Social security, life insurance and annuities for families [☆]

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Abstract

In this paper we ask whether an aspect of social security, namely its role as a provider of insurance against uncertain life spans, is welfare enhancing. To this end we use an OLG model where agents have a bequest motive and differ in sex and marital status and where families are formed and destroyed and their characteristics evolve (exogenously) according to U.S. demographic patterns of marriage, divorce, fertility and mortality. We compare the implications of social security under a variety of market structures that differ in the extent to which life insurance and annuities are available. We find that social security is a bad idea. In economies where the private sector provides annuities and life insurance, it is a bad idea for the standard reason that it distorts the intertemporal margin by lowering the capital stock. In the absence of such securities social security is still a very bad idea, only marginally less so compared with economies with annuities and life insurance. We also explore these issues in a world where people live longer and we find no differences in our answers. As a by-product of our analysis we find that the existence of life insurance opportunities for people is important in welfare terms while that of annuities is not.
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1. Introduction

One of the possible rationales for social security is market failure. A particular type of market failure is the absence of annuities, or insurance against surviving beyond a certain age. In the U.S. annuities are either very expensive or inexistent which may indicate that there is a market failure and social security provides benefits that are effectively annuities. The usefulness of social security as a provider of annuities has been explored in a variety of papers such as Abel (1986), Hubbard and Judd (1987), Imrohoroğlu et al. (1995), and Conesa and Krueger (1999), but always in a context that identifies agents with households or with individuals that have no concerns over others. In the environments postulated by these papers there is no rationale for insuring against dying too early (or life insurance as is known) just against living too long (annuities). Yet, the average adult holds up of $50,000 (in face value) of life insurance. We think that because life insurance and annuities are securities that insure the same event (even if with opposite signs) they should be studied in an environment that provides a role for both type of securities.

In this paper we revisit the issue of the usefulness of social security under a variety of market structures with respect to the existence of life insurance and annuities. What we bring to the table is that we do model households as families and not as individual agents which provides a rationale for the existence of life insurance and hence it provides for a much better modeling of the margins that may be of concern when facing death. Models where all households are single individuals are badly suited to answer questions about the possible role of social security as a substitute for market imperfections because they assume that all people would purchase annuities if available and this is just wrong. Most people purchase life insurance which makes it unlikely that they would also purchase annuities. Moreover, our model environment also allows us to incorporate altruism towards dependents, providing a unified picture of the various risks and considerations associated to the timing of death.

We use a two-sex OLG 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. Agents change their marital status as often as people do in the U.S. Our environment, that is placed in a model that replicates an aggregate (small open) economy, poses that 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. This paper uses the theory of multiperson households and the estimates in Hong and Ríos-Rull (2006) where agents in multiperson households have access to life insurance markets and where we estimated preference parameters that generate equilibrium patterns of life insurance holdings like those in the data. In that paper we looked at the effects of publicly provided life insurance, specifically the Survivors' Benefits portion of the U.S. social security system.[1] In this paper, we extend Hong and Ríos-Rull (2006) to incorporate alternative market structures with respect to the existence of securities contingent on the survival of individuals. We take the benchmark economy to be one with existence of life insurance and inexistence of annuities markets but where the assets of those that die and do not have survivors are rebated lump sum among survivors[2]—which we believe most closely resembles the U.S. economy; a *Pharaoh*

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[1]This structure has also been used in Hong (2005) to measure the value of nonmarket production over life cycle.
[2]This means that agents receive it *independently* of their savings.

economy with life insurance where the assets of the deceased without dependants disappears; an economy with access to both annuities and life insurance; and finally an economy where there are not markets for either life insurance or annuities.

We ask whether social security, because it has a role as provider of insurance against uncertain life span is welfare enhancing. To answer this question, we compare the allocations of the various economies that differ in the private provision of securities based on individual survival with and without a social security program and compare its allocations and compute a measure of welfare associated to the policy change. A second output of our work is to learn the value of completing markets by adding private annuities (and life insurance). This paper is the first to our knowledge that has addressed simultaneously the existence of annuities and of life insurance.

Our main finding is that social security's negative effect in terms of distortion of the intertemporal margin is much more quantitatively important than any positive role that it may have by providing a substitute for annuities and/or life insurance in economies where these markets do not exist. We also explore these issues in a world with people live longer and we find no differences in our answers.

We also find that life insurance is important in the sense that its absence reduces people's welfare. The existence or inexistence of annuities, however, does not generate wildly different allocations and their absence may even have good welfare implications. This seemingly surprising fact (after all annuities provide a larger set of options)[3] is due to the fact that there is an externality in giving in this model since it provides utility not only to the giver but also to the receiver, so some distortions that increase bequests may be welfare increasing, and to this extent social security by being an annuity contributes to reduce bequests.[4]

This paper proceeds under the assumption of a small open economy. The reasons are three: First, we are pushing the limits of computability (with the current specification we use a massive parallel machine with 26 processors running for days). Second, the negative effects of social security via lower capital and lower wages are well understood already. Third, the use of the small open economy assumption allows us to incorporate transition analysis that allow us to consider our numbers as appropriate measures of welfare. We take into account the initial distribution of bequests when doing the welfare analysis. This margin turned out to be quantitatively small.

