Life Insurance and Household Consumption

By Jay H. Hong and José-Víctor Ríos-Rull*

Using life insurance holdings by age, sex, and marital status, we infer how individuals value consumption in different demographic stages. We estimate equivalence scales and bequest motives simultaneously within a fully specified model where agents face U.S. demographics and save and purchase life insurance. Our findings indicate that individuals are very caring for dependents, that economies of scale are large, that children are very costly (or yield very high marginal utility), that wives with children produce lots of home goods, and that females display habits from marriage, while men do not. These findings contrast sharply with standard equivalence scales.
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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 in economic units has to be resolved, and exciting new work 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

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[1]The list of papers is by now very large, but we can trace this line of research to İmrohoroğlu (1989) and Díaz-Giménez et al. (1992), as well as the theoretical developments of Bewley (1986), Huggett (1993), and Aiyagari (1994) and the technical developments of Krusell and Smith (1997).

[2] Chiappori (1988, 1990) is credited 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. Bourguignon et al. (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 noncooperative model of household decisions where the members of the household have different discount factors because of differences in life expectancy. Mazzocco (2007) extends the collective model to a multiperiod framework and analyzes household intertemporal choice. Lise and Seitz (2011) use the collective model to measure consumption inequality within the household.

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 generations models. We use information on the changing nature of the composition of the household and on life insurance (henceforth LI) purchases by households to produce our estimates. We exploit that LI requires the death of one of the spouses to be enjoyed by the other (a great example of a purely private good), that LI is very widely held, and that death is quite 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 marital status (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 United States. 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] We use LI purchases as well as aggregate restrictions to identify individual preferences in different demographic stages jointly with bequest motives for (or, more precisely, the joy of giving to) dependents and also jointly with the weights of each spouse within the household. In other words, we use revealed preference, via LI purchases, to estimate a form of equivalence scales.[5]

LI can be held for various reasons. In standard life cycle models, households are identified with individual agents, and their prediction is that only death insurance, i.e., annuities, will be willingly held. LI arises only in the presence of bequest motives.[6] In two-person households, while LI can also arise because of a bequest motive, there is also a role to insure because of the lower availability of resources in the absence of the spouse. The widespread prevalence of marriage across space and time indicates that it is a very efficient organizational form, and losing its members because of death could 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, agents have a bequest motive toward depen-

[3] Attanasio and Browning (1995) show the importance of household size in explaining the hump-shaped consumption profiles over the life cycle. In Cubeddu and Ríos-Rull (1997, 2003), consumption expenditures are normalized with standard OECD equivalence scales. Greenwood, Güner, and Knowles (2003) use a functional form with equivalence scales, which is an increasing and concave function in family size, as Chambers, Schlagenhauf, and Young (2004) do. Attanasio, Low, and Sánchez-Marcos (2008) 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 to 2.2 adults if the child is between 13 and 18). See Browning (1992) and Fernández-Villaverde and Krueger (2007) for a detailed survey on equivalence scales.

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

[5] The interpretation of our estimates as average equivalence scales requires a functional form assumption. This is because our estimates are based on marginal conditions, and hence our findings cannot be interpreted to assess the extent to which people value different marital status. The analysis of policy changes in terms of welfare can be made only when we assume that no changes in marital status occur as a result of the policy.

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

dents, and they also want LI to protect themselves from the death of their spouse. We abstract from a direct bequest motive toward their spouse because we cannot identify separately the intensity of the bequest motive toward the spouse and the weight of the spouse in the maximization problem that the household solves. In our environment, household composition affects the utility of agents because it affects how consumption expenditures translate into consumption enjoyed (equivalence scales) and because it affects household earnings. These features change over time as the number and type of dependents evolve and as earnings vary, and they translate into different amounts of LI purchases. The life cycle patterns of LI contain a lot of information about how agents' utility changes. This is the effective information of the data that inform our findings.

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 \$1.33 have the same marginal utility as those living alone and spending \$1.00. *iii)* Children are quite expensive. A single man with one child has to spend more than \$3.5 to get the same marginal utility as he would have had alone. *iv)* Women are much better at providing for children than single men. Children who live with either single women or married couples require 30 percent fewer expenditures than children who live with single men to keep the same marginal utility. *v)* Adult dependents seem to be costless. *vi)* Men have the upper hand in the marriage decision because 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 Social Security. 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 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 relatively minor: married couples can easily cope with the elimination of survivor's benefits by purchasing additional LI. Still, the policy change improves the welfare of men (by 0.0036 percent of their consumption) and reduces that of women (by 0.0264 percent of their consumption).

We assume that household decisions are determined by solving a Pareto problem with fixed Pareto weights. Two traditional approaches are used to solve for the within-household allocation: fixed Pareto weights (which implies constancy of the slope of the Pareto possibility frontier) or a bargaining problem with fixed bargaining weights (constant ray to the point in the Pareto frontier from the best outside alternative). There are no sound theoretical reasons for favoring one approach over the other, although perhaps the fixed bargaining weights approach is slightly more popular. Our choice is based on a few reasons. First, to compute any bargaining solution, we need to know the utility of alternative outcomes, in this case, the utility of being single. This we could only do based on the extreme assumption that there are no additive terms associated with different marital status, an assumption for which we have no evidence given the data that we have and that it was already recognized by Pollak and Wales (1979). Second, our problem is extremely computationally intensive, and in addition to solving marginal conditions to determine allocations, we would have had to solve for utility levels, which would have prevented us from estimating the range of parameters that we specify, let alone calculating standard deviations. Last, our computational approach that approximates the derivative of the value function is capable of dealing with the problem of having contexts in which future decision makers do not coincide with current decision makers, a form of induced time-inconsistent preferences, which would have generated complications in terms of the first order conditions if we used other computational approaches given that a generalized Euler equation appears.[7]

There is an empirical literature on how LI ownership varies across different household types. Auerbach and Kotlikoff (1991) document LI purchases for middle-aged married couples, while Bernheim (1991) does so for elderly married and single individuals. Bernheim et al. (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 (2003), which carefully documents LI holding patterns from the Survey of Consumer Finances. Chambers, Schlagenhauf, and Young (2004) use a dynamic overlapping generations model of households to estimate LI holdings for the purpose of smoothing family consumption and conclude that the LI holdings of households in their model are so large that it constitutes a puzzle.

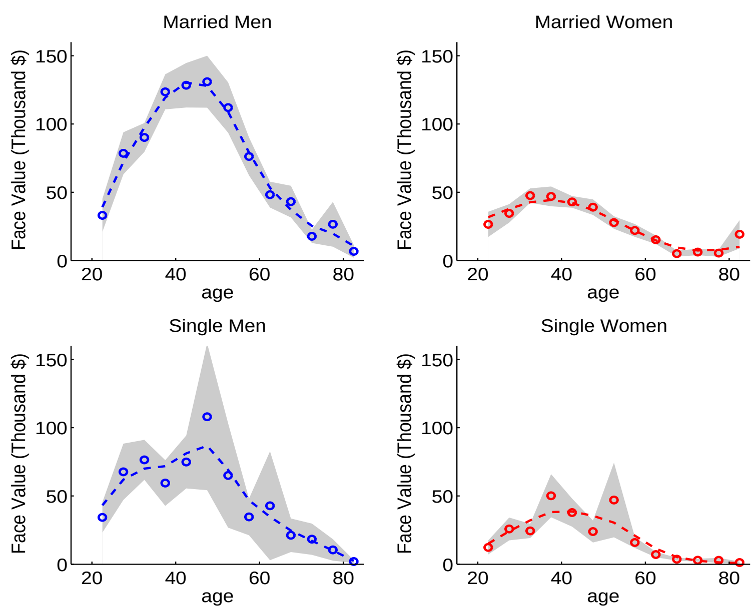
Section I reports U.S. data on LI ownership patterns in various respects. Section II illustrates the logic of how LI holdings may shed light on preferences across different demographic configurations of the household. Section III poses the model we use and describes it in detail. Section IV describes the quantitative targets and the parameter restrictions we impose in our estimation. Section V carries the estimation and includes the main findings. In Section VI we make the case for the choices we made by exploring various alternative (and simpler) specifications. Section VII describes the sensitivity of our findings as related to various issues: whether LI purchases are voluntary, the LI holdings of households composed of singles without dependents, the outcome when LI holdings of single and married people are targeted separately, and the load factors for LI (when LI premiums

[7]We do not discuss this issue in this paper. See, for example, Krusell and Smith (2003) or Klein, Krusell, and Ríos-Rull (2008).

are priced unfairly). Section VIII explores a Social Security policy change in our environment, and Section IX concludes. An online Appendix describes some details of LI in the United States, provides some details of the computation and estimation of the model, and provides additional sensitivity analysis.

