) \; \chi(y+b) \tag{17}$$

$$\text{s.t.} \qquad c + y + (1-\gamma_{i,g}) b = (1+r)\, a + (1-\tau) w \; \varepsilon_{i,g,z} + T_{i,g,z,R} \tag{18}$$

$$a' = \begin{cases} y & \text{if } z' \in \{n_o, n_w, d_o, d_w, w_o, w_w\}, \\ y + y_{z',g^*} & \text{if } \; z' \in \{1_o, 1_w, .., I_o, I_w\}. \end{cases} \tag{19}$$

Note that here we decompose savings into uncontingent savings and life insurance that pays only in case of death and that goes straight to the dependents. The face value of the life insurance paid is b, and the premium of that insurance is $(1-\gamma_{i,g})b$.

The problem of a married couple without dependents. The household itself does not have preferences, yet it makes decisions. Note that there is no agreement between the two spouses, since they have different outlooks (in case of divorce, they have different future earnings, and their life horizons may be different). We make the following assumptions about the internal workings of a family:

1. Spouses are constrained to enjoy equal consumption.
2. The household solves a joint maximization problem with weights: $\xi_{i,m,j} = 1 - \xi_{j,f,i}$.
3. Upon divorce, assets are divided, a fraction, $\psi_{i,g,j}$, goes to the age i sex g agent and a fraction, $\psi_{j,g^*,i}$, goes to the spouse. These two fractions may add to less than 1 because of divorce costs.
4. Upon the death of a spouse, the remaining beneficiary receives a death benefit from the spouse's life insurance if the deceased held any life insurance.

With these assumptions, the problem solved by the household is:

$$v_{i,g,j}(a) = \max_{c\geq 0, b_g \geq 0, b_{g^*}\geq 0,, y \in A} u_{i,g,j}(c) + \xi_{i,g,j} \;\; \beta\, \gamma_{i,g}\, E\{v_{i+1,g,z'_g}(a'_g)|j\} + \xi_{j,g^*,i} \;\; \beta\, \gamma_{j,g^*} \;\, E\{v_{j+1,g^*,z'_{g^*}}(a'_{g^*})|i\} \quad (20)$$

$$\text{s.t.} \;\; c + y + (1-\gamma_{i,g})b_g + (1-\gamma_{j,g^*})b_{g^*} = (1+r)\, a + (1-\tau)w(\varepsilon_{i,g,j} + \varepsilon_{j,g^*,i}) + T_{i,g,j,R} \quad (21)$$

$$\begin{array}{ll}
a'_g = a'_{g^*} = \frac{y}{\gamma_{i,j}}, & \text{if remain married } z' = j+1 \\
a'_g = \psi_{i,g,j} \; \frac{y}{\gamma_{i,j}}, & \\
a'_{g^*} = \psi_{j,g^*,i} \; \frac{y}{\gamma_{i,j}}, & \text{if divorced and no remarriage, } z' \in S \\
a'_g = \psi_{i,g,j} \; \frac{y}{\gamma_{i,j}} + y_{z'_g,g^*}, & \\
a'_{g^*} = \psi_{j,g^*,i} \; \frac{y}{\gamma_{i,j}} + y_{z'_{g^*},g}, & \text{if divorced and remarriage, } z' \in M \\
a'_g = \frac{y}{\gamma_{i,j}} + \frac{b_{g^*}}{\gamma_{i,g}}, & \\
a'_{g^*} = \frac{y}{\gamma_{i,j}} + \frac{b_g}{\gamma_{j,g^*}}, & \text{if widowed and no remarriage } z' \in S \\
a'_g = \frac{y}{\gamma_{i,j}} + \frac{b_{g^*}}{\gamma_{i,g}} + y_{z'_g,g^*}, & \\
a'_{g^*} = \frac{y}{\gamma_{i,j}} + \frac{b_g}{\gamma_{j,g^*}} + y_{z'_{g^*},g}. & \text{if widowed and remarriage, } z' \in M
\end{array} \quad (22)$$

where $\gamma_{i,j} = \gamma_{i,g} + \gamma_{j,g^*} - \gamma_{i,g}\gamma_{j,g^*}$ is the probability that both spouses die at the same time. We assume that savings are annuatized for this contingency. Note that the household may purchase different amounts of life insurance, depending on who dies. Equation (22) describes the evolution of assets for both household members under different scenarios of future marital status.

The problem of a married couple with dependents. The problem of a married couple with dependents is slightly more complicated, since it involves altruistic concerns. The main change is the objective function:

$$v_{i,g,j}(a) = \max_{c\geq 0, b_g \geq 0, b_{g^*}\geq 0, y \in A} u_{i,g,j}(c) \; + \beta \; (1-\gamma_{i,g}) \; (1-\gamma_{j,g^*}) \; \chi(y + b_g + b_{g^*}) +$$

$$\xi_{i,g,j} \;\; \beta \left\{ \gamma_{i,g} \, E\{v_{i+1,g,z'_g}(a'_g)|j\} \; + \; (1-\gamma_{i,g}) \; \gamma_{j,g^*} \; \Omega_{j+1,g^*,z'} \; (y + b_g) \right\} +$$

$$\xi_{j,g^*,i} \;\; \beta \; \left\{ \gamma_{j,g^*} \; E\{v_{j+1,g^*,z'_{g^*}}(a'_{g^*})|i\} + \; (1-\gamma_{j,g^*}) \; \gamma_{i,g} \; \Omega_{i+1,g,z'} \left(y + b^*_g\right) \right\} \quad (23)$$

The budget constraint is as in equation (21). The law of motion of assets is as in equations (22) except that there is no use of annuities, which means there is no division by $\gamma_{i,j}$. Note also how the weights do not enter either the current utility or the utility obtained via the bequest motive if both spouses die, since both spouses agree over these terms. As stated above, functions Ω do not involve decisions, but they do involve forecasting the former spouse's future consumption decisions.

These problems yield solutions $\{y_{i,g,j}(a)[= y_{j,g^*,i}(a)], b_{i,g,j}(a), b_{j,g^*,i}(a)\}$. These solutions and the distribution of prospective spouses yield the distribution of next period assets $a'_{i+1,g,z}$, and next period value functions, $v_{i+1,g,z'}(a')$.