Section 2 briefly describes the logic of how the presence or absence of life insurance and annuities shape the decision making of agents. Section 3 poses the model we use and describes it in detail. Section 4 describes and calibrates the model, that includes the current social security system and fairly priced life insurance but assumes the absence of annuities. Section 5 compares the performance of the benchmark model economy with the other market structures. In Section 6 we take away social security and compare allocations and assess the welfare implications of the policy. Section 7 revisits the welfare implications of social security policies under a higher longevity. Section 8 concludes.

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[3]Under incomplete markets a version of the welfare theorem does not hold, so a partial completion of markets need not improve matters in terms of welfare. For a recent discussion of this issue in growth models see Dávila et al. (2005).

[4]We thank the referee for this insight.

2. Decisions in the presence and absence of annuities and life insurance

In this section we briefly describe how decisions are affected by the presence or absence of annuities and of life insurance.

2.1. Annuities

Consider a single agent without dependents. With probability γ the agent may live another period. Its preferences are given by utility function $u(\cdot)$ if alive. If the agent is dead, its utility is zero. Under perfect annuity markets and zero interest rate, the agent could exchange γ units of the good today for one unit of the good tomorrow if survives getting zero otherwise. The problem of this agent is

$$\max_{c,s,c' \geqslant 0} \quad u(c) + \gamma u(c')$$
$$\text{s.t.} \quad c + q_1 s_1 + q_2 s_2 = y,$$
$$c' = s_1,$$

where c and c' are current and future consumption, y is its income and s_1 is the amount of goods purchased to be delivered if he survives and s_2 if it dies. The price of these assets is q_i. It is immediate to see that actuarially fair prices are given by $q_1 = \gamma$ and $q_2 = 1 - \gamma$ and that the optimal choice is that $c = c'$. A way to interpret this is to say that its savings have a rate of return of $1/\gamma$ if surviving. If the agent dies the annuity providing company keeps the savings. This allocation is Pareto optima as it has complete markets.

If there are no annuities the agent solves

$$\max_{c,s,c' \geqslant 0} \quad u(c) + \gamma u(c')$$
$$\text{s.t.} \quad c + s = y,$$
$$c' = s.$$

The first-order conditions of this problem imply now that $u_c(c) = \gamma u_c(c')$. With standard preferences, $c' < c$ and the savings disappear if the agent dies (many assumptions can be made to implement this).

We can see now how social security can help in the absence of annuities. Consider the following problem:

$$\max_{c,s,c' \geqslant 0} \quad u(c) + \gamma u(c')$$
$$\text{s.t.} \quad c + s = y(1 - \tau),$$
$$c' = s + Tr,$$
$$Tr = \frac{\tau y}{\gamma},$$

where τ is the social security tax rate and Tr is the transfer. The government collects social security at zero costs and redistributes it to the survivors. We can subsume the last three constraints into

$$c + c' = y + y\tau \frac{1 - \gamma}{\gamma}$$

and the right hand side is bigger than y. While the allocation that solves this problem is not Pareto optimal, it is better than that without annuities because the choice set is strictly larger. In this sense social security may help in the presence of annuities.

2.2. Life insurance and annuities

However, in the case of agents with dependents or with spouses, the presence of annuities may not be exploited because what the agent could want to do is to have more assets if it dies for the enjoyment of its survivors. 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

$$\max_{c,c',b \geqslant 0} \quad u(c) + \gamma u(c') + (1 - \gamma)\chi(b)$$

$$\text{s.t.} \quad c + q_1 s_1 + q_2 s_2 = y,$$
$$c' = s_1,$$
$$b = s_2.$$

Again, it is immediate to see that actuarially fair prices are given by $q_1 = \gamma$ and $q_2 = 1 - \gamma$ and that the optimal choices are given by $c = c'$ and by $u_c(c) = \chi_b(b)$. This allocation in general requires two assets to be implemented. Imagine that both life insurance and annuities are available. Then s_1 is the amount annuitized and s_2 is the amount of life insurance.

Imagine now that annuities are not available but an unconditional asset and life insurance are. Then if in the optimal complete market allocation $b > c'$ this can be implemented with an unconditional savings of c' and a life insurance purchase of $(b - c')$.

Consequently, the inexistence of annuities only matters in some circumstances: when the unconstrained choice of the asset contingent on the death of the agent is negative. And in those circumstances social security may help. A similar reasoning be used for married households is married, but we do not think it is necessary to discuss it here. We now turn to describe the model that we use.

3. The model

The economy is populated by overlapping generations of agents embedded into a standard neoclassical growth structure (although this is only the case in the benchmark model). At any point in time, its living agents are indexed by age, $i \in \{1, 2, \ldots, I\}$, sex, $g \in \{m, f\}$ (we also use g^* to denote the sex of the spouse if married), and marital status, $z \in \{S, M\} = \{n_o, n_w, d_o, d_w, w_o, w_w, 1_o, 1_w, 2_o, 2_w, \ldots, I_o, I_w\}$, which includes being single (never married, divorced, and widowed) with and without dependents and being married with and without dependents where the index denotes the age of the spouse. Agents are also indexed by the assets owned by 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 $\pi_{i,g}$. Denoting 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 of becoming of type z' next period is $\pi_{i,g}(z'|z)$. Assets vary both because of savings and because of changes in the composition of the household. Once a couple is married, all assets are shared, and agents do not keep any record of who brought which assets into the marriage. If a couple gets divorced, assets are divided. In the case of the early death of one spouse, the surviving spouse gets to keep all assets and to collect the life insurance death benefits of the deceased. We look at the steady states of these model economies. We next go over the details.