I. LI Holdings of U.S. Households

Figure 1 and Table 1 show the face value of LI (the amount that will be collected in the event of death) by age, sex, and marital status. The data are from the Stanford Research Institute (SRI), a consulting company, and were generated from 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 LI 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 rather than when the wife dies.



Note: One standard error band of average face value (gray)

Figure 1. U.S. LI holdings by age, sex, and marital status (1990 SRI)

Some of the key features of these data are that the face value of LI is greater for males than for females for all ages and marital status. The ratio of face values for males relative to face values for females is 2.9. The face value reaches its peak around age 45 for males, while for females the peak comes around ages 35-40. The face value of LI 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 (76.3 percent) own LI than women (62.9 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 LI than single men and women. The percentage of men owning LI is 77.4 percent, 75.1 percent, and 69.9 percent for married men, single men with dependents, and single men without dependents, respectively. The percentage of women owning LI is 65.7 percent, 58.4 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.

Table 1—LI Statistics from SRI (1990)

	Face Value (U.S. dollars)		Participation (Percent)	
	Men	Women	Men	Women
All	80,374	28,110	76.3	62.9
Married	85,350	32,197	77.4	65.7
Single	54,930	18,718	71.1	56.5
Single /w dep	65,826	26,527	75.1	58.4
Single w/o dep	51,728	13,691	69.9	55.4

A. *Data Issues about LI*

We now turn to address some concerns regarding LI: the type of LI products we are referring to, and the extent to which LI is voluntarily held and fairly priced.

Term Insurance versus Whole LI

There are many types of LI products, but they can be divided into two main categories: *term insurance* and *whole LI*. 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 policyholder's mortality increases with age.[8] Whole LI doesn't have an 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

[8]Even the LI contracts labeled as term insurance may have some front loading. Hendel and Lizzeri (2003) compared annually renewable term insurance with level term contracts that offer a premium increase only every few years and found that the latter have some front loading compared with annually renewable policies.

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 the tax bill. Since whole LI offers a combination of insurance and savings, we subtract the saving component from the face value to obtain the pure insurance amount.

On the Optimality of LI Holdings

Some of the LI held by people is obtained through employment or membership in organizations (group insurance), and some is obtained directly from an LI company. Provision by the employer may imply that the amount of insurance covered by group policies is not the result of policyholders' optimal choices.[9] Fortunately, we can explore whether this is the case in detail because the SRI data provide separate information on both types of policies. Among those that hold some insurance, 73 percent of men and 71 percent of women hold some individual insurance. Clearly, for those people group insurance was not sufficient, so they hold additional insurance. In addition, individual LI is about 50 percent larger than group LI.[10] We therefore consider all holdings by people who hold both types of insurance as voluntary and optimally chosen. Even when we impose the very restrictive criterion that the insurance held by people who have group policies only is all involuntary,[11] we obtain that 84 percent of the total face value is considered voluntary for men, 80 percent for women, and less for single women (especially for single women without dependents).[12] Figure 2 shows how this conservative measure of voluntary insurance compares with the insurance measure used as the benchmark. Tables D-5 and D-6 in the Appendix show the measure of voluntary insurance across different employment status (full-time, part-time, and non-employed). The differences across employment status are quite small. If employees are given too much insurance which they don't want, we should have seen very low conservative measures of voluntary insurance for full-time employed, but these numbers are not very different across employment status.

Singles without dependents also hold LI. Note, however, that we use the reported number of household members to determine the existence of dependents, which is the right measure to relate consumption expenditures and consumption enjoyment, but not perhaps to determine the existence of a bequest motive. Singles who do not live with dependents may still have relatives outside of their household to whom they want to leave bequests in case of their death. We discuss the LI holdings of singles without dependents in Section VII. Consequently, we think that to a first approximation, the consideration of insurance purchases as voluntary is appropriate.

[9] In fact, this may be what accounts for the fact that up to 70 percent of single males without dependents own LI.

[10] Tables D-1 and D-2 in the Appendix show, respectively, the participation rate and the face value of each type of insurance policy.

[11] People may have actually wanted some, if not all, of the insurance provided by the organization.

[12] Table D-3 for males and Table D-4 for females in the Appendix provide the details.

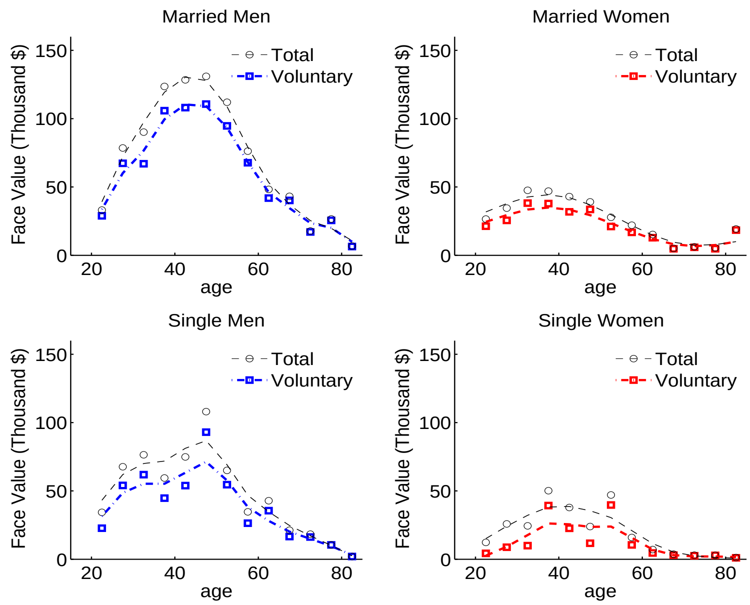


FIGURE 2. VOLUNTARY MEASURE OF LI BY AGE, SEX, AND MARITAL STATUS (1990 SRI)

PRICING

Our data do not have details on pricing. As noted, a majority of insurance is purchased by people with some individual insurance. Individual insurance is clearly not subsidized and is a marginal purchase, so we do not think that subsidized group insurance distorts people's choices. Moreover, 20 percent of men and 18 percent of women hold group insurance but no individual insurance, so we do not think that there is bias because of differential labor force participation among the sexes. In most of our analysis, we assume that the price of LI is actuarially fair. We discuss pricing behavior associated with "load factors" in the LI industry in Section VII.