Equilibrium. In a steady-state equilibrium, the following conditions have to hold:

1. Factor prices r and w are consistent with the aggregate quantities of capital and labor and the production function.

2. There is consistency between the wealth distribution that agents use to assess prospective spouses and individual behavior. Furthermore, such wealth distribution is stationary.

$$\phi_{i+1,g,z'}(B) = \sum_{z \in Z} \pi_{i,g}(z'|z) \int_{a \in \; A} 1_{a'_{i,g,z}(a) \in B} \;\; \phi_{i,g,z}(da), \quad (24)$$

where again 1 is the indicator function.

3. The government balances its budget, and dependents are born with the bequests chosen by their parents.

5 Quantitative Specification of the Model

We now restrict the model quantitatively.

Demographics. The length of the period is 5 years. Agents are born at age 15 and can live up to age 85. The annual rate of population growth λ_μ is 1.2 percent, which approximately corresponds to the average U.S. rate over the past three decades. Age- and sex-specific survival probabilities, $\gamma_{i,g}$, are taken from the 1999 United States Vital Statistics Mortality Survey.

We use the Panel Study of Income Dynamics (PSID) to obtain the transition probabilities across marital status $\pi_{i,g}$. We follow agents over a 5-year period, between 1994 and 1999, to evaluate changes in their marital status. Appendix A describes how we constructed this matrix.

Preferences. For a never married agent without dependents, we pose a standard CRRA per period utility function with a risk aversion parameter σ, which we denote by $u(c)$. We assume no altruism between the members of the couple. There are a variety of features that enrich the preference structure, which that we list in order of simplicity of exposition and not necessarily of importance.

1. Habits from marriage. A divorcee or widow may have a higher marginal utility of consumption than a never married person. Think of getting used to living in a large house or having conversation at dinner time. We allow habits to differ by sex but not by age. We write this as:

$$u_{*,g,n_o}(c) = u\left(c\right), \qquad u_{*,g,d_o}(c) = u_{*,g,w_o}(c) = u\left(\frac{c}{1+\theta^g_{dw}}\right). \tag{25}$$

2. A married couple without dependents does not have concerns over other agents or each other, but it takes advantage of the increasing returns to scale that are associated with a multiperson household. We model the utility function as:

$$u_{*,g,m_o}(c) = u\left(\frac{c}{1+\theta}\right). \tag{26}$$

where θ is the parameter that governs the increasing returns of the second adult in the household.

3. Singles with dependents. Dependents can be either adults or children, and they both add to the cost (in the sense that it takes larger expenditures to enjoy the same consumption) and provide more utility because of altruism. We also distinguish the implied costs of having dependents according to the sex of the head of household. The implied per period utility function is:

$$u_{*,g,n_w}(c) = \kappa \; u\left(\frac{c}{1+\theta^g\{\theta_c\#_c+\theta_a\#_a\}}\right) \tag{27}$$

$$u_{*,g,d_w}(c) = u_{*,g,w_w}(c) = \kappa \; u\left(\frac{c}{1+\theta^g_{dw}+\theta^g\{\theta_c\#_c+\theta_a\#_a\}}\right) \tag{28}$$

where κ is the parameter that increases utility because there exist dependents while the number of children and adult dependents increases the cost in a linear but differential way. We denote by $\#_c$ and $\#_a$ the number of children and of adults, respectively, in the household. Note that there is an identification problem with our specification. Parameters $\{\theta^g, \theta_c, \theta_a\}$ yield the same preferences as $\left\{1, \frac{\theta_c}{\theta^g}, \frac{\theta_a}{\theta^g}\right\}$. We write preferences this way because these same parameters also enter in the specification of married couples with dependents, which allows us to identify them. We normalize θ^f to 1 and we impose that single males and single females (and married couples) have the same relative cost of having adults and children as dependents.

4. Finally, married with dependents is a combination of singles with dependents and married without dependents. The utility is then

$$u_{*,g,m_w}(c) = \kappa \; u\left(\frac{c}{1+\theta+\{\theta_c\#_c+\theta_a\#_a\}}\right) \tag{29}$$

Note that we are implicitly assuming that the costs of having dependents are the same for a married couple and a single female. We allowed these costs to vary, and it turned out that the estimates are very similar and the gain in accuracy quite small so we imposed these costs to be identical as long as there is a female in the household.

We pose the altruism function χ to be a CRRA function, $\chi(x) = \chi_a \frac{x^{1-\chi_b}}{1-\chi_b}$. Note that two parameters are needed to control both the average and the derivative of the altruism intensity. In addition, we assume that the spouses may have different weights when solving their joint maximization problem, $\xi_m + \xi_f = 1$. Note that this weight is constant regardless of the age of each spouse.[14]

With all of this, we have 12 parameters: the discount rate β, the weight of the male in the married household maximization problem, ξ_m, the coefficient of risk aversion σ and those parameters related to the multiperson household $\{\theta^m_{dw}, \theta^f_{dw}, \theta, \theta^m, \theta_c, \theta_a, \chi_a, \chi_b, \kappa\}$. We restrict θ^m_{dw}, θ_a to be 0, which means that there is no habit from marriage for men and adult dependents are costless. Estimating the model with these two parameters restricted to be nonnegative only (the only values that allow for a sensible interpretation) yielded estimated values of zero so we impose this restriction. We leave these two parameters in the general specification of the model for the sake of comparison with our alternative specifications. We also set the risk aversion parameter to 3, and we estimate all other parameters.

Other features from the marriage. We still have to specify other features from the marriage. With respect to the partition of assets upon divorce, we assume equal share[15] ($\psi_{\cdot,m,\cdot} = \psi_{\cdot,f,\cdot} = 0.5$). For married couples and singles with dependents, the number of dependents in each household matters because they increase the cost of achieving each utility level. We use the Current Population Survey (CPS) of 1989-91 to get the average number of child and adult dependents for each age, sex, and marital status. For married couples, we compute the average number of dependents based on the wife's age. Female singles have more dependents than male singles, and widows/widowers tend to have more dependents than any other single group. The number of children peaks at age 30-35 for both sexes, while the number of adult dependents peaks at age 55-60 or 60-65.

Endowments and technology. To compute the earnings of agents, we use the Current Population Survey (CPS) March files for 1989-1991. Labor earnings for different years are adjusted using the 1990 GDP deflator. Labor earnings, $\varepsilon_{i,g,z}$, are distinguished by age, sex, and marital status. We split the sample into 7 different marital statuses $\{M, n_o, n_w, d_o, d_w, w_o, w_w\}$.[16] Single men with dependents have higher earnings than those

[14]Lundberg, Startz, and Stillman (2003) show that the relative weight shifts in favor of the wife as couples get older when women live longer than men. This weight also could depend on the relative income of each member of the couple, which in our model is a function of age of each spouse and marital status. (See also Browning and Chiappori (1998) and Mazzocco (2003))

[15]Unlike Cubeddu and Ríos-Rull (1996) and Cubeddu and Ríos-Rull (2003), we account explicitly for child support and alimony in our specification of earnings, which makes it unnecessary to use the asset partition as an indirect way of modeling transfers between former spouses.