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 $\gamma_g^i = \prod_{j=1}^{i-1} \gamma_{j,g}$. 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:

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

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 who 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. Denoting 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:

$$v_{i,g,z}(a) = u_{i,g,z}(c) + \beta\gamma_{i,g}\mathrm{E}\{v_{i+1,g,z'}(a')|z\} + \beta(1 - \gamma_{i,g})\chi(a') \tag{2}$$

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 the decision-making process and the budget constraints, we have the following relation:

$$v_{i,g,j}(a) = u_{i,g,j}(c) + \beta\gamma_{i,g}\mathrm{E}\{v_{i+1,g,z'}(a')|z\} + \beta(1 - \gamma_{i,g})(1 - \gamma_{j,g^*})\chi(a')$$
$$+ \beta(1 - \gamma_{i,g})\gamma_{j,g^*}\mathrm{E}\{\Omega_{j+1,g^*,z'_{g^*}}(a'_{g^*})\}, \tag{3}$$

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

$$\Omega_{i,g,z}(a) = \hat{u}_{i,g,z}(c) + \beta\gamma_{i,g}\mathrm{E}\{\Omega_{i+1,g,z'}(a'|z)\} + \beta(1 - \gamma_{i,g})\chi(a'), \tag{4}$$

where $\hat{u}_{i,g,z}(c)$ 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.

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 death or survival of the agents. We assume that the life insurance and annuity industry operates at zero costs without cross-subsidization across age and sex.

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 benefit if they are eligible. The model also has Survivors' Benefits program so that widowed singles can choose between their own benefits and the benefit amount of the deceased. The budget constraint of singles can be written as follows:

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

$$T_{i,g,z,R} = \begin{cases} T_g & \text{if } i > R, \\ \max\{T_g, T_{g^*}\} & \text{if widowed}, \end{cases}$$

where y is saving, b_g is an amount of life insurance or annuities of single agent, R is the retirement age, and T_g, T_{g^*} are the amounts of social security benefits of herself and her spouse, respectively.

The budget constraint of couples is

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

$$T_{i,g,j,R} = \begin{cases} T_g & \text{if agent is eligible}, \\ T_{g^*} & \text{if only spouse is eligible}, \\ T_M & \text{if both are of retirement age}, \end{cases}$$

where b_{g^*} is life insurance/annuity of spouse, T_M is the amounts of social security benefits for two-person households. We assume that this is the only role of government, which 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 $\hat{a}$ from its new spouse is given by

$$\int_A 1_{y_{j,g^*,s_o}(a) \leqslant \hat{a}} \ \phi_{j,g^*,s_o}(da), \tag{5}$$

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

$$v_{i,g,z}(a) = \max_{c \geqslant 0, y \in A} \quad u_{i,g,z}(c) + \beta \gamma_{i,g} \mathrm{E}\{v_{i+1,g,z'}(a')|z\} \tag{6}$$

$$\text{s.t.} \quad c + y = (1 + r)a + (1 - \tau)w\varepsilon_{i,g,z} + T_{i,g,z,R}, \tag{7}$$

$$a' = \begin{cases} y + L_{i,g,z} & \text{if } z' \in \{n_o, n_w, d_o, d_w, w_o, w_w\}, \\ y + L_{i,g,z} + y_{z',g^*} & \text{if } z' \in \{1_o, 1_w, \ldots, I_o, I_w\}, \end{cases} \tag{8}$$

$$a' \geqslant 0. \tag{9}$$

Eq. (7) 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 Eq. (8), 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 dependent of same age, sex group. Second, if the agent marries, the assets associated with it also 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

$$v_{i,g,z}(a) = \max_{c \geqslant 0, b \geqslant 0, y \in A} \quad u_{i,g,z}(c) + \beta \gamma_{i,g} \mathrm{E}\{v_{i+1,g,z'}(a')|z\} + \beta(1 - \gamma_{i,g})\chi(y + b) \tag{10}$$

$$\text{s.t.} \quad c + y + (1 - \gamma_{i,g})b = (1 + r)a + (1 - \tau)w\varepsilon_{i,g,z} + T_{i,g,z,R}, \tag{11}$$

$$a' = \begin{cases} y & \text{if } z' \in \{n_o, n_w, d_o, d_w, w_o, w_w\}, \\ y + y_{z',g^*} & \text{if } z' \in \{1_o, 1_w, \ldots, I_o, I_w\}, \end{cases} \tag{12}$$

$$a' \geqslant 0, \tag{13}$$

$$y + b \geqslant 0. \tag{14}$$

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 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

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

$$+ \xi_{j,g^*,i}\beta\gamma_{j,g^*}\mathrm{E}\{v_{j+1,g^*,z'_{g^*}}(a'_{g^*})|i\} \tag{15}$$

$$\text{s.t.} \quad c + y + (1 - \gamma_{i,g})b_g + (1 - \gamma_{j,g^*})b_{g^*}$$

$$= (1 + r)a + (1 - \tau)w(\varepsilon_{i,g,j} + \varepsilon_{j,g^*,i}) + T_{i,g,j,R}, \tag{16}$$