II. Retrieving Information from LI Holdings

In this section we briefly describe how we use LI holdings to make inferences about preferences about the bequest motive for dependents and about equivalence scales or how consumption expenditures translate into utilities across different types of marital status. We also discuss the identification problem at the root of the assumption of no bequest motive for spouses. First, a caveat: agents' decisions in this model are based on marginal considerations, and estimates based on average allocations require a functional form assumption in order to make statements about levels or about welfare.[13] We make the standard assumption in macroeconomics of preferences belonging to the constant relative risk aversion (CRRA) class, but we use its implications of utility levels only in the policy analysis at the end of the paper. Even if such welfare estimates are taken with a grain of salt, we think that the findings about our notions of equivalence scales are interesting in themselves.[14] An additional, if obvious, caveat is that our findings display no information about the value of different types of marital status. Our analysis excludes marital choices and is compatible with any type of additive utility terms associated with some type of marital status and not others. Our estimates of the bequest motive, however, do not have this problem: we use a two-parameter function flexible enough to capture the level of implied bequests and its variation over family circumstances and the life cycle.

LI and the Bequest Motive

Consider a single agent with dependents that may live a second period with probability γ. Its preferences are given by the 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 given by function $\chi(\cdot)$. Under perfectly fair insurance markets and a zero interest rate, the agent could exchange $1-\gamma$ units of the good today for one unit of the good tomorrow if it dies by purchasing LI. Its problem is

$$\max_{c,a',b} \quad u(c) \;+\; \gamma\, u(a') \;+\; (1-\gamma)\, \chi\big(a'+b\big)$$
$$\text{s.t.} \qquad c + a' + (1-\gamma)\, b = W,$$

where c is current consumption, a' is unconditional saving, b is the LI purchase, and W is its income. The first-order conditions of this problem imply that $a' = c$ and

$$u_c(c) = \chi'(c+b). \tag{1}$$

With data on consumption and the LI holdings of single households, we can recover the relation of the utility function u and the bequest function χ from the estimation of (1).

LI and the Differential Utility while Married and while Single

To see how to estimate preferences across different marital status, now consider a married couple where one of the agents lives for two periods, while the other agent lives a second period with probability γ. Let $u^m(c)$ be the utility when consumption expenditures are c and there are two persons in the household,

[13] Pollak and Wales (1979) already noted that demand analysis faces severe limitations to provide guidance to welfare analysis, which requires "unconditional" equivalence scales estimation.

[14] "Conditional" equivalence scales in the Pollak and Wales (1979) terminology.

while $u^w(c)$ is the utility when living alone, which matters only for the agent that survives for sure. We start by posing the problem when there is joint decision making:

$$\max_{c^m,a',b} \left[\begin{array}{c} \xi \ \{u^m(c^m) \ + \ \gamma \ u^m(a') \ + \ (1-\gamma) \ u^w(a'+b)\} \\ +(1-\xi)\{u^m(c^m) \ + \ \gamma \ u^m(a') \ + \ (1-\gamma) \ \chi(a'+b)\} \end{array} \right] \tag{2}$$
$$\text{s.t.} \qquad c^m + a' + (1-\gamma)b = W,$$

where ξ is the weight in the decision problem of the agent that survives for sure and where a' denotes unconditional savings. The first-order conditions to the joint maximization problem are $c^m = a'$ and $u^m_c(c^m) = \xi \ u^w_c(a'+b) + (1-\xi) \ \chi'(a'+b)$. Notice now that when $\xi = 1$, the sole sure survivor is also the sole decision maker and the FOCs collapse to $u^m_c(a') = u^w_c(a'+b)$. Consequently, we can infer from insurance holdings and savings the relation between the marginal utility of consumption when living alone and the marginal utility when living in a two-person household.

When the agent that can die is the sole decision maker ($\xi = 0$), we have that $u^m_c(a') = \chi'(a'+b)$, which is the same as when the agent is single. When $\xi \in (0,1)$, both agents have a say in the decision and the FOC does not simplify, since there is disagreement unless $u^w_c(\cdot) = \chi'(\cdot)$. However, we can estimate χ' and u^w_c jointly using the first-order conditions of single and married households.

Pareto Weights and Bequest Motive between the Spouses

To see why the bequest motive cannot be identified separately from the Pareto weights, consider a version of equation (2) where λ determines the degree of altruism for the other of the spouse that may die (again, for simplicity we ignore the symmetric altruistic motive):

$$\max_{c^m,a',b} \left[\begin{array}{c} \xi \ \{u^m(c^m) \qquad + \ \gamma \qquad u^m(a') \ + \ (1-\gamma) \ u^w(a'+b)\} \\ +(1-\xi)\{(1+\lambda)u^m(c^m) \ + \ \gamma \ (1+\lambda)u^m(a') \ + \ (1-\gamma)\lambda \ u^w(a'+b)\} \end{array} \right],$$

with the FOC given by $c^m = a'$, and $u^m_c(c^m) = \overline{\xi} u^w_c(a'+b)$ where $\overline{\xi} \equiv \frac{\xi+(1-\xi)\lambda}{1+(1-\xi)\lambda}$. From this expression we cannot tell whether LI purchases are the result of high values of ξ or of λ.

III. The Model

The economy is populated by overlapping generations of agents embedded into a standard neoclassical growth structure. In any period, alive agents are indexed by age, $i \in \{1, 2, \cdots, I\}$, sex, $g \in \{m, f\}$ (denote by g^* 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 (n), divorced (d), and widowed (w)) without (subscript o) and with (subscript w) dependents, and being married without and with dependents where the index denotes the age of the spouse. Agents are also indexed by the assets of 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 $\pi_{i,g}(z'|z)$.[15]

Demographics

Agents live up to a maximum of I periods and 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 as $\gamma_g^i = \Pi_{j=1}^{i-1}\gamma_{j,g}$.[16] 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

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

An important additional restriction on the matrices $\{\pi_{i,g}\}$ 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 $u_{i,g,z}(c)$. With respect to the joy of giving, we assume that upon death, a single agent with dependents gets utility from leaving its dependents with a certain amount of resources $\chi(\cdot)$. 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 toward dependents becomes operational again. We assume that there is no bequest motive between the spouses. The reason is that there is no known identification strategy to separately measure a bequest motive between the spouses and the relative weight in the decision-making process.

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

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

[16]Here we abstract from differential mortality based on marital status.

the agent has dependents we have

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

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

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

where the first two terms on the right-hand side are standard, the third term represents the utility that the agent gets from the bequest motive toward dependents 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

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

where $\widehat{u}_{i,g,z}(c)$ is the utility obtained from dependents (not the spouse) under the care of a former spouse that now has type $\{i, g, z\}$ and expenditures c. Notice that we assume that an agent expects to get utility even if dead through *i)* the stream of utilities that are enjoyed by its *dependents* (but not the spouse) until the spouse dies given by $\widehat{u}$, and *ii)* the bequest the former spouse might leave to its dependents upon death. This aspect of the model captures the fact that the well-being of the dependents is now under the control of the surviving spouse, whose decision on consumption/saving would be different from that of the deceased individual. Note also that function Ω does not involve decision making. It does, however, involve the forecasting of what the former spouse will do, which implies that the FOC has the features of a generalized Euler equation (see Klein, Krusell, and Ríos-Rull (2008)).

Endowments and Technology

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 in addition to alimony and child support. All idiosyncratic uncertainty is thus related to marital status and survival.

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.[17]

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 is also an LI market to insure against the event of early death of the agents. We assume that the insurance industry operates at zero costs without cross-subsidization across age and sex. 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

The model includes Social Security, which requires that agents pay the payroll tax with a tax rate τ on labor income and receive Social Security benefits $(T_{i,g,z,R})$ when they become eligible. The model also has a survivor's benefits program so that widowed singles can have a choice between their own benefits and the benefit amounts based on their own contribution and on the contribution of the deceased. 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 the age and existence of dependents, but this is not enough. Agents also have to know 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

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

[17]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.

