How Family Status and Social Security Claiming Options Shape Optimal Life Cycle Portfolios

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Abstract

This paper investigates how demographic shocks – marriage, divorce, widowhood, and children – along with complex financial options arising from Social Security benefit claiming rules affect optimal household decisions about saving, asset allocation, insurance, and work patterns. In line with empirical evidence, the model predicts stable equity fractions and earlier claiming by wives versus husbands and single women; life insurance is mainly purchased by men. Policy simulations show that Social Security benefit changes will alter work more than financial outcomes.

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1. Introduction

Two crucial factors drive households' optimal life cycle saving and investment decisions: labor market work and family status. This is because decisions about hours of work as well as retirement shape labor earnings, which in turn influence how people spend, save, invest, and build up retirement benefits through the Social Security system. Not only are wages uncertain, but so too is family status due to marriage/divorce, the arrival/departure of children, and spousal death. Each of these poses risks to the household's financial position: for instance, the arrival of children changes both household spending and saving patterns due to higher consumption needs, college costs, and child support in the case of marital dissolution (Love, 2010). Not only do children influence finances directly; they also change the amount of time that household members, especially mothers, can work to earn income essential to build up financial assets (Kimmel and Connelly, 2007).

Also central to life cycle decisions is the role of the Social Security system. In the United States, this is a national mandatory deferred life annuity scheme with complex claiming options and cash-flow patterns that depend on age, work history, and family status. Social Security is especially crucial because it represents such a large component of household assets. For example, the median Baby Boomer household on the verge of retirement has accumulated $600,000, of which 40 percent is comprised of Social Security wealth; the remainder is divided evenly between home equity, non-pension financial assets, and pension wealth.[1] The risk and return profile of the Social Security asset should therefore have important consequences for how households manage their financial wealth, both during their worklives and in retirement. Moreover, it is increasingly becoming clear that *when* to exercise the option to claim Social Security benefits is one of the most crucial and complex financial decisions facing workers. For example, claiming benefits at age 70 instead of age 62 boosts lifelong payments by 76 percent (Myers, 1985). Also the financial decision of when to claim Social Security benefits is different from, although related to, the decision about when to leave the labor force (c.f., Coile et al., 2002). For example, workers can retire early at age 62, delay claiming until age 70 to earn higher deferred benefits, and draw down financial

[1] This measure (in $2010) includes financial assets, home equity, business and pension assets, and Social Security benefits, and it nets out financial and mortgage debt (see Gustman et al., 2010).

assets to maintain consumption. Or they could claim at the earliest possible age, 62, by accepting lower benefits but continuing to work, and concurrently receive income from work and Social Security benefits.

The Social Security system also includes a complex set of rules regarding family benefits that shape optimal financial wealth and claiming patterns. For instance, couples build up entitlements to their own old age retirement benefits over their worklives, along with spousal and widow(er) benefits that depend on the partners' work histories. Moreover, Social Security rules permit individuals to first claim old age benefits on their own work records, and later switch to spousal/widow benefits. In other words, the decision about when to claim benefits depends intimately on family status; in turn, the claiming age has a large effect on payouts to spouses and survivors. For these reasons, family benefits can have a pronounced effect on saving and investment decisions including the demand for risky stocks and life insurance products. Accordingly, theoretical analysis of the claiming dynamics and the influence of Social Security benefits on financial wealth management requires examining a full household optimization framework over the complete life cycle, jointly modeling work, saving, investment, and claiming decisions. Until now, such a rich and detailed model has not been available in the literature.

The present paper is the first to incorporate all of these key elements of the household life cycle – Social Security benefits and family dynamics including children – in a realistically-calibrated portfolio and consumption choice life cycle model in discrete time with forward-looking rational multi-person households. We allow for risky asset returns as well as uncertainty in family status, mortality, labor income, and retirement income. Using data from the Panel Study of Income Dynamics (PSID), we calibrate wage rate dynamics by age, sex, education, and family status. In addition, we calibrate the impact of child care needs on household time using the American Time Use Survey (ATUS). We track individual work histories for each person separately, and we realistically model Social Security benefits with spousal and survivor benefits as well as delayed claiming options. In this environment, people make decisions about saving, investment (stocks/bonds/life insurance products), work hours, and benefit claiming.

We show that family status has a powerful impact on investment and claiming decisions. Couples with children invest less in risky assets and purchase much more life insurance than childless couples or singles. Also, married women claim their own Social Security benefits much earlier than single women, while married men claim much later. Interestingly, children have little impact on claiming decisions. These predictions from our theoretical model are consistent with empirical evidence in the Health and Retirement Study (HRS). Policy simulations confirm that changing Social Security benefits can have a strong influence on household wealth management and work patterns. For instance, eliminating survivor benefits would substantially increase women's claiming ages, by 4 years on average, while men would claim a year earlier. It would also lead to much higher life insurance demand for men, with few consequences for household allocations to risky stocks.