$$\begin{aligned} a'_g = a'_{g^*} = y + L_{i,g,j} & \quad \text{if remain married } z' = j + 1, \\[4pt] a'_g = \psi_{i,g,j}(y + L_{i,g,j}) & \\ a'_{g^*} = \psi_{j,g^*,i}(y + L_{i,g,j}) & \quad \text{if divorced and no remarriage, } z' \in S, \\[4pt] a'_g = \psi_{i,g,j}(y + L_{i,g,j}) + y_{z'_g,g^*} & \\ a'_{g^*} = \psi_{j,g^*,i}(y + L_{i,g,j}) + y_{z'_{g^*},g} & \quad \text{if divorced and remarriage, } z' \in M, \\[4pt] a'_g = y + L_{i,g,j} + b^*_g & \\ a'_{g^*} = y + L_{i,g,j} + b_g & \quad \text{if widowed and no remarriage } z' \in S, \\[4pt] a'_g = y + L_{i,g,j} + b^*_g + y_{z'_g,g^*} & \\ a'_{g^*} = y + L_{i,g,j} + b_g + y_{z'_{g^*},g} & \quad \text{if widowed and remarriage, } z' \in M, \end{aligned} \tag{17}$$

$$a' \geqslant 0 \tag{18}$$

where $L_{i,g,j}$ is 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 life

insurance, depending on who dies. Eq. (17) 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 in the objective function:

$$
\max_{c \geqslant 0, b_g \geqslant 0, b_{g^*} \geqslant 0, y \in A} u_{i,g,j}(c) + \beta(1 - \gamma_{i,g})(1 - \gamma_{j,g^*})\chi(y + b_g + b_{g^*})
$$
$$
+ \xi_{i,g,j}\beta\{\gamma_{i,g}E\{v_{i+1,g,z'_g}(a'_g)|j\} + (1 - \gamma_{i,g})\gamma_{j,g^*}\Omega_{j+1,g^*,z'}(y + b_g)\}
$$
$$
+ \xi_{j,g^*,i}\beta\{\gamma_{j,g^*}E\{v_{j+1,g^*,z'_{g^*}}(a'_{g^*})|i\} + (1 - \gamma_{j,g^*})\gamma_{i,g}\Omega_{i+1,g,z'}(y + b^*_g)\}. \tag{19}
$$

The budget constraint is as in Eq. (16). The law of motion of assets is as in Eqs. (17) except that there is no lump sum rebate of the unclaimed assets. 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.

$$
\phi_{i+1,g,z'}(B) = \sum_{z \in Z} \pi_{i,g}(z'|z) \int_{a \in A} 1_{a'_{i,g,z}(a) \in B} \phi_{i,g,z}(da), \tag{20}
$$

where again 1 is the indicator function.
3. The government balances its budget, and dependents are born with the bequests chosen by their parents.

4. Quantitative specification of the model

Before we turn to calibrate the model, we specify some important details of demographics, preferences across the different types of households, some other features of marriages (assets partition upon divorce, decision making process, endowments of labor and relation to production). The justification for most of our choices is in Hong and Ríos-Rull (2006).

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%, 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.

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 set the risk aversion parameter to 3. We assume no altruism between the members of the couple. There are a variety of features that enrich the preference structure, that we list in order of simplicity of exposition and not necessarily of importance.

1. Marriage experiences. 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 marriage experiences to differ by sex but not by age. We write this as

$$u_{*,g,n_o}(c) = u(c), \quad u_{*,g,d_o}(c) = u_{*,g,w_o}(c) = u\left(\frac{c}{1 + \theta_{dw}^g}\right). \tag{21}$$

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

$$u_{*,g,m_o}(c) = u\left(\frac{c}{1 + \theta}\right), \tag{22}$$

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

$$u_{*,g,n_w}(c) = \kappa u\left(\frac{c}{1 + \theta^g\{\theta_c \#_c + \theta_a \#_a\}}\right), \tag{23}$$

$$u_{*,g,d_w}(c) = u_{*,g,w_w}(c) = \kappa u\left(\frac{c}{1 + \theta_{dw}^g + \theta^g\{\theta_c \#_c + \theta_a \#_a\}}\right), \tag{24}$$

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 $\{1, \theta_c/\theta^g, \theta_a/\theta^g\}$. 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

$$u_{*,g,m_w}(c) = \kappa u\left(\frac{c}{1 + \theta + \{\theta_c \#_c + \theta_a \#_a\}}\right). \tag{25}$$

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, $\chi(x) = \chi_a(x^{1-\chi_b})/(1-\chi_b)$. 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.

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 $(\psi_{\cdot,m,\cdot} = \psi_{\cdot,f,\cdot} = 0.5)$. 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. For married couples, we compute the average number of dependents based on the wife's age.

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 seven different marital statuses $\{M, n_o, n_w, d_o, d_w, w_o, w_w\}$. Single men with dependents have higher earnings than those 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.

The social security tax rate τ is set to be 11% to account for the fact that there is an annual limit of social security contribution. Agents are eligible to collect benefits starting at age 65. We use 1991 social security beneficiary data to compute average benefits per household. We break eligible households into three groups: single retired male workers, single retired female workers, and couples. Single females' benefit is 76% 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% 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% to get a reasonable consumption to output ratio.

We use the calibration of the model described in Hong and Ríos-Rull (2006) that estimates preference parameters that describe equivalence scales and other features so that the model economy replicates as close as possible the life insurance holdings of singles and

married, men and women in the data as well as the model economy delivering a wealth to earnings ratio of 3.3.

The model is estimated under the assumption that life insurance is generally available and its prices are exactly actuarially fair. The model also assumes the existing social security regime. The actual parameter estimates are shown in Table 1.

4.1. Market structures

We pose the following four economies with different market structure.