[16]This is a compromise for not having hours worked. Married men have higher earnings than single men, while the opposite is true for women.

without dependents. This pattern, however, is reversed for single women. For single women, those never married have the highest earnings, followed by the ones divorced and then the widowed. But for single men, those divorced are the ones with highest earnings, followed by widowed and never married.

To account for the fact that most women who divorce receive custody of their children, we also collect alimony and child support income of divorced women from the same CPS data. We add age-specific alimony and child support income to the earnings of divorced women on a per capita basis. We reduce the earnings of divorced men in a similar fashion. Note that we cannot keep track of those married men who pay child support from previous marriages. Figure 4 shows the earnings profile by each sex and marital status excluding alimony and child support.

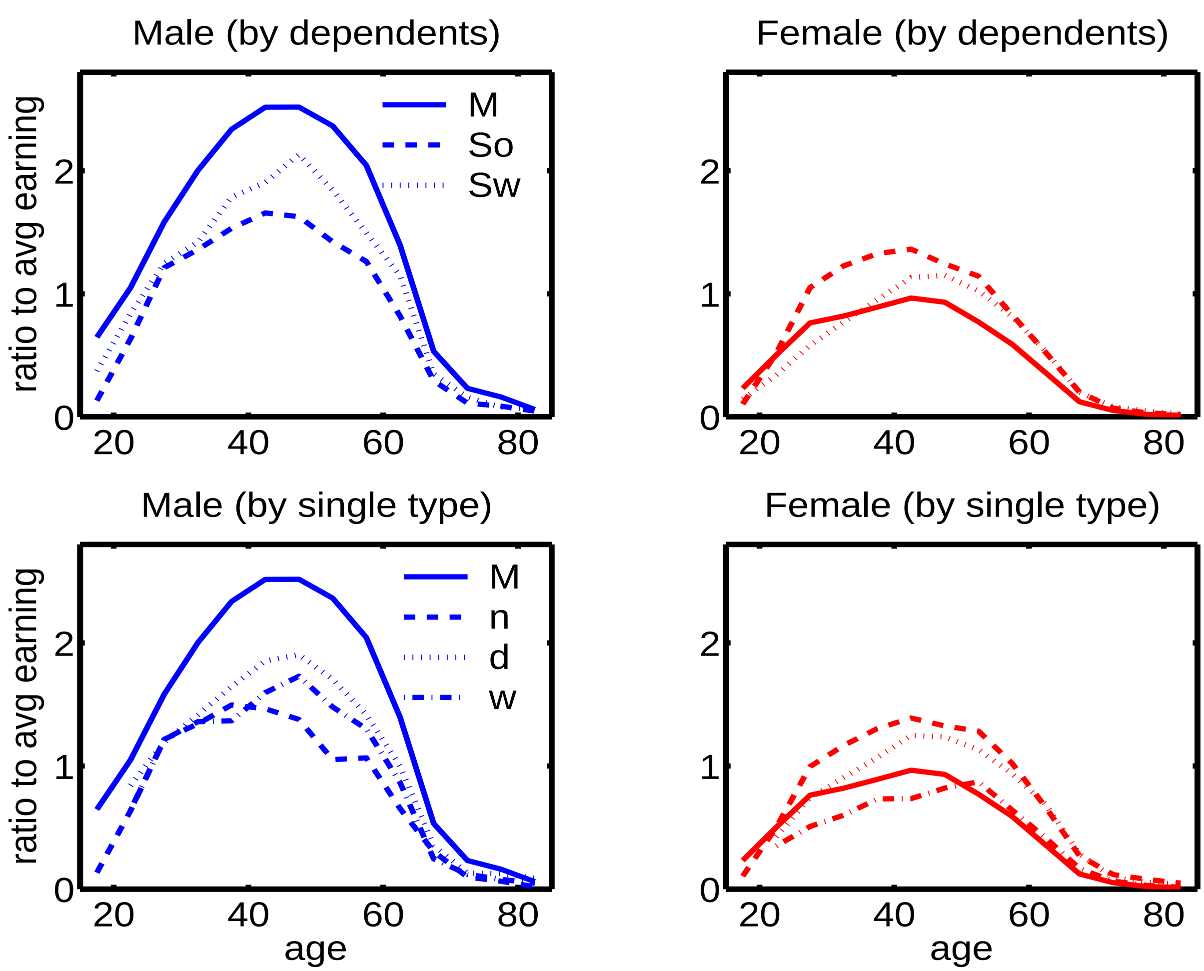

Figure 4: CPS earnings by age, sex, and marital status

The Social Security tax rate τ is set to be 11 percent to account for the fact that there is an upper limit for Social Security payments. Agents are eligible to collect benefits starting at age 67. We use 1991 Social Security beneficiary data to compute average benefits per household. We break eligible households into 3 groups: single retired male workers, single retired female workers, and couples. Single females' benefit is 76 percent of the average benefit of single males because women's contribution is smaller than men's. When both spouses in a married couple are eligible, they receive 150 percent of the benefit of a single man. To account for the survivor benefits of Social Security, we assume that a widow can collect the benefits of a single man instead of those of a single woman upon her retirement, $T_f^w = \max\{T_m, T_f\}$.

We also assume a Cobb-Douglas production function where the capital share is 0.36. We set annual depreciation to be 8 percent.

6 Estimation

The benchmark model economy has 9 parameters to estimate. The strategy we follow is to choose those parameters so that we minimize the sum of the square of the residuals of the age profile of life insurance holdings by sex and marital status, subject to the model economy's generating a wealth to earnings ratio of 3.2.[17] As a practical matter, we simultaneously search for suitable parameters that provide the smallest possible residuals, that ensure that the economy is in equilibrium, and that guarantee that the government satisfies its budget constraint by minimizing a weighted sum of residuals where the equilibrium considerations are essentially required to be satisfied with equality. This is a very cumbersome process, since it essentially involves a minimization over 9 variables of a function that is very expensive to evaluate. In addition, this function is imprecisely evaluated owing to both sampling and approximation errors, which prevents the use of fast minimization algorithms that use gradients. We have pushed computational capacity by using various Beowulf clusters with up to 26 processors.