Our research builds on and extends the literature initiated by Merton (1969) on life cycle consumption and portfolio choice models. Recent research has sought to make those models more realistic by introducing new sources of risk,[2] important non-financial assets,[3] and endogeneity of labor supply or retirement ages.[4] Nevertheless, most of these took the perspective of an individual representative agent, rather than examining the possibly differing perspectives of households of varying sizes and compositions. Love's (2010) work is an important and invaluable exception, as his was the first model[5] to incorporate the effect of family and marital status risk on portfolio and saving choice. Drawing on PSID data and the Urban Institute's Model of Income in the Near Term (MINT), he fitted family transition probabilities, housing cost processes, and labor income paths that depended on age, sex, marital status, and children. His main results were that children lead to less accumulation of financial assets when living at home, and households with children have substantially higher demand for term life insurance than singles. Nevertheless, that important study was silent on the likely impact of endogenous labor supply and retirement age on optimal household patterns, taking account of Social Security rules. By contrast, our more realistic formulation of Social Security benefit options departs rather dramatically from prior work which assumes that retirement benefits are simply a fixed fraction of labor earnings as of a pre-specified date. And our more general approach also permits us to evaluate potential policy reforms including changes in Social Security rules.

Other papers related to ours in the household finance literature include Shoven and Slavov (2012) and Coile et al. (2002), both of which explored benefit claiming options under U.S. Social Security system rules. Using a structural estimation model, Gustman and Steinmeier (2005) analyzed how retirement and claiming patterns responded to Social

[2] For example, non-tradable risk labor income by Viceira (2001) and Cocco et al. (2005), interest rate risk by Campbell and Viceira (2001), health risk by French (2005), and risk on housing expenditures by Gomes and Michaelides (2005).
[3] For example, housing wealth by Cocco (2005), life annuities by Horneff et al. (2008) and Inkmann et al. (2011).
[4] See Bodie et al. (1992), Farhi and Panageas (2007), Gomes at al. (2008), and Chai et al. (2011).
[5] Earlier work by Scholz et al. (2006, 2007) explored the impact of children on wealth accumulations within a life cycle framework, but it assumed exogenous labor supply/retirement dates and excluded portfolio choice decisions.

Security incentives. Yet those studies did not integrate the portfolio choice problem within a household lifetime optimization framework. Hubener et al. (2013) developed a multi-person portfolio choice model, allowing for investments in risky stocks, annuities, and life insurance purchases. Once again, however, that paper focused on retired couples and said nothing about the work life issue; it also included a simple Social Security benefit rule rather than the more realistic one we examine here.

In what follows, Section 2 develops the structure of the life cycle portfolio choice model for households with uncertain family status, time budget constraints that depend on the arrival and presence of children of various ages, and realistic Social Security benefit options. Section 3 presents the parameter calibration, most importantly the impact of children on available time for work and the dynamics of uncertain wage rates. In Section 4, we discuss the main findings from the model simulations and compare our model predictions about claiming with empirical evidence from HRS data. Section 5 explores possible policy reforms like changes in benefit structures under Social Security rules. A final Section concludes and summarizes results.

2. The Life Cycle Optimization Model

In our model, agents face the risk of exogenous family transitions throughout their working lives and into retirement. In the following, x (y) denotes a woman (man). Time $t = (0, \dots, T)$ is measured in years. At time $t = 0$ (assuming age 20 for women and 24 for men), the individual starts working life as either single or married; we assume that the four-year age difference between spouses is fixed over the life cycle. Each individual has an uncertain life span and may live for a maximum of $T = 80$ years.

2.1 Family dynamics

The state variable family s_t is modeled at each point in time as a Markov chain with 35 discrete states. Before retirement, the possible family states are never married, married couple, divorced, and widowed. We further differentiate each of these states for the woman and man. In addition, a household can have between zero and three children. We do not distinguish between never married, divorced, and widowed single retirees. Possible retirement states for couples include only the wife being retired, only the husband being retired, and both spouses being retired. When modeling spousal benefits, it is also necessary to differentiate these states with respect to the age when the husband claimed his own retirement benefits (see section 2.5). A complete list of all possible family states is given in Appendix A.