4.1.1. The benchmark: social security, no annuities and rebates and life insurance

In the benchmark market structure agents have access to life insurance but not to annuities. This means that agents can take only nonnegative life insurance $b \geqslant 0$. If death occurs to people with dependents, their remaining assets will be transferred to the newborns. In case of death of people without dependents, their unclaimed assets will be collected and rebated in lump sum transfer ($L_{i,g,z}$) to survivors of same age, sex, and marital status groups. There is a social security system run by a government who collects payroll taxes and transfers its benefits to the retirees.

4.1.2. The Pharaoh economy: social security, no annuities and no rebates and life insurance

Under the Pharaoh economy, we keep same market structure as in the benchmark economy with only one exception. We assume that the assets of the deceased without dependents are buried and disappear from the economy. Therefore, there are no rebates to survivors: $L_{i,g,z} = 0$.

4.1.3. Annuities: social security, annuities and life insurance

In this economy all possible contracts with regard to death of agents can be made. There are no complete contracts since changes in marital status due to divorce or to changes in the number of dependents cannot be insured. To implement this economy, we solve the model under the same parameterization that the benchmark economy, but we eliminate the constraint that $b \geqslant 0$. Recall that in an open economy the risk free interest rate and the wages are the same as in the benchmark model economy, as well as the social security policy.

4.1.4. No contingencies: social security, no annuities and rebates and no life insurance

In this economy there are no contingent claims available contingent on the death agents. In fact, there is only one asset in this economy, a risk-free asset. If death occurs to people without dependents, their assets are rebated to survivors in the same way as in the benchmark model. In this economy there is also social security.

4.2. Welfare comparisons

In small open economies typically one could consider the welfare effects of a policy on the first generation born after its introduction given that there are no price effects. This is not our case because a fraction of assets of previous generations is transferred as bequests. To make welfare comparisons across market structures and policies we do two calculations and report their consumption equivalence measures. One of them is among steady

Table 1
Parameter values estimated by Hong and Ríos-Rull (2006)

β	θ	θ_c	θ_a	θ_{dw}^m	θ_{dw}^f	θ^m	χ_a	χ_b	κ	ξ_m
.982	.07	2.39	.00	.00	2.19	1.19	0.40	6.02	1.00	.89

states, C^s. The other, that we prefer C^b imputes to a generation born under a new policy but with the bequests of the benchmark model economy with social security.[5]

We report consumption equivalent variation measures. That is, how much additional consumption is needed for a newborn in the baseline economy to be indifferent to be born in the other economies.

To calculate this we calculate both steady-state value which is defined by

$$W^s = \int v_{1,g,z}(a) \, d\mu_{1,g,z} \tag{26}$$

that is, the average value of the value function of age 1 agents, and the value of agents who are born at the time of change and that we write as

$$W^b = \int v_{1,g,z}(a^b) \, d\mu_{1,g,z}, \tag{27}$$

where a^b is initial asset of a newborn in the benchmark economy.

5. Economies with social security

We now turn to describe the main properties of the benchmark economy with social security, life insurance and no annuities where the assets of the dead without descendants are rebated lump sum to the survivors in Section 5.1. We then drop the assumption of the rebate and make the assets of the dead disappear in Section 5.2. We then turn in Section 5.3 to an economy where there is social security, life insurance and also annuities. Finally, we eliminate all claims contingent on death or survival in Section 5.4. All those economies have the same social security tax rates and revenues. Note that the small open economy assumption plus the pure labor nature of the tax automatically ensures that the proceeds of the policy are independent of market structure.

5.1. The benchmark economy: no annuities, rebates, and life insurance

The first column in Table 2 summarizes the most important aggregate steady state statistics of the benchmark model where output is normalized to 100. Aggregate life insurance face value is 129% of GDP. The wealth to earning ratio is its targeted value of 3.3 as well as the consumption to output ratio (81). The amount of social security is 7.8 and

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[5]Actually this is not the right measure of welfare yet, because during the transition the assets of prospective spouses are given by a mixture of the decision rules of one economy and the initial conditions of the other, but our calculations indicate that this is quite a small margin. In Table 2 we report another welfare measure ($\widehat{C}^b$) where we fix bequests as well as the asset distribution of prospective spouses as in the benchmark model.

Table 2
Comparison between market structures with social security

	Benchmark economy	Pharaoh economy	With annuities	Without contingent claims
Wealth	236.17	243.05	236.94	291.10
Consumption	81.19	80.56	81.31	83.27
Life insurance	129.06	134.75	122.66	0
Annuity	0	0	127.05	0
Output	100.00	100.85	100.10	106.78
Bequest	0.85	0.87	0.79	0.88
Assets that disappear	–	0.81	–	–
Earnings	70.85	70.85	70.85	70.85
Social security tax	7.78	7.78	7.78	7.78
Survivors' Benefits	0.32	0.32	0.32	0.32
Consumption equivalence C^s		0.021%	−0.037%	−0.707%
Consumption equivalence C^b		0.014%	−0.007%	−0.721%
Consumption equivalence $\widehat{C}^b$		−0.002%	0.001%	−0.843%

there is no deficit in the system. We also see that bequests (including life insurance) in the economy amount to 0.85% of output.

Fig. 1, transcribed from Hong and Ríos-Rull (2006), compares life insurance holdings by age, sex, and marital status from the benchmark model with data to get an idea of the goodness of fit. While the profile of life insurance holding from model cannot perfectly match to the actual data, it captures most of the patterns of the data.[6]

5.2. The Pharaoh economy: social security, life insurance, no annuities, no rebates

The second column of Table 2 reports the properties of the Pharaoh economy. Agents save more and consume less, but they purchase a lot more life insurance. The welfare costs of the asset destruction are not very large because there is not a large difference between the amount of voluntary and the amount of involuntary bequests.