As a measure of the goodness of fit of the estimation, we provide the size of the residuals of the function we are minimizing. We also provide the pictures of the U.S. life insurance holdings data and the model life insurance holdings by age, sex, and marital status.

[17] While the actual number in the U.S. is higher, we choose this target as a way of dealing with the enormous wealth concentration in the U.S., which this paper does not attempt to account for and which makes median wealth so much lower than mean wealth.

	θ	θ_c	θ_{dw}^{f}	θ^m	χ_a	χ_b	κ	ξ_m	β	SSE
Benchmark	.07	2.39	2.19	1.19	0.40	6.02	1.00	.89	.982	18.8

Table 2: Parameter Estimates and Residuals of of the Benchmark Model

Table 2 shows the results of the estimation and the sum of squared errors (SSE) that we use as our measure of fit. The findings are very interesting and can be summarized by:

- **Marriage generates strong economies of scale.** When two adults get married, they spend a total of \$1.07 together to enjoy the same utility they could get as singles by spending \$1 each.

- **Marriage generates habits for women.** The divorcee or widow is different from a never married female. A divorced/widowed woman has to spend an additional \$2.19 to enjoy the same utility of a never married woman who spends \$1. This is not the case for males.[18] We say that marriage generates strong habits for females.

- **Children are very costly for males.** A single male with a dependent child has to spend an additional \$2.39 to get the same utility he would get if he did not have dependents and spent \$1. This contrasts with the fact that if the dependent is an adult, there is no additional cost.[19]

- **Children are less costly for females than for males.** A dependent costs a single man 19 percent more than it costs single women or married couples. This indicates that females produce a lot of home goods.

- **Agents care a lot for their dependents.** Our estimates imply that the average single man of age I with dependents consumes 49 cents and gives 51 cents as a bequest. The estimates for single women range from consuming 38 cents for never married to 60 cents for a widow.[20]

- **Men have a higher weight in the joint-decision problem.**

[18] Recall that we also reestimated the benchmark with θ_{dw}^{m} restricted to be nonnegative and the estimate value was zero which yields the same SSE.

[19] Again, when a reestimation of the benchmark with θ_a restricted to be nonnegative yields an estimated value of zero and identical SSE.

[20] This large variation is due to the possible presence of marriage habits.

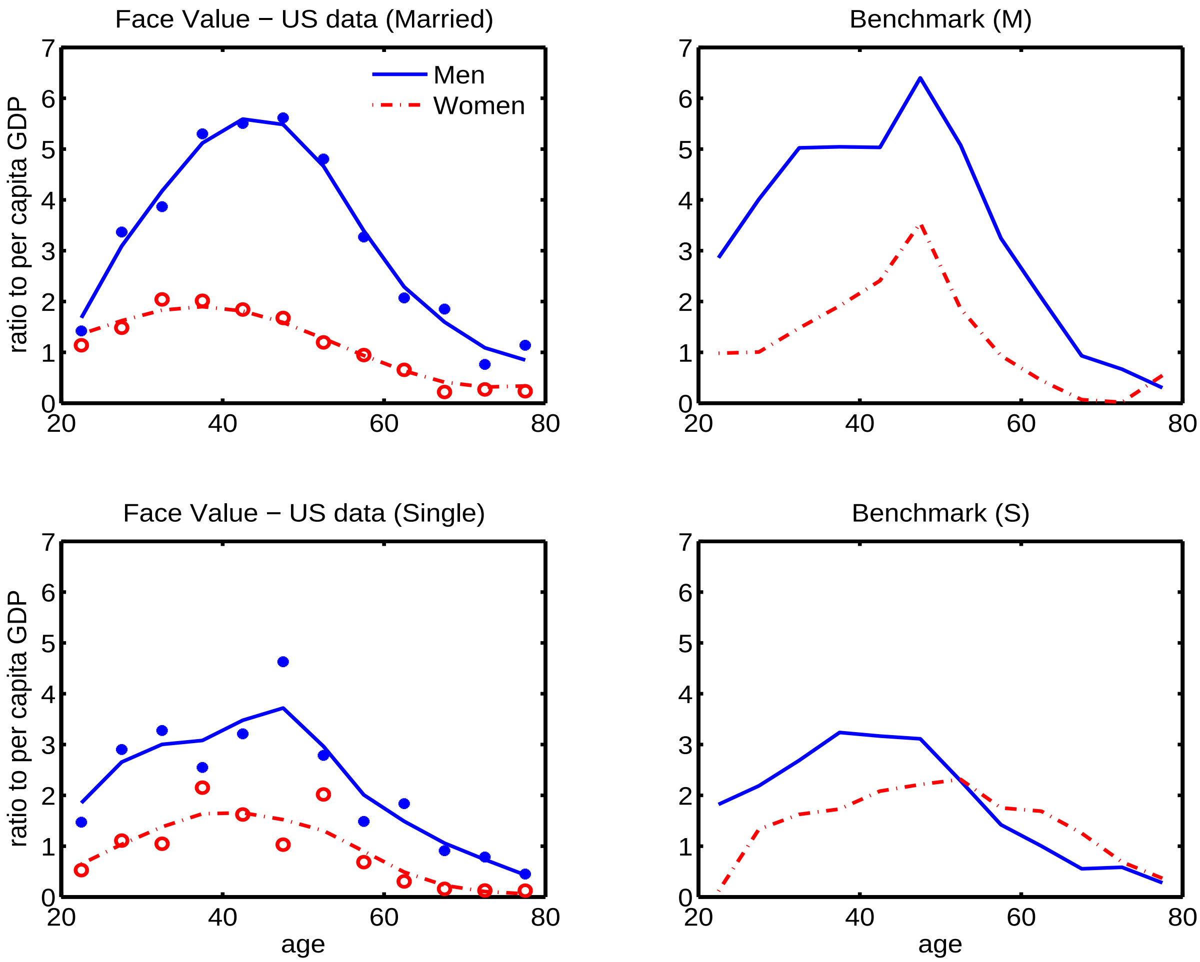

Figure 5: Benchmark model and U.S. life insurance holdings by age, sex, and marital status.