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 between the cases of keeping the same spouse or changing the spouse (see Cubeddu and Ríos-Rull (1997) 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

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

$$c + y = (1+r)\, a + (1-\tau) w\ \varepsilon_{i,g,z} + T_{i,g,z,R} \tag{3}$$

$$a' = \begin{cases} y + L_{i,g,z} & \text{if } z' \in \{n_o, n_w, d_o, d_w, w_o, w_w\}, \\ y + L_{i,g,z} + y_{z',g^*} & \text{if } z' \in \{1_o, 1_w, .., I_o, I_w\}. \end{cases} \tag{4}$$

There are several features to point out. Equation (3) 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. Social Security benefit $T_{i,g,z,R}$ can be either T_g, which is the benefit from an agent's own account, or $\max\{T_g, T_{g^*}\}$, which captures the survivor's benefits program where a widowed single can claim benefits from the account of her deceased spouse. More interesting is equation (4), which shows the evolution of assets associated with this agent. First, if the agent remains single, its assets are its savings and possible rebates of unclaimed asset $L_{i,g,z}$ from deceased single agents without dependents of the same age, sex group. We assume that the government collects any unclaimed assets of the deceased agents without dependents and redistributes them as lump-sum transfers.[18] 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.

[18] Alternatively, we could allow agents to hold annuities, which is another way of dealing with the assets of agents who die early. Given that annuities markets are not widely used, we do not model the annuity market explicitly. This is not, we think, an important feature. See Hong and Ríos-Rull (2007) for a study of Social Security policies in the presence or absence of annuities that uses some of the ideas developed in this paper.

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

$$\begin{aligned} v_{i,g,z}(a) \quad &= \quad \max_{c \geq 0, b \geq 0, y \in A} u_{i,g,z}(c) + \beta\gamma_{i,g} E\{v_{i+1,g,z'}(a')|z\} + \beta\,(1-\gamma_{i,g})\,\chi(y+b) \\ \text{s.t.} \quad & c + y + q_{i,g}b = (1+r)\,a + (1-\tau)w\;\varepsilon_{i,g,z} + T_{i,g,z,R} \\ & a' = \begin{cases} y & \text{if } z' \in \{n_o, n_w, d_o, d_w, w_o, w_w\}, \\ y + y_{z',g^*} & \text{if } z' \in \{1_o, 1_w, .., I_o, I_w\}. \end{cases} \end{aligned}$$

Note that here we decompose savings into uncontingent savings and LI that pays only in case of death and that goes straight to the dependents.[19] The face value of the LI paid is b, and the total premium is $q_{i,g}b$, where the premium per dollar is $q_{i,g} = (1-\gamma_{i,g})$ when the price of LI is actuarially fair.

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 subsequent family type and life horizons are different). We make the following assumptions about the internal workings of a family:

1) Spouses are constrained to enjoy equal marginal utility from current consumption. Sufficient conditions for this assumption are that all consumption is private, that both spouses are constrained to have equal consumption, and that they have equal utility functions.[20]

2) The household solves a joint maximization problem with weights: $\xi_{i,m,j} = 1-\xi_{j,f,i}$. Given that both spouses have equal marginal utility out of current consumption, the role of different weights only affects how the first-order condition of the maximization problem treats consumption in future states that are not shared because of either early death or divorce.

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. The sum of these two fractions may be 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 LI if the deceased held any LI.

[19] Allowing agents with dependents to choose annuities does not change the allocation chosen as long as they have a strong bequest motive. In fact, LI is the opposite of an annuity.

[20] The constraint can also be implemented with all consumption being public or with some public consumption and some private, equally shared consumption, or with private consumption in fixed proportions between the two spouses and a certain relation between the utility functions of each. These constraints are independent of the utility weights.

With these assumptions, the problem solved by the household is

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

$$\text{s.t.} \ \ c + y + q_{i,g}b_g + q_{j,g^*}b_{g^*} = (1+r)\, a + (1-\tau)w(\varepsilon_{i,g,j} + \varepsilon_{j,g^*,i}) + T_{i,g,j,R} \tag{5}$$

$$\begin{array}{ll} a'_g = \ a'_{g^*} \ = y + L_{i,g,j}, & \text{if remain married } z' = j+1 \\ a'_g = \psi_{i,g,j} \ \ (y + L_{i,g,j}), & \\ a'_{g^*} = \psi_{j,g^*,i} \ \ (y + L_{i,g,j}), & \text{if divorced and no remarriage, } z' \in S \\ a'_g = \psi_{i,g,j} \ \ (y + L_{i,g,j}) + \ y_{z'_g, g^*}, & \\ a'_{g^*} = \psi_{j,g^*,i} \ \ (y + L_{i,g,j}) + \ y_{z'_{g^*}, g}, & \text{if divorced and remarriage, } z' \in M \\ a'_g \ = \ y + L_{i,g,j} + b_{g^*}, & \\ a'_{g^*} \ = \ y + L_{i,g,j} + b_g, & \text{if widowed and no remarriage, } \ z' \in S \\ a'_g \ = \ y + L_{i,g,j} + b_{g^*} + \ y_{z'_g, g^*}, & \\ a'_{g^*} \ = y + L_{i,g,j} + b_g + \ y_{z'_{g^*}, g}. & \text{if widowed and remarriage, } z' \in M, \end{array} \tag{6}$$

where $L_{i,g,j}$ is the lump-sum rebate of the unclaimed assets in case of joint death of couples without dependents. Note that the household may purchase different amounts of LI, depending on who dies. Equation (6) 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:

$$\max_{c\geq 0, b_g\geq 0, b_{g^*}\geq 0, y\in A} u_{i,g,j}(c) \ + \beta\ (1-\gamma_{i,g})\ (1-\gamma_{j,g^*})\ \chi(y + b_g + b_{g^*}) + \\ \xi_{i,g,j} \ \ \beta \left\{ \gamma_{i,g}\, E\{v_{i+1,g,z'_g}(a'_g)|j\} \ + \ (1-\gamma_{i,g})\ \gamma_{j,g^*}\ \Omega_{j+1,g^*,z'}\ (y + b_g) \right\} + \\ \xi_{j,g^*,i} \ \ \beta\ \left\{ \gamma_{j,g^*}\ E\{v_{j+1,g^*,z'_{g^*}}(a'_{g^*})|i\} + \ (1-\gamma_{j,g^*})\ \gamma_{i,g}\ \Omega_{i+1,g,z'}\left(y + b^*_g\right) \right\}.$$

The budget constraint is as in equation (5). In this case if both spouses die, their assets go to their dependents. The law of motion for assets becomes equation (6) with $L_{i,g,j} = 0$. 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. Recall that function Ω does not involve decisions, but it involves forecasting the former spouse's future 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.

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

where, again, $\mathbf{1}$ is the indicator function.

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

IV. 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 those in the United States in 1999.[21] 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 bequest motive between the members of the couple. A variety of features enrich the preference structure, which we list in order of simplicity of exposition and not necessarily of importance.

[21] Source: United States Vital Statistics Mortality Survey.

1) Habits from marriage. A divorcee or widow may have a higher marginal utility of consumption than a never-married person. Habits can differ by sex but not by age.

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

2) A married couple without dependents does not have concerns over other agents or each other, but it has increasing returns to scale in household consumption, parametrized by θ.

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

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 the bequest motive. We also distinguish the implied costs of having dependents according to the sex of the head of household.

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

where κ is a parameter that increases utility because there exist dependents regardless of the number. Note that the number of children and adult dependents increases the cost in a linear but differential way. The cost is net of possible home production (and income) produced/earned by dependents. We denote by $\#_c$ and $\#_a$ the number of children and adults, respectively, in the household. There is an identification problem with this specification. Parameters $\{\theta^g, \theta_c, \theta_a\}$ yield the same preferences as $\left\{1, \frac{\theta_c}{\theta^g}, \frac{\theta_a}{\theta^g}\right\}$. However, we write preferences this way because these same parameters also enter in the specification of married couples with dependents, which solves the identification problem. 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.