5.3. The economy with social security, life insurance and annuities

It turns out that in the economy with annuities it is middle-age married women who use annuities the most. Women outlive men, which implies that women have an incentive to

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[6]Fig. 1 shows that the model predicts too much life insurance for single women over age 50 and too little insurance for single men over age 50. Even in Hong (2005) that addresses explicitly home production has this pattern (although it can yield a better fit for women). So there must be something else other than home production which has not been included in the model. Recall that life insurance of singles comes solely from their bequest motive and that we specify our bequest function $\chi(a)$ to be independent of age and gender. A possible way to improve the fit is to have age, and sex dependent bequest motives with younger women having a stronger bequest motive than older women while the opposite occurs for men. We leave the exploration of this issue for future work.
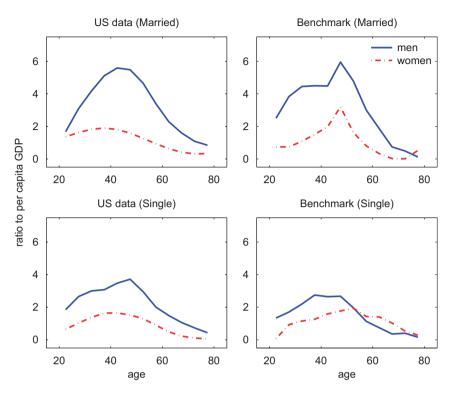
Fig. 1. Life insurance holdings by age, sex, and marital status in benchmark economy.

save more than men. Moreover, according to our utility specification, women have a stronger marriage experience motive than men and, therefore, married women want both to hold life insurance against their husband's life and annuities for themselves. Fig. 2 depicts the life insurance and annuity holdings of this economy. Note that the annuity holdings of married women drop significantly at retirement when social security starts providing its annuity benefits.

The aggregate statistics of this model economy are in the third column of Table 2. We see that the existence of annuities increases wealth by .3% (recall that the rate of return of assets is higher). The existence of annuities prevents involuntary bequests which reduces their size. Consumption is a little bit higher.

Agents held a little bit less life insurance in this economy. The face value of life insurance in the two economies is very similar: 129 in the benchmark vs. 123 in the annuity economy. Self-insured people who did not need life insurance in the benchmark economy might want to hold annuities now.

A very interesting property of this economy is that markets are more complete than in the baseline yet the welfare seems to be smaller.[7] The reason for this as the referee astutely

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[7]We say seems to be because none of our measures are exactly welfare measures, and one of them has (barely) the opposite sign.
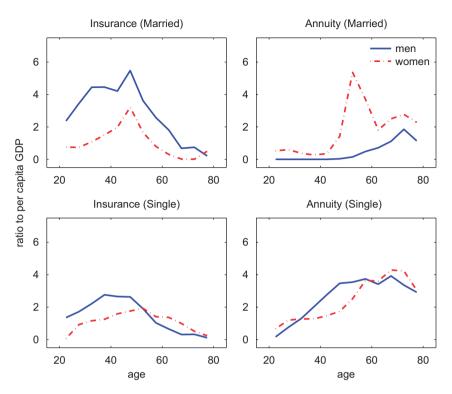
Fig. 2. Life insurance and annuity holdings by age, sex, and marital status.

pointed out lies in the externality that is implicit in a bequest: it provides utility to the giver and that is why she chooses it, yet it also provides utility to the receiver. The existence of annuities reduces in a sizable amount of (involuntary) bequests as people can insure against living too long.

5.4. Economy with social security and without annuities and life insurance

The fourth column of Table 2 displays the main statistics of a model economy with the same parameterization as the benchmark but where there are no annuities or life insurance opportunities. The differences with the previous two economies are very large. Since agents do not have access to life insurance, they make up for it by increasing their savings. Here the amount of assets accumulated is 23% higher than in the benchmark economy where life insurance is available. As a consequence, the level of National Income is 7% higher than in the benchmark. A higher level of economy-wide assets is achieved by increasing savings throughout the lifetime, especially when young. All bequests are slightly higher than in the previous economy due to the large amounts of wealth held.

The lack of life insurance seriously hampers the ability of people to cover against early death in the families and the welfare losses are quite large both if we do adjust for different amounts of bequests or not.

6. Economies without social security

We now proceed to look at the properties of the economies without social security under different market structures. Like in previous sections, we first take away social security in the benchmark economy and then move to the Pharaoh economy, to the economy with annuities and we finish with the economy without contingent markets of any sort.

Recall that social security induces various types of effects in our context: first the standard effect (reduces income early in life and returns later an amount smaller than the capitalized tax) that acts as a deterrent to savings which is the standard distortion analyzed in the literature; second, social security provides an implicit annuity to a single beneficiary, since it is only paid if alive; finally, there is a partial life insurance component in the form of Survivor's Benefits.