	θ	θ_c	θ_a	θ^m_{dw}	θ^f_{dw}	θ^m	χ_a	χ_b	κ	ξ_m	β	SSE
Benchmark	**.07**	**2.39**	*.00*	*.00*	**2.19**	**1.19**	**0.40**	**6.02**	**1.00**	**.89**	**.982**	18.8
No Habit	**.00**	**2.27**	*.00*	*.00*	*.00*	**2.03**	**0.49**	**5.27**	**1.50**	**.55**	**.983**	53.1
Sym Habit	**.00**	**2.41**	*.00*	**.23**	**.23**	**1.80**	**0.43**	**5.41**	**1.00**	**.58**	**.980**	50.1
Sym HP	**.00**	**1.55**	*.00*	*.00*	**1.51**	*1.00*	**0.74**	**4.92**	**1.71**	**.92**	**.981**	36.1
Equal Weight	**.00**	**2.51**	*.00*	*.00*	**.00**	**1.98**	**1.31**	**4.70**	**1.89**	*.50*	**.969**	57.7
OECD	*.70*	*0.50*	*.70*	*.00*	*.00*	*1.00*	**1.12**	**2.99**	**1.00**	**.58**	**.977**	121.7

Note: Numbers with bold are estimates and numbers in italic are restricted by the model.

Table 3: Parameter Estimates and Residuals of Alternative Models

Figure 5 shows the results of the estimation by putting next to each other the values of life insurance holdings by age, sex, and marital status, 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.

7 Alternative Specifications

We now turn to exploring the validity of our specification by postulating a variety of alternative models that ignore some of the features we have included in our benchmark model. This will give us an idea of the role played by the features we have included. We report the estimates in Table 3, and we plot the predicted life insurance holdings in Figure 6.

7.1 Marriage does not generate habits

We start asking about the relevance of habits in marriages by setting $\theta^m_{dw} = \theta^f_{dw} = 0$, which implies that those who are divorced/widowed are not different from those who never married. All singles enjoy the same utility for a dollar spent. Compared with the benchmark model where women acquire strong habits while in a marriage, this no-habit model generates too little life insurance holdings late, especially in the case of a male's death, relative to the data. This shows that given the rest of the estimates, something is needed to account for the large purchases of life insurance that occur late in life after most earnings have been made. In fact, the estimated model attempts to tilt consumption toward married females by choosing a much lower weight for the male than does the benchmark model. The quality of the estimates as measured by the SSE is notoriously worse than the benchmark's.

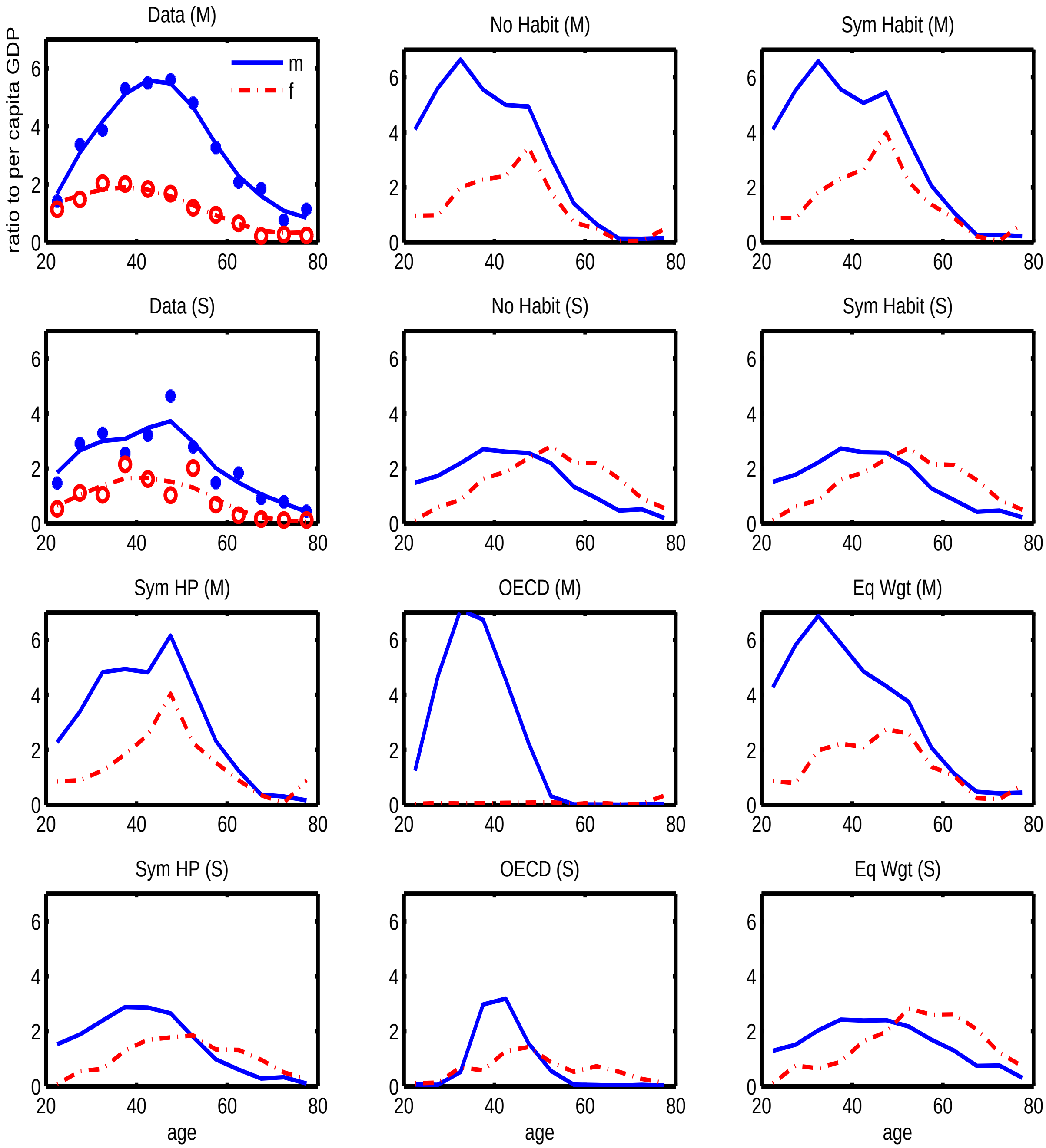

Figure 6: Face value of he models by sex and marital status

7.2 Marital habits are symmetric between men and women

We also impose a symmetric structure in the habits created by marriage, $\theta^m_{dw} = \theta^f_{dw}$. This is an intermediate case between the previous two. Still, the quality of the estimation is not so great, generating life insurance holdings for older males that are too low. We conclude that it is hard to avoid the use of some form of habits to account for the purchases of older males.