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

which assumes that the costs of dependents are the same for couples and single women.[22]

We assume the utility obtained from dependents who are under the care of a surviving spouse is $\widehat{u}_{i,g,z}(c) = \frac{\kappa-1}{\kappa} u_{i,g,z}(c)$. We pose the bequest 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 bequest 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.[23]

With all of this, we have 12 parameters: the discount factor 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 an equal share[24] ($\psi_{\cdot,m,\cdot} = \psi_{\cdot,f,\cdot} = 0.5$). 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 1989-1991 to get the average number of child and adult dependents for each age, sex, and marital status (reported in Tables D-7 and D-8 of the Appendix). For married couples, we compute the average number of dependents based on the wife's age. Single women have more dependents than single men, 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.

[22] 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 woman in the household.

[23] 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 could also depend on the relative income of each member of the couple, which in our model is a function of the age of each spouse and marital status. See also Browning and Chiappori (1998) and Mazzocco (2007).

[24] Unlike Cubeddu and Ríos-Rull (1997, 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.

Endowments and Technology

To compute the earnings of agents, we use the CPS March files for 1989-1991 reported in Table D-9 of the Appendix. 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 $\{M, n_o, n_w, d_o, d_w, w_o, w_w\}$.[25] Single men with dependents have higher earnings than those without dependents. This pattern, however, is reversed for single women: those never married have the highest earnings, followed by divorced and then widowed women. But for single men, those divorced have the highest earnings, followed by widowed and never married men.[26] The earnings that we use include alimony and child support paid and received. We collect data on the alimony and child support income of divorced women from the same CPS data reported in Table D-10 of the Appendix. We then 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 correspondingly. Note that we cannot keep track of those married men who pay child support from previous marriages.

We use 1991 Social Security beneficiary data to compute average benefits per household.[27] We break eligible households into 3 groups depending on whether it has both a male and a female worker retired, a male worker only, or a female worker only. In 1991, the average monthly benefit amounts per family were $,1068, $712, and $542, respectively. To account for the survivor benefits of Social Security, we allow for a widow to collect the benefits of her deceased spouse instead of those of her own upon her retirement, $T_f^w = \max\{T_m, T_f\}$.[28] People are eligible to collect benefits starting at age 65. Aggregating these benefits requires a Social Security tax rate τ of 11 percent.[29]

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

V. Estimation

We estimate the 9 parameters, $\Theta = \{\theta^m_{dw}, \theta^f_{dw}, \theta, \theta^m, \theta_c, \theta_a, \chi_a, \chi_b, \kappa\}$, of the benchmark model economy jointly by matching 48 moment conditions, the averages of simulated and actual age (12 groups), sex (2 groups), and marital status (2 groups) profiles of LI and imposing a model-generated wealth to earnings ratio

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

[26]While the correlation between earnings and family composition is likely to be closely related to selection, in this paper we just want to reproduce such relation, which ends up implying that demographics are what cause earnings. Since in this model demographics are modeled as exogenous, we think that is a reasonable assumption.

[27]Source: http://www.socialsecurity.gov/OACT/ProgData/famben.html.

[28]In 1991 the average monthly survivor benefit per family for a widow is $618.66, which is in between the amount received by a male worker only retired and a female worker only retired. This may be because of the higher mortality of workers with lower earnings, which our model is abstracted from.

[29]Throughout the paper we have assumed that defined benefits pensions are consolidated with general household savings, and consequently, only Social Security has the form of a defined benefits pension.

of 3.2[30] using the method of simulated moments (MSM).[31] We use our model to simulate life cycle profiles, obtaining a sample of 4,000 individuals per each age and sex from age 15 to age 85 (14 age groups) for a total of 112,000. The estimates $\widehat{\Theta}$ solve

$$\min_{\Theta} g(\Theta)' \, W \, g(\Theta),$$

where $g(\Theta) = (g_1(\Theta), \cdots, g_J(\Theta))'$ and $g_j(\Theta) = \overline{m}_j - \widehat{m_j}(\Theta)$, which is the distance between the empirical and the simulated average face value of LI for each age–sex–marital status group ($J = 48$). In the benchmark model, singles without dependents do not hold LI. For this reason, we exclude singles without dependents when matching the simulated LI profile from the model to the data. We relax this restriction in Section VII where singles without dependents do have an operational bequest motive. For most of the analysis, we use as weighting matrix W the identity matrix, but we also use another one based on sampling errors, which will be discussed in Section E of the Appendix. The variance-covariance estimator is calculated by

$$\widehat{\Sigma}_{\widehat{\Theta}} = (\widehat{G}'W\widehat{G})^{-1}\widehat{G}'W\Omega W\widehat{G}(\widehat{G}'W\widehat{G})^{-1},$$

where $\widehat{G} = \frac{\partial}{\partial \Theta} g|_{\Theta = \widehat{\Theta}}$, which we compute using the numerical derivatives of g at $\widehat{\Theta}$, and Ω is the variance matrix of the empirical moments. 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. LI holdings data and the model LI holdings by age, sex, and marital status.

Table 2—Parameter Estimates and Residuals of the Benchmark Model

θ	θ_c	θ^f_{dw}	θ^m	χ_a	χ_b	κ	ξ_m	β
0.330 (0.123)	2.502 (0.685)	3.756 (0.047)	1.295 (0.177)	1.296 (0.689)	4.744 (0.011)	1.000 (0.129)	0.932 (0.001)	0.981 (0.010)
SSE : 18.47					J stat : 236.42			

Note: Numbers in parentheses are standard deviations.

Table 2 shows the results of the estimation with the standard deviation of estimates and the sum of squared errors (SSE) that we use as our measure of fit. We summarize the main properties of the estimates by the following:

- **Marriage generates strong economies of scale.** When two adults get

[30]The actual wealth to earnings ratio in the United States is higher, 5.57 in 1992, but this is because wealth is highly concentrated in the top percentiles. The wealth to earnings ratio for the bottom 99 percent of the wealth distribution is 4.25; for the bottom 95 percent and 90 percent the ratios are 3.24 and 2.64. Our choice to target 3.2 is a way of representing the relevant margins for the majority of people.

[31]See Gourinchas and Parker (2002).

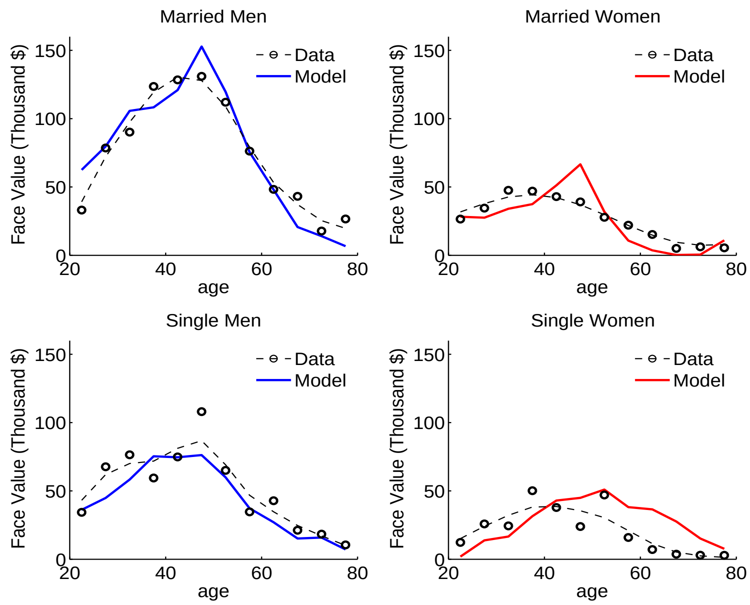


FIGURE 3. BENCHMARK MODEL AND U.S. LI HOLDINGS BY AGE, SEX, AND MARITAL STATUS.

married, they spend a total of \$1.33 together to enjoy the same marginal utility they could get as singles by spending \$1.00 each. We easily reject the extreme hypotheses of no economies of scale ($\theta = 1$) and no cost for a spouse ($\theta = 0$) at the 1 percent level. Stronger economies of scale means that it is more beneficial to live together. Consequently, an important incentive to hold LI appears because the death of a spouse destroys those benefits. The estimates are high to account for the fact that married couples hold more LI than singles, and the model predicts the strong economies of scale within a marriage.