The benchmark: *no annuity markets*: Tables 3 shows the allocations of various economies differing in their market structure without social security and compares them with their counterparts with social security. First, we note the massive increase in asset holdings when social security is inexistent which is the standard effect found everywhere in the literature. The increase in assets is 61%. As a consequence, consumption goes up 8%. The total amount of life insurance does not change much but given that the increase in assets is 61% this is like a decrease (it went from 55% of assets to 34%). Why is this? According to the estimates in Hong and Ríos-Rull (2006) two-person married households do not want to consume an amount that is very different from what they would consume if one spouse becomes a widow, and as a consequence, eliminating social security reduces future income in the case of the death of the beneficiary because Survivors' Benefits are small and they reduce the total amount paid to the household. The response of the household is to reduce drastically its life insurance purchases when reaching retirement age, as Fig. 3 shows. Bequests are higher than in the benchmark with social security, they are up 27% higher. The reason why the increase is less than proportional relative to wealth is that the life cycle component of asset accumulation is present at the same time as higher endowment which is the only thing that affects bequests.

The welfare effects are huge. To achieve the same utility, a newborn in the benchmark economy with social security needs an additional 12.27% of consumption per period to be indifferent between the two systems. This number is 12.39% in a steady state comparison.

The Pharaoh economy: *no rebates*: The effects are very similar to the benchmark for essentially the same reasons as the increase in bequests is quite small. If anything the absence of rebates to the survivors makes social security look like a worse policy.

The economy with annuity markets and without social security: As we have said social security provides an implicit annuity to all agents and its Survivor's Benefits program produces a limited amount of life insurance for married people. Eliminating social security in an economy that has access to annuities and to life insurance implies that these mechanisms take up the slack. Fig. 4 shows the life insurance and annuity holdings in the economies with and without social security. Without social security the annuities are much larger, particularly for women and for singles. Privately provided contingent claims substitute the social security program effectively.

The differences between the removal of social security in the benchmark economy and in this economy provide the main insight to answer the role of social security as a provider of annuities. In this economy, the elimination of social security also increases dramatically the stock of wealth but less so than in the benchmark economy. The difference, which amounts

Table 3
Getting rid of social security (Social security counterparts in parentheses)

	Benchmark economy	Pharaoh economy	With annuities	Without contingent claims
Wealth	380.31	396.30	370.55	426.56
	(236.17)	(243.05)	(236.94)	(291.10)
Earnings	70.85	70.85	70.85	70.85
	(70.85)	(70.85)	(70.85)	(70.85)
Consumption	87.31	86.37	87.11	89.05
	(81.19)	(80.56)	(81.31)	(83.27)
Life insurance	130.65	133.87	125.22	0
	(129.06)	(134.75)	(122.66)	(0)
Annuity	0	0	225.97	0
	(0)	(0)	(127.05)	(0)
Social security tax	0	0	0	0
	(7.78)	(7.78)	(7.78)	(7.78)
Survivors' Benefits	0	0	0	0
	(0.32)	(0.32)	(0.32)	(0.32)
Output	117.79	119.77	116.59	123.50
	(100.00)	(100.85)	(100.10)	(106.78)
Bequest	1.08	1.12	0.81	1.12
	(0.85)	(0.87)	(0.79)	(0.88)
Assets that disappear	–	1.40	–	–
	(–)	(0.81)	(–)	(–)
Consumption equivalence C^s	12.387%	12.492%	12.249%	11.813%
Consumption equivalence C^b	12.267%	12.364%	12.235%	11.692%

to 10% of output in the baseline is due to the implicit effect of annuities that social security provides. In an economy with annuities the elimination of social security increases the wealth stock for the standard reasons while in the benchmark it increases the stock of wealth both for the standard reasons and for the need of substitute the annuities. The welfare numbers confirm this notion. The elimination of social security implies an enormous increase in welfare for the newborns in the benchmark economy and a slightly smaller, but still huge, increase in the welfare of the newborn in the economy with annuities.

Overall, then we see that this role of social security as a provider of annuities while positive, is not very quantitatively important and cannot be used to justify such a policy.

The economy without contingent markets and without social security: Table 3 also displays the effects of getting rid of social security in an environment without any type of contingent claim. This is the economy where social security has the best chance to be useful since the private sector does not provide contingent markets while the policy does in some form. Recall that social security also provides a form of life insurance via its Survivors' Benefits program. Consistently with this notion, the benefits of eliminating social security are lower than in the other economies, but not that much lower and such an elimination produces a huge welfare gain. A newborn in the no contingency world with social security
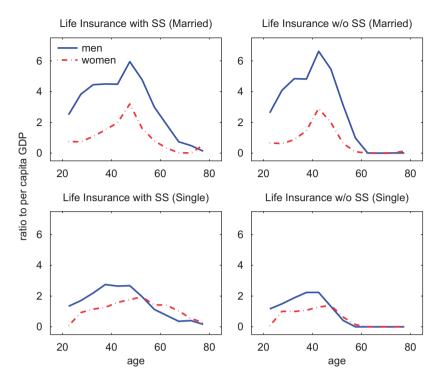
Fig. 3. Life insurance holdings by age, sex, and marital status in the benchmark economies.

needs additional 11.7% of her consumption to be indifferent to the world without social security. These findings are in line with those of Hong and Ríos-Rull (2006) in their exploration of the Survivor's Benefits program.

7. Increased longevity

In this section we evaluate the policies that we have studied above under a scenario where population ages much more due to longer longevity. Throughout this section, we maintain the same social security tax rate of 11% that we used above so that we isolate the effects of a change in population structure under the current policy. We look at two different demographic patterns. First, we increase life expectancy of women by 5 years while men's longevity stays the same. Next, we explore a situation in which both men and women live longer where life expectancy is prolonged by 5 years.