7.3 Men and women are equally good at home production

In the benchmark model, it costs men 19% more than it costs women to take care of dependents, which we interpret as indicating that women are better at home production in the presence of dependents. We now impose $\theta^m = \theta^f = 1$ that we interpret as implying that men and women are equally good at home production. The model now predicts excessive purchases of life insurance for young married males, (the group for which this assumption matters most, since young married males have a large number of dependents). Still, the fit of this model is quite good; it is the best among the alternative specifications.

7.4 Equal weights in the joint maximization process

We also impose equal weights in the joint maximization problem that a couple solves. The results change and the fit of the estimation is worse. The model tries to account for what would be holdings of life insurance that are too low in the case where the wife dies by increasing men's disadvantage at home production dramatically (98 percent versus 19 percent).

7.5 The OECD equivalence scales

For the sake of comparison with a very standard measure of what a household is, we pose a version of the model that incorporates the OECD equivalence scales.[21] To implement these ideas, we re-estimate the patience and altruism parameters as well as the weights in the joint maximization problem. The fit is terrible. The model predicts that insurance is held in different circumstances from those in which people in the U.S. hold insurance: the model underpredicts the holdings of married couples, especially late in life and conditional on the death of females. Notice that among the estimates, the curvature of the bequest function is much lower, which is the way this model increases insurance holdings, by bumping up

[21] Under the OECD view,[22] each additional adult in a household requires an expenditure of 70 cents in order to enjoy one dollar of consumption, while each child requires 50 cents. The OECD assumes also that there are no habits or differences between males and females.

altruism.

Our main conclusion from this brief assessment of alternative models is that abstracting from any of the features of the benchmark model yields a much worse fit of the model. We have explored many other versions that do not match the data well, but we do not report them, to avoid boring the reader. We also have shown that the OECD equivalence scales do a very bad job in accounting for the patterns of holdings of life insurance.

8 Policy Experiment

We now proceed to look at a policy change that directly affects the nature of income streams depending on agents' demographic circumstances. We abolish Survivor's Benefits, that typically pay widows when their own Social Security entitlement is lower than that of their deceased spouse.

In the benchmark model, a widow, once she reaches retirement age, collects the same Social Security Benefits than a single man. This is our way of immpleminting the current system in the U.S. of Survivor's Benefits. We implement the abolition of Survivor's Benefits as giving widows the same Social Security Benefits than never married women, which amounts to a 24 percent reduction of her benefits.

In the benchmark model, female widows consume almost the same amount as married couples due to the importance of the habits acquired by women in marriage. Consequently, the death of an elderly husband acts as a drawback, since it implies lower income but not lower consumption. The abolition of Survivor's Benefits is dealt with by an increase in the amount of life insurance (payable when the male dies) purchased by the household and not by decreases of consumption by widows. Figure 7 displays the insurance face values in the Benchmark model under the current policy and without Survivor's Benefits. There is a noticeable increase in the holdings of married men over age 50. Aggregate life insurance face value rises to 160 percent of GDP from 150 percent. In addition to this effect on life insurance holdings, there is a 0.2 percent increase in total assets.[23]

We also compute a compensated variation measure of welfare.[24] Specifically, we compute the *ex ante* discounted lifetime utility of newborns and calculate what percentage change in consumption makes agents indifferent between living in the benchmark economy and in an economy without survivor's benefits. Note that the policy change is effectively an abolition

[23]This is under the small open economy assumption with constant interest rates.

[24]This is not, strictly speaking, a welfare measure because it ignores the transition.

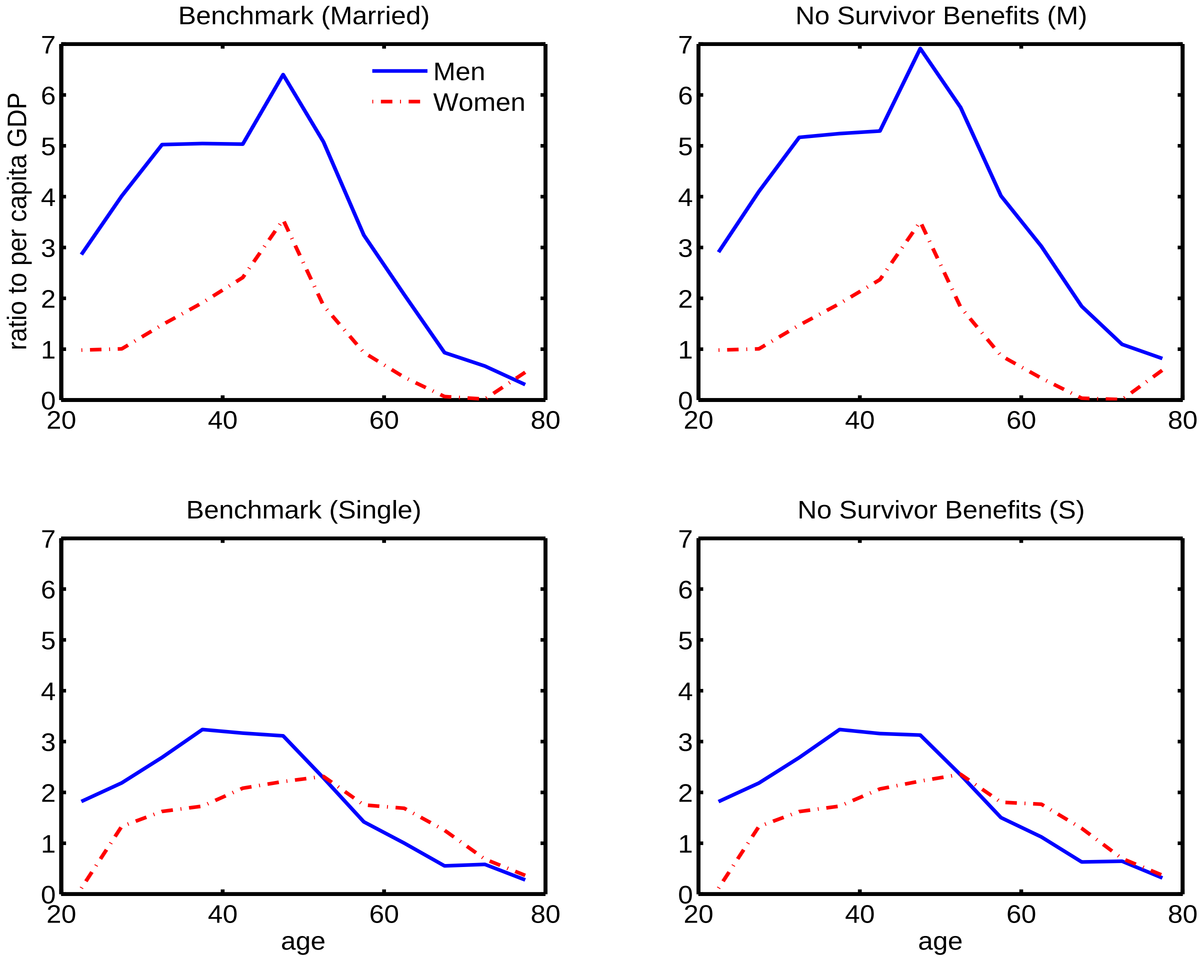

Figure 7: Life insurance holdings by age, sex, and marital status without widow's pension