- **Children are very costly.** Households with a dependent child have to spend an additional \$2.502 to get the same utility they would get if they did not have dependents and spent \$1.00. This contrasts with the fact that if the dependent is an adult, there is no additional cost.[32] The estimate for the dependent adult may be due to the contributions of this person in terms of income and/or home production. The more expensive the dependents, the more households consume, the less they save, and the less they purchase LI. If children were costless to live with, the model would have predicted that households with children purchased a lot more LI than what we observed in the data. To account for the fact that the LI profile of married men reaches its peak at the age of 45-50, the model estimates that children are

[32]If we reestimate the model with $\theta_a \geq 0$, we obtain an estimated value of zero and identical SSE.

costly so that young married men (who are more likely to have children in this household) hold less LI than that of the middle-age group. Without this estimate, the model would predict that the LI profile peaks too early in the lives of young married men. The cost of dependent children does not matter much after age 50: there are very few children by then. Also, a low cost of dependents implies that women's advantage in home production is less valuable. This in turn gives less incentive to insure against the death of a wife, which is why the model also predicts little insurance for married women. This parameter is identified essentially by the timing of the peak of married men's insurance profiles.

- **Children are less costly for females than for males.** A dependent costs a single man 30 percent more than it costs single women or married couples. This indicates that females produce a lot of home goods. Without this advantage of women with children dependents, the model would have predicted too little LI for women between ages 25 and 45.

- **Agents care a lot for their dependents.** Our estimates imply that the average single man of age I with dependents consumes 45.8 cents and gives 54.2 cents as a bequest. The estimates for single women with dependents are 56.9 cents of consumption and 43.1 cents of bequest, ranging from consuming 37 cents for never married to 61.6 cents for a widow.[33]

- **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 \$3.756 to enjoy the same utility of a never-married woman who spends \$1.00. This is not the case for men.[34] Retired married men purchase a lot of LI at a time when there are no dependents and when their wives will see their future income only minimally reduced given the nature of survivor's benefits in the United States. The estimation accounts for this by posing a high marginal utility of consumption for widows via the habits parameter. Note that the absence (or at least the very limited existence) of dependents at this stage of the life cycle prevents altruistic considerations toward those dependents to account for the high amount of LI.

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

Figure 3 shows the results of the estimation by comparing the values of LI holdings by age, sex, and marital status, both in the model and in the data. The model replicates all the main features of the data that we described in Section I. The only shortcoming of the model may be in the holdings of single women where

[33]This large variation is due to the possible presence of marriage habits.
[34]If we reestimate the model with $\theta^m_{dw} \geq 0$, we obtain an estimated value of zero and identical SSE.

the model slightly underpredicts the LI holdings of young single women and overpredicts the LI holdings of older single women.[35] Possible explanations are that there is a cohort effect, since the older women in the data come from very different cohorts than younger women (with very different labor market experiences), or that for young single women there are some involuntary LI holdings as discussed in Section I.A, or that men may have a stronger bequest motive than women.

VI. Alternative Specifications

We explore the validity of our specification by abstracting sequentially the various features included in the benchmark model. See Table 3 and Figure 4.

Marriage Does Not Generate Habits

In the benchmark model, the women's habit parameter is significantly different from zero, and we say that marriage generates strong habits for females. To see the extent of this feature, we reestimate the model 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 LI holdings in the case of a male's death, especially later in his life relative to the data. In the absence of habits from marriage for women, married men do not need to hold much insurance. To account for the fact that married men hold 2.7 times more insurance than married women, the newly estimated model attempts to tilt consumption toward married females by choosing a much lower decision weight for the male than in the benchmark. To deal with the lower regard for consumption of older women without habits, this version of the model attempts to lowers the bequest motive intensity (χ_a). Overall, though, the quality of the estimates as measured by the SSE is notoriously worse than the benchmark's, and we can reject the hypothesis of no habits at the 0.1 percent level based on the Wald test. This shows that habits for women are needed to account for the large purchases of LI that occur late in the husband's life after most earnings have been made.

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 benchmark model and the restricted model without habit. The restricted model predicts LI holdings for older males that are still too low, and we can reject the hypothesis of symmetric habits at the 0.1 percent level. We conclude that it is hard to avoid the use of some form of habits to account for the LI purchases of older married men.

[35] All things equal, bequests are typically increasing in survival probability, and women's survival differential with men is increasing with age, which makes single women hold relatively more LI as they get older.

Table 3—Parameter Estimates and Residuals of Alternative Models

	Benchmark	No Habit	Sym Habit	Sym HP	Eq Weight	OECD
θ	0.330	0.000	0.000	0.291	0.084	*0.7*
	(0.123)	(0.102)	(0.963)	(0.187)	(0.010)	
θ_c	2.502	2.272	2.415	2.565	3.921	*0.5*
	(0.685)	(0.385)	(1.389)	(0.524)	(0.084)	
θ_a	*0*	*0*	*0*	*0*	*0*	*0.7*
θ_{dw}^m	*0*	*0*	*0.232*	*0*	*0*	*0*
θ_{dw}^f	3.756	*0*	0.232	3.607	0.415	*0*
	(0.047)		(1.252)	(0.519)	(0.019)	
θ^m	1.295	2.037	1.803	*1*	2.422	*1*
	(0.177)	(0.232)	(0.336)		(0.049)	
χ_a	1.296	0.495	0.439	0.873	0.458	1.787
	(0.689)	(0.114)	(0.717)	(0.593)	(0.013)	(0.197)
χ_b	4.744	5.272	5.405	5.030	5.632	4.072
	(0.011)	(0.142)	(1.004)	(0.512)	(0.050)	(0.218)
κ	1.000	1.000	1.000	1.000	1.000	1.257
	(0.129)	(0.303)	(0.300)	(0.016)	(0.014)	(0.112)
ξ_m	0.932	0.550	0.585	0.930	*0.5*	0.540
	(0.001)	(0.035)	(0.066)	(0.004)		(0.045)
β	0.981	0.983	0.980	0.983	0.969	0.970
	(0.010)	(0.009)	(0.019)	(0.009)	(0.009)	(0.005)
SSE	18.47	57.86	54.91	20.29	49.67	100.61
J stat	236.42	356.61	379.89	257.65	303.57	548.18
Wald	−−	1990.7^{**}	192.8^{**}	0.96	37606^{**}	2657.8^{**}

Note: Numbers in italics are restricted by the model.

Men and Women Are Equally Good at Home Production

In the benchmark model, it costs men 30 percent 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 $\theta^m = \theta^f = 1$, which we interpret as implying that men and women are equally good at home production. The model now predicts less LI in case young married women die because there is no need to insure against the lack of home production. Still, the fit of this model is quite good; it is the best among the alternative specifications. We cannot reject the symmetric home productivity between men and women based on our Wald test.