The time-dependent transition matrix $\Pi_{ij,t} = Prob(\, s_t = i \mid s_{t+1} = j \,)$ for this Markov chain is influenced by five factors: mortality, marriage, divorce, fertility, and children leaving the household. We abstract from multiple births and divorces during retirement. We only allow married couples to receive children, and we treat three or more children as the same family state.[6] In the case of a divorce, children are assumed to stay with their mothers.[7] At the end of our projection horizon T (age 100 for women and 104 for men), we set the survival probability to zero. In the following, we describe the model for couples and refer to the single case only when it is not a straightforward simplification of ignoring the absent partner.

2.2 Financial products

Individuals may select from three different financial products to manage their liquid wealth: riskless bonds, risky stocks, and term life insurance. Bonds are characterized by a constant annual real gross rate of return R_0. The distribution of the stock return R_t is assumed to be lognormal and serially independent.

Each period the individual $i \in \{x, y\}$ may purchase a one-year term life insurance contract. If the insured person dies within the period $[t, t+1)$, any surviving spouse or children receive the face value L_t^i at time $t+1$. If the insured person survives, no payments are distributed, since no cash value is built up by the insurance contract. According to the actuarial principle of equivalence, the premium LP_t^i charged by the insurance company equals the present value of the expected payout plus some expense loadings δ_t^i, which is given by

$$LP_t^i = (1 + \delta_t^i) \cdot \left(1 - p_t^i\right) \cdot \frac{L_t^i}{R_0} \,. \qquad (1)$$

Here p_t^i denotes the probability from a mortality table that individual i conditional on being alive at time t survives to time $t+1$. The (age-dependent) loading factor δ_t^i reflects expenses covered by the insurance company for administration and to control for adverse selection.[8]

2.3 Time budget

Each individual has an available time budget Θ. Depending on family status and age, a certain amount of time must be spent on child care $\theta_{s,t}^i$. Before retirement, the worker can decide how much of his available time he will spend in the paid labor market τ_t^i to generate

[6] This limits computational effort. Moreover, the marginal effects of an additional child regarding consumption scaling or child care time decrease with the number of children.

[7] The different number of children for a divorced husband matters only for child support payments and affects the possible family states to which he may switch.

[8] Modeling life insurance as multi-year contracts would require at least one more state variable for each additional spouse, which would make the model intractable. See Hubener et al. (2013) for a discussion of how single period life insurance contracts can substitute for longer-running contracts.

labor income. Working for pay inflicts (unpaid) commuting time $\tau_{\text{t, trav}}^{i}$. Time remaining is utility-increasing leisure l_t^i. Accordingly, the time budget equation is given as follows:

$$\Theta = \theta_{s,t}^{i} + \tau_t^i + \tau_{\text{t, trav}}^{i} + l_t^i \qquad (2)$$

2.4 Labor income

Depending on the time devoted to paid work τ_t^i, each agent earns uncertain labor income specified as follows:

$$Y_t^i = \tau_t^i \cdot w_{s,t}^i \cdot P_t \cdot \varepsilon_t, \qquad (3)$$

Here $w_{s,t}^i$ denotes the wage rate which depends on sex, age, and family status. The variable ε_t is an independent identically lognormal distributed transitory income shock with mean of one, and P_t is the permanent component of the wage rate with lognormal shock η_t evolving according to:

$$P_{t+1} = P_t \cdot \eta_t \qquad (4)$$

Note that, in the case of a couple, the transitory shock as well as the permanent income component is assumed to affect both spouses identically or, equivalently, both transitory and permanent shocks are perfectly correlated across partners.[9] The permanent income component P_t (and its shock η_t) have a mean of one, such that $w_{s,t}^i$ is the average wage for the given combination of sex, age, and family state.

2.5 Retirement income

From age 62 onward, each spouse has the possibility of claiming Social Security retirement benefits, up to age 70 when claiming becomes mandatory. The retirement income payable to the individual is equal to his Primary Insurance Amount (PIA), which is based on lifetime earnings with adjustment for early or delayed benefit claiming. The Social Security retirement benefit is given by:

$$Y_t^{i,\text{ret}} = PIA_t^i \cdot \lambda^i \cdot \varepsilon_t^{\text{ret}} \qquad (5)$$

with λ^i being the adjustment factor for early claiming reduction or delayed retirement credit (relative to the Full Retirement Age), and $\varepsilon_t^{\text{ret}}$ is a lognormal transitory shock with a mean of one.

[9] The modeling of different income shocks requires one additional state variable which increases the computational burden of solving the model.