of a transfer to women since only women receive Survivor's Benefits,[25] and its abolition implies an increase of standard benefits, and a larger part of this goes to single men than to single women. Consequently, and to understand the effects of the policy change we should analyze men and women separately.

We find that the effects of abolishing Survivor's Benefits are significant for women while they are much smaller for men. Our welfare measure indicates that women need to be given an additional 0.025% of their consumption to be indifferent with the current policy, while men are willing to give up 0.008% of their consumption to abolish Survivor's Benefits. This is consistent with Chambers, Schlagenhauf, and Young (2003b), who found the effect of survivor benefits to be so small that aggregates are almost unaffected.

[25] In the model only women receive and in the data mostly women receive it.

9 Conclusion

In this paper we have used life insurance purchases to infer how people assess consumption across different family types. This allowed us to estimate utility functions for men and women that depend on marital status. We learned that children are quite expensive and that females are much better at home production than males. We have learned that marriage increases marginal utility of consumption for females when they are no longer married. We have used our estimates of the utility function to assess the effects of some Social Security policies, and we found that the loss of survivor's benefits can be accommodated via larger life insurance purchases in the case of the death of male.

Needless to say, this type of research has three immediate directions that call for more work: *i)* the explicit modeling of time use, allowing for the possibility, not always exercised, of specialization in either market or home production activities; *ii)* the consideration of more interesting decision-making processes within the household that essentially will imply that the weights depend on outside opportunities that are time varying, and finally *iii)* the explicit consideration of the problem of agents that differ in types (which may shed light on what is behind the vast differences in the performance of single and married men and that allow for the consideration of education groups and of assortative matching). We are looking forward to seeing more work in these directions.

References

Aiyagari, S. R. (1994). Uninsured idiosyncratic risk, and aggregate saving. *Quarterly Journal of Economics 109*, 659–684.

Attanasio, O., H. Low, and V. Sanchez-Marcos (2004). Explaining changes in female labour supply in a life-cycle model. Manuscript, University College London.

Attanasio, O. P. and M. Browning (1985). Consumption over the life cycle and over the business cycle. *American Economic Review 85*(5), 1118–1137.

Auerbach, A. and L. Kotlikoff (1991). The adequacy of life insurance. *Journal of Financial Intermediation 1*, 215–241.

Bernheim, B. D., L. Forni, J. Gokhale, and L. J. Kotlikoff (2003). The mismatch between life insurance holdings and financial vulnerabilities: Evidence from the health and retirement survey,. *American Economic Review 93*(1), 354–365.

Bernheim, D. (1991). How strong are bequest motives? evidence based on estimates of the demand for life insurance and annuities. *Journal of Political Economy 99*, 899–927.

Browning, M. (1992). Children and household economic behavior. *Journal of Economic Literature 30*(3), 1434–1475.

Browning, M. (2000). The saving behaviour of a two-person household. *Scandinavian Journal of Economics 102*(2), 235–251.

Browning, M., F. Bourguignon, P.-A. Chiappori, and V. Lechene (1994). Incomes and outcomes: A structural model of within household allocation. *Journal of Political Economy 102*(6), 1067–1096.

Browning, M. and P.-A. Chiappori (1998). Efficient intra-household allocations: A general characterization and empirical tests. *Econometrica 66*(6), 1241–1278.

Chambers, M., D. Schlagenhauf, and E. Young (2003a). Are husbands really that cheap? Manuscript, Florida State University.

Chambers, M., D. Schlagenhauf, and E. Young (2003b). Husbands might really be that cheap. Manuscript, Florida State University.

Chiappori, P.-A. (1988). Rational household labor supply. *Econometrica 56*(1), 63–90.

Chiappori, P.-A. (1992). Collective labor supply and welfare. *Journal of Political Economy 100*(3), 437–467.

Cubeddu, L. M. and J.-V. Ríos-Rull (1996). Marital risk and capital accumulation. Mimeo, University of Pennsylvania.

Cubeddu, L. M. and J.-V. Ríos-Rull (2003). Families as shocks. *Journal of the European Economic Association 1*(2-3), 671–682. (Papers and Proceedings of the Seventeenth Annual Congress of the European Economic Association, Venice, 21-24 August 2002).

Díaz-Giménez, J., E. C. Prescott, T. Fitzgerald, and F. Alvarez (1992). Banking in computable general equilibrium economies. *Journal of Economic Dynamics and Control 16*, 533–559.

Fernández-Villaverde, J. and D. Krueger (2003). Consumption over the life cycle: Some facts from consumer expenditure survey data. CAERP Working papers No. 2003-07.

Fischer, S. (1973). A life cycle model of life insurance purchases. *International Economic Review 14*, 132–152.

Greenwood, J., N. Guner, and J. A. Knowles (2003). More on marriage, fertility and the distribution of income. *International Economic Review 44*(3), 827–862.

Hendel, I. and A. Lizzeri (2003). The role of commitment in dynamic contracts: Evidence from life insurance. *Quarterly Journal of Economics 118*(1), 299–327.

Huggett, M. (1993). The risk free rate in heterogeneous-agents, incomplete insurance economies. *Journal of Economic Dynamics and Control 17*(5/6), 953–970.

İmrohoroğlu, A. (1989). The cost of business cycles with indivisibilities and liquidity constraints. *Journal of Political Economy 97*(6), 1364–83.

Krusell, P. and A. Smith (1997). Income and wealth heterogeneity, portfolio choice, and equilibrium asset returns. *Macroeconomic Dynamics 1*(2), 387–422.

Lewis, F. (1989). Dependents and the demand for life insurance. *American Economic Review 79*, 452–467.