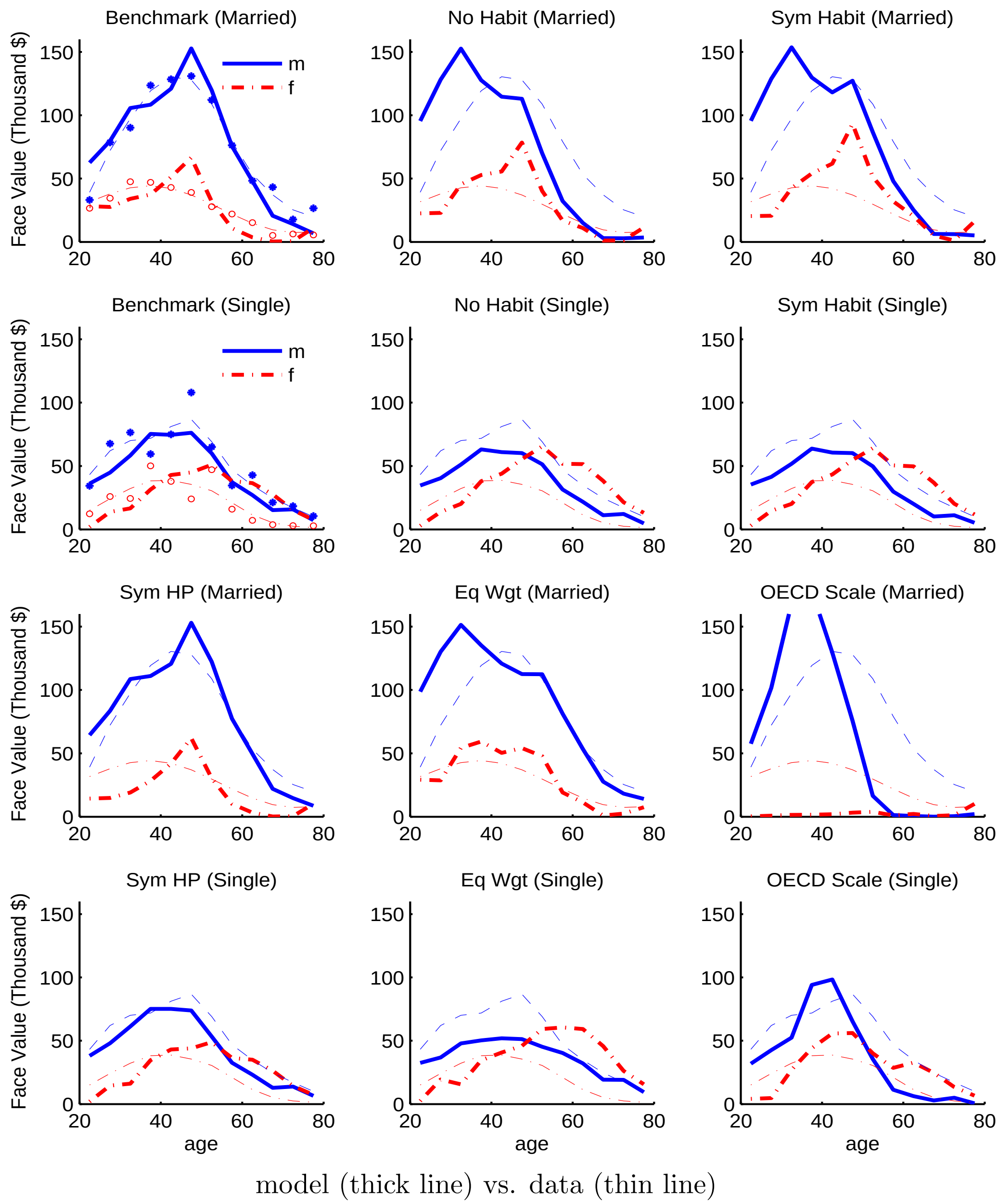


Figure 4. Face value of the models by sex and marital status

Equal Weights in the Joint Maximization Process

Because the decision weight of women is now higher relative to the benchmark model, absent changes in other parameters the model would imply more insurance in case of a husband's death and less in case of the wife's death. The adjustment is made by dramatically bumping up the men's disadvantage at home production (142 percent versus 30 percent) and decreasing the marital habits for women (3.756 to 0.415). Even with these adjustments, the model predicts too much LI for young husbands. The hypothesis of equal decision weights is rejected at the 0.1 percent level.

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.[36] To implement these ideas, we reestimate the patience and bequest parameters as well as the weights in the joint maximization problem. The fit is worst among various alternative specifications. The model predicts that insurance is held under circumstances that are different from those in which people in the United States 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 and the scale parameter for the bequest function is much higher, which is the way in which this model increases insurance holdings.

The assessment of alternative models shows that abstracting from any of the features of the benchmark model yields a much worse fit of the model (except perhaps for symmetric home production). We have explored many other versions that do not match the data well, but to avoid boring the reader, we do not report them. We have also shown that the OECD equivalence scales do a very bad job in accounting for the patterns of holdings of LI.

VII. Other Modeling and Data Issues

We now turn to the sensitivity of our findings to various issues. All estimates are shown in Table 4.

Voluntary Insurance

We also estimate the model to match the conservative measure of voluntary insurance introduced in Section I.A. In this case the model adapts to the slightly lower amounts of LI holdings by posing a lower value for the bequest intensity parameter χ_a (0.7 vs. 1.3) and a slightly higher weight for the husband in the household's decision problem ξ (0.95 vs 0.93). Even when we use this extremely conservative measure of voluntary insurance, we still confirm our main findings: i) individuals are very caring for their dependents; ii) there are large economies of

[36] Under the OECD view (OECD (1982)), 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 also assumes that there are no habits or differences between males and females.

Table 4—Parameter Estimates of Various Alternative Versions of the Model

	Benchmark	Voluntary Insurance	Bequest Motive for all	Separate Target by Dependents	Model with 25% loading
θ	0.330	0.319	0.661	0.790	0.106
	(0.123)	(0.132)	(0.219)	(0.395)	(0.099)
θ_c	2.502	2.543	2.267	2.420	1.947
	(0.685)	(0.310)	(0.407)	(0.468)	(0.357)
θ_{dw}^f	3.756	3.854	4.749	4.749	4.274
	(0.047)	(1.307)	(0.855)	(1.175)	(1.102)
θ^m	1.295	1.000	1.613	1.471	1.633
	(0.177)	(0.113)	(0.105)	(0.289)	(0.327)
χ_a	1.296	0.685	1.178	1.278	1.197
	(0.689)	(0.563)	(0.584)	(1.308)	(0.259)
χ_b	4.744	4.744	4.874	5.084	5.076
	(0.011)	(0.497)	(0.569)	(0.944)	(0.097)
κ	1.000	1.000	1.000	1.000	1.000
	(0.129)	(0.083)	(0.034)	(0.041)	(0.071)
ξ_m	0.932	0.949	0.941	0.945	0.943
	(0.001)	(0.028)	(0.018)	(0.001)	(0.031)
β	0.981	0.987	0.954	0.956	0.974
	(0.010)	(0.014)	(0.005)	(0.007)	(0.007)
SSE	18.47	19.72	18.35	99.87	16.55
J stat	236.42	245.15	189.94	332.92	222.61

scale in consumption when a couple lives together; iii) children are quite expensive; and iv) men have the upper hand in the marriage decision.