Under both scenarios, there are more elderly people eligible for social security benefits which requires a reduction in the social security benefits to satisfy the government budget constraint. The reduction in benefits implies smaller income after retirement without changes in current income. Therefore people save more. Table 4 shows that the wealth to earnings ratio is now 4.0 when both live longer and 3.5 when women live longer; rather than the 3.3 of our benchmark economy.

Men and women live longer: Fig. 5 shows that with higher life expectancy of both men and women, life insurance holdings drop regardless of sex, and marital status. When both
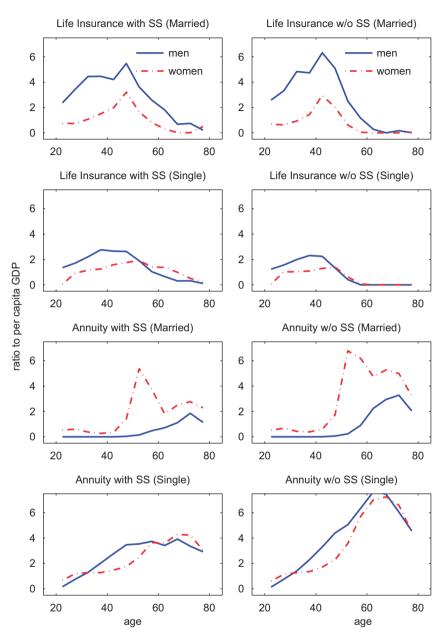
Fig. 4. Life insurance and annuity holdings in annuity economies.

men and women live longer survivor benefits do not play a big role. The size of Survivors' Benefits is now only .17% of national income and 2% of total social security program. This is because couples are more likely to live longer together and the size of the benefits has been squeezed out by the larger social security payments.

Table 4
Economies with increased longevity

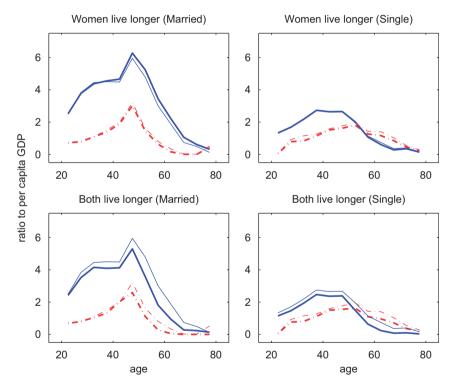|	Benchmark	Both live longer	Women live longer
Wealth	236.17	268.07	245.29
Earnings	70.85	66.91	69.72
Consumption	81.19	78.44	80.51
Life insurance	129.06	105.31	129.57
Social security tax	7.78	7.35	7.66
Survivors' Benefits	0.32	0.17	0.35
Output	100.00	100.00	100.00
Bequest	0.85	0.78	0.73

Fig. 5. Life insurance holdings with increased longevity (thin line: benchmark population).

Women live longer: Fig. 5 shows that life insurance purchase pattern changes differently by sex, and marital status when women live longer. Married men and single women increase their insurance holdings. The expected duration of widowhood is now longer and married couples respond by purchasing more life insurance against the death of the husband. While married men increase their life insurance holdings, the purchases of single men change very little. Life insurance holdings of women drop regardless of their marital

status. Survivor's Benefits play a similar role as the life insurance of married men. The size of this program is .35% of national income, about 4.5% of total social security program.

8. Conclusion

One of possible rationales for the existence of social security is market failure, in particular the absence of annuities. In this paper we have argued that the usefulness of social security should be looked at in the context of models that treat explicitly families as different to individual agents because annuities, life insurance, and social security are related to the risks associated to the timing of people's death.

We have used an OLG model of multiperson households where agents may change their marital status through marriage, divorce, and death of spouses. We have calibrated the model to match the pattern of life insurance holdings in the U.S. as well as key statistics of the aggregate U.S. economy and we have used our model to understand the role of annuities markets and the welfare implication of current social security system.

We have find that the existence of life insurance is important in enhancing welfare of agents while the existence of annuities does not improve welfare when there is strong bequest motive due to the externality implied by bequests. We have also confirm that social security acts as a deterrent to savings and that it lowers welfare. Last but not least, we have found that while social security plays some role as a provider of annuities (and also life insurance) such a beneficial role is much smaller than the pernicious effect that imposes on the savings decision for the standard reasons of affecting the incentives and not being actuarially fair and, consequently, the provision of annuities cannot be used as a justification of the program.

References

Abel, A.B., 1986. Capital accumulation and uncertain lifetimes with adverse selection. Econometrica 54 (5), 1079–1098.

Conesa, J.C., Krueger, D., 1999. Social security reform with heterogeneous agents. Review of Economic Dynamics 2 (4), 757–795.

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

Dávila, J., Hong, J.H., Krusell, P., Ríos-Rull, J.-V., 2005. Constrained efficiency in the neoclassical growth model with uninsurable idiosyncratic shocks. Unpublished Manuscript, CAERP.

Hong, J.H., 2005. Life insurance and the value of spouses: labor supply vs. household production. Unpublished Manuscript, University of Pennsylvania.

Hong, J.H., Ríos-Rull, J.-V., 2006. Life insurance and household consumption. Unpublished Manuscript, University of Pennsylvania.

Hubbard, R.G., Judd, K.L., 1987. Social security and individual welfare: precautionary saving, borrowing constraints, and the payroll tax. American Economic Review 77 (4), 630–646.

Imrohoroğlu, A., Imrohoroğlu, S., Joines, D., 1995. A life cycle analysis of social security. Economic Theory 6 (1), 83–114.