Lise, J. and S. Seitz (2004). Consumption inequality and intra-household allocations. Manuscript, Queen's University.

Lundberg, S., R. Startz, and Stillman (2003). The retirement-consumption puzzle: A marital bargaining approach. *Journal of Public Economics 87*(5-6), 1199–1218.

Manser, M. and M. Brown (1980). Marriage and household decision-making: A bargaining analysis. *International Economic Review 21*(1), 31–44.

Mazzocco, M. (2003). Household intertemporal behavior: A collective characterization and empirical tests. Manuscript, University of Wisconsin.

McElroy, M. B. and M. J. Horney (1981). Nash-bargained household decisions: Toward a generalization of the theory of demand. *International Economic Review 22*(6), 333–349.

OECD (1982). *The OECD list of Social Indicators*. Paris: Organization for Economic Cooperation and Development.

Ríos-Rull, J.-V. (1996). Life cycle economies and aggregate fluctuations. *Review of Economic Studies 63(3)*(215), 465–490.

Yaari, M. (1965). Uncertain lifetime, life insurance and the theory of the consumer. *Review of Economic Studies 32*, 137–150.

Appendix

A Construction of Marital Status Transition Matrix

We now describe briefly how we constructed the transition matrix π, and which criteria we used to ensure that the number of men and women married are the same.

1. We calculate from the PSID the followings;
   - Probability of remarrying: $q_{i,g}$ - couples who change spouses over couples who reported being married in both interviews.
   - Transitions from singles: $\hat{\pi}_{i,g}(j|s), \hat{\pi}_{i,g}(s_o|s), \hat{\pi}_{i,g}(s_w|s)$
   - Transitions from married: $\hat{\pi}_{i,g}(M|M), \hat{\pi}_{i,g}(s_o|M), \hat{\pi}_{i,g}(s_w|M)$
   - Switching between two dependents status: $p_{i,g}(d'|d)$
2. We use the fact that transition from one spouse to another involves a spell of being single. We construct transitions from married to married distinguishing by age, by using information on transitions from single to married. Specifically, we construct the following statistics:

$$\pi^*_{i,g}(\ell|j) \;=\; q_{i,g}\hat{\pi}_{i,g}(M|M)\left(\frac{\hat{\pi}_{i,g}(s_o|M)}{\hat{\pi}_{i,g}(S|M)}\frac{\hat{\pi}_{i,g}(\ell|s_o)}{\hat{\pi}_{i,g}(M|s_o)} + \frac{\hat{\pi}_{i,g}(s_w|M)}{\hat{\pi}_{i,g}(S|M)}\frac{\hat{\pi}_{i,g}(\ell|s_w)}{\hat{\pi}_{i,g}(M|s_w)}\right) \tag{30}$$

   for $k = j + 1$, and then add the probability of not remarrying:

$$\pi^*_{i,g}(k|j) \;=\; \pi^*_{i,g}(j+1|j) + (1 - q_{i,g})\hat{\pi}_{i,g}(M|M) \tag{31}$$

   To account for change in couples' dependent status:

$$\pi^*_{i,g}(\ell_{d'}|j_d) = p_{i,g}(d'|d)\pi^*_{i,g}(\ell|j) \tag{32}$$

3. We have to account for mortality, and the PSID does not allow us to do so, since we cannot disentangle those who died from those who left the sample. To properly account for mortality, we use the following steps:
   (a) We compute the complement of those who stay married to the same spouse, $\hat{x}_{i,g}(j)$:

$$\hat{x}_{i,g}(j) \;=\; 1 - (1 - q_{i,g})\pi^*_{i,g}(M|j). \tag{33}$$

   (b) We define the probability of marital dissolution as the maximum value of $\hat{x}_{i,g}(j)$ and the probability of spousal death:

$$x_{i,g}(j) \;=\; \max\ \{\hat{x}_{i,g}(j),\ (1 - \gamma_{j,g^*})\}. \tag{34}$$

(c) Then we redefine the transition probabilities and account for the agent's own probability of death as follows:

$$\frac{\pi_{i,g}(z|j)}{\gamma_{i,g}} = \begin{cases} \frac{\hat{\pi}_{i,g}(z|M)}{\hat{x}_{i,g}(j)} x_{i,g}(j) & \text{for } z \in S \\ \frac{\pi^*_{i,g}(z|j)}{\hat{x}_{i,g}(j)} x_{i,g}(j) & \text{for } z \in M \text{ and } z \neq j+1 \\ (1 - x_{i,g}(j)) + \frac{\pi^*_{i,g}(z|j)}{\hat{x}_{i,g}(j)} x_{i,g}(j) - & \\ \qquad (1 - q_{i,g}) \frac{\pi^*_{i,g}(M|j)}{\hat{x}_{i,g}(j)} x_{i,g}(j) & \text{for } z \in M \text{ and } z = j+1 \end{cases} \tag{35}$$

4. We make the transitions of males and females consistent with each other. (Recall that $\mu_{i,m,j} = \mu_{j,f,i}$ for all $i, j \in \mathcal{I}$.) We impose that the male's transition has to adjust to match the number of females of each type. We do this by scaling the rows of $\pi_{i,m,j}$ appropriately while conserving the ratios generated by the original matrix between single males with and without dependents, and between the transition from and to marriage across the different age groups of the wives. The transformation also requires that the new matrix be a Markov matrix; that is, 1) no element is either negative or above 1; and 2) each row has to sum to 1. This requires some additional rules when this property is violated. The rules are designed so that the new male transition matrix inherits as many properties as possible from the original.

5. We partition singles into three different groups $\{n, d, w\}$. We use the following facts:[26]

   - $\pi_{i,g}(n|j) = 0$
   - $\pi_{i,g}(S|j) = \pi_{i,g}(d|j) + \pi_{i,g}(w|j)$
   - $\pi_{i,g}(w|j) = \min\{\pi_{i,g}(S|j), (1 - \gamma_{j,g^*})\}$

B Tables of Interest

A few tables that we have used to carry out our work and that may be of interest can be found at `http://www.ssc.upenn.edu/~vr0j/papers/tablesjayins.pdf` and they include:

1. Number of Children (CPS 1989-1991) by Age, Sex, and Marital Status.

2. Earnings by Age, Sex, and Marital Status (CPS March 1989-1991).

3. Alimony and Child Support (CPS March 1989-1991) as percentage of earnings.

[26] While studies reveal that the probability of remarriage, controlling for age and sex, is slightly higher after divorce than after the death of a spouse, we assume they are equal.