Bequest Motives for All

In the benchmark model, singles without dependents do not hold LI because we assume that they do not have any operational bequest motive. They do, however, hold LI in the data. To explore the sensitivity of our findings to this assumption, we estimate the model assuming that all households have an operational bequest motive, and the difference between households with and without dependents lies only in the number and type of members. The estimation targets the same 48 moment conditions used to estimate the benchmark. Figure 5 shows the predictions of this model and of the benchmark for singles with and without dependents. We see that the model improves its matching with the data for singles, and overall the quality of the estimates as measured by the sum of the square of the residuals is about the same as in the benchmark. There is a change in the estimated

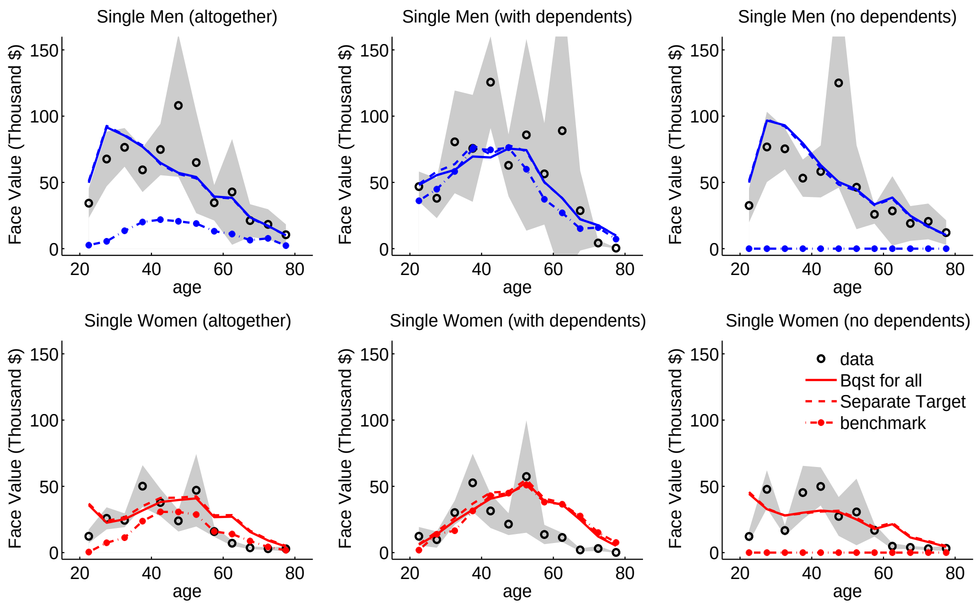


Figure 5. LI holdings of singles by age and sex with bequest motive for all

value of two parameters. The value of the economy of scale for the spouse is lower to account for the consumption of married couples with dependents, and the patience to match aggregate wealth is also lower, given that there is now an additional saving motive for households without dependents.

Separate Targets by Dependents

We also estimated the model where all households have a bequest motive by targeting separately the LI holdings of households with and without dependents (that is, using 96 moments instead of 48). Note that with such a fine partition, the sample sizes are very small for some cells.[37] The estimates are similar to the ones targeting 48 moments except for the economies of scale of couples, which are now smaller. The new estimates imply a lower economy of scale in order to match the fact that in the data, married men without dependents hold smaller LI holdings than single men without dependents relative to the data.

Load Factors for LI

While in the benchmark model, we assume that the price of LI is actuarially fair, we have also estimated our model introducing positive load factors in the

[37]In fact, one particular group, married women ages 70 to 75 with dependents, have only two observations, while the total number of married women in that group has 105 observations. Table D-11 in the Appendix displays the number of observations by sex, age, and family type.

insurance premium such that the premium is $q_{i,g} = (1+x)(1-\gamma_{i,g})$, where x is the load factor set to 0.25.[38] Again, the estimates are reported in Table 4. To account for the fact that married couples hold more life insurance than singles despite the unfair premium, the model predicts stronger economies of scale, $\theta = 0.106$ relative to 0.330 in the benchmark. The model also predicts a stronger marital habit for women, $\theta^f_{dw} = 4.274$ (3.756 in the benchmark), to match the insurance holdings of married men, and the estimate for the relative disadvantage of single men with dependents becomes larger, $\theta^m = 1.63$ (1.30 in the benchmark), to match the fact that young married women hold significant amounts of life insurance.

VIII. 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, which 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 of a male worker. This is our way of implementing the current system of survivor's benefits in the United States. We implement the abolition of survivor's benefits as giving widows the same Social Security Benefits that never-married women receive ($T^w_f = T_f$), which amounts to a 24 percent reduction in their benefits.

In the benchmark model, widows consume almost the same amount as married couples due to the importance of the habits acquired by women in marriage, and the death of an elderly husband acts as a drawback, since it implies lower income but not lower consumption. Eliminating survivor's benefits is dealt with by an increase in the amount of LI (payable when the male dies) purchased by the household and not by a reduction of consumption by widows. Figure 6 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 LI face value rises from 138 percent to 150 percent of GDP. In addition to this effect on LI holdings, there is a 0.24 percent increase in total assets.[39]

We also compute a compensated variation measure of welfare.[40] 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 living in an economy without survivor's benefits.[41] Note

[38]Mulligan and Philipson (2004) document the operating expense-premium ratios of five insurance companies, which range from 9 percent to 38 percent.

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

[40]This is not, strictly speaking, a welfare measure because it ignores the transition, except (almost) for a cohort that is of age 20 at the time of the policy implementation.

[41]The caveat made above about using estimates based on marginal conditions also applies here. However, given that the changes that we study are small, we think that the local information obtained is sufficient to get a good idea of how the changes affect people.

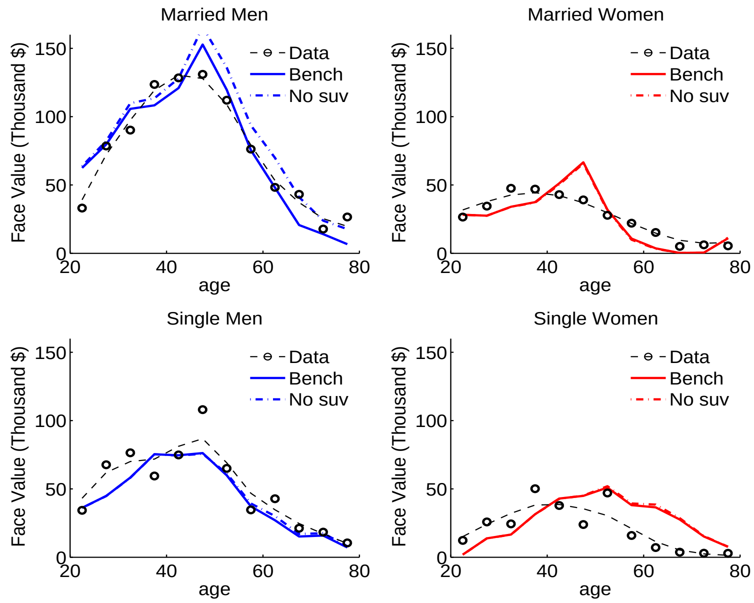


FIGURE 6. LI HOLDINGS BY AGE, SEX, AND MARITAL STATUS WITHOUT WIDOW'S PENSION

that the policy change is effectively an abolition of a transfer to women, since only women receive survivor's benefits,[42] its abolition implies an increase of standard benefits, and a larger part of this increase goes to single men rather than single women. Consequently, and to understand the effects of the policy change, we should analyze men and women separately.

We find that abolishing survivor's benefits implies a significant welfare loss for women, while there is a much smaller welfare gain for men. Our welfare measure indicates that women would need to be given an additional 0.0264 percent of their consumption to be indifferent with the current policy, while men are willing to give up 0.0036 percent of their consumption to abolish survivor's benefits. This is consistent with Chambers, Schlagenhauf, and Young (2004), who found the effect of survivor's benefits to be so small that aggregates are almost unaffected.

IX. Conclusion

We have used LI purchases to infer how people assess consumption across different family circumstances. We estimated utility functions for men and women that depend on marital status. We have learned that children are quite expensive; that females are better at home production than males; and that marriage increases the marginal utility of consumption for females when they are no longer

[42]In the model only women receive the transfer, and in the data mostly women receive it.

married. With our estimates, we assessed the effects of some Social Security policies, and we found that eliminating survivor's benefits can be accommodated via larger LI purchases in the case of the death of the male, but that it also implies a small reduction in female well-being and a much smaller improvement in male well-being.

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.

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