In accordance with U.S. practice, the PIA is based on the individual's earnings history. Using a concave piece-wise linear function, the PIA is computed from the Average Indexed Monthly Earnings (AIME), which is the worker's average monthly labor earnings over his (wage-appreciation adjusted) best 35 years. To keep the model tractable, we use the PIAs for each spouse as state variables. To be precise, the state variable after claiming is the benefit amount, which is the product $PIA_t^i \cdot \lambda^i$ of the PIA and the adjustment factor for early claiming reduction or delayed retirement credit. Hence we need not treat the claiming age as a different state variable.[10] Further details on how the PIAs are used as state variables can be found in Appendix C.

After claiming retirement benefits, individuals still have the opportunity to continue working until age 70. If they do, they are taxed at a rate of 50 cents per dollar earned above the exempt amount of the retirement earnings test, consistent with the U.S. Social Security rules.[11]

After both partners have claimed their retirement benefits, the partner with the lower retirement income may elect to receive spousal benefits instead of his own benefits. These amount to 50% of the partner's benefits, unless the spousal benefits are claimed before reaching Full Retirement Age, whereupon a permanent reduction of up to 30% applies. In contrast to own retirement benefits, claiming spousal benefits after the Full Retirement Age is not incentivized with an increase of lifelong payments. Since tracking the claiming age for spousal benefits requires an additional state variable, our model framework only allows for claiming spousal benefits at the Full Retirement Age.[12] After this age, a partner receives spousal benefits, if these exceed the own already-claimed old age retirement benefits. Another rule is that if one partner claims after his Full Retirement Age, the delayed retirement credit only increases his own benefits, but not his partner's spousal benefits. In order to exclude the delayed retirement credit for spousal benefits, we use separate retirement states for different claiming ages of the husband.[13]

When a spouse passes away, the surviving spouse may switch to widow(er) benefits. These are equal to 100% of the deceased spouse's benefits. In our model, this is not an active decision; instead, these benefits are automatically paid if the widow(er) benefits are higher. If

[10] For a couple, there are 81 possible combinations.
[11] Survey evidence shows that most people do understand Social Security benefits are reduced by the earnings test, but most are unaware that their benefits foregone are paid back after the Full Retirement Age; see Brown et al. (2013). Nevertheless, this has been true only since the year 2000.
[12] If the spousal benefits exceed the wife's own benefits at the Full Retirement Age, but she would like to receive benefits from age 62 onwards, she can claim her own benefits at this age, and switch to her spousal benefits four years later. In this way, she can avoid a permanent benefit reduction.
[13] Our results suggest that this differentiation is only necessary for husbands, since their retirement benefits are never less than half their wives' benefits.

retirement benefits have not yet been claimed, the PIA of the surviving spouse is substituted in place of the PIA of the deceased spouse. Accordingly, we need not track whether the widow(er)'s PIA results from own work history or that of a deceased spouse.

This quite realistic formulation of Social Security benefit options differs from and extends substantially the typical approach taken in prior portfolio choice life cycle studies. That is, the usual approach until now has been to assume that the worker's retirement benefit is given by a fixed proportion of his last labor income as of a prespecified date.[14] Moreover, prior studies have not modeled spousal or survivor payments, ignoring the possibility that one spouse can claim first on her own account, and later switch to alternative benefit payment streams.

2.6 Wealth dynamics

Besides determining how much time to spend working, each period the household must also decide how much of its liquid wealth (W_t) to spend on consumption (C_t), life insurance premiums for (LP_t^x, LP_t^y) for the wife (husband) x (y), and how to allocate savings to bonds B_t and stocks S_t. The household is liquidity-constrained so it cannot borrow to finance consumption and life insurance purchases:

$$W_t = C_t + LP_t^x + LP_t^y + B_t + S_t \tag{6}$$

$$LP_t^x \geq 0 \quad LP_t^y \geq 0 \quad S_t \geq 0 \quad B_t \geq 0 \tag{7}$$

Next period's liquid wealth is given by any remaining wealth including capital market returns, labor income (Y_t^i), and Social Security benefits ($Y_t^{i,\text{ret}}$), less income taxes according to proportional rates ϑ_{labor} and ϑ_{ret} and housing expenses $h_{s,t}$:

$$\begin{aligned} W_{t+1} = {} & S_t \cdot R_{t+1} + B_t \cdot R_0 + (1 - \mathbb{I}_{t+1}^x)\, L_t^x + \left(1 - \mathbb{I}_{t+1}^y\right) L_t^y \\ & + \left(\left(Y_t^x + Y_t^y\right) \cdot (1 - \vartheta_{\text{labor}}) + \left(Y_t^{x,\text{ret}} + Y_t^{y,\text{ret}}\right) \cdot (1 - \vartheta_{\text{ret}})\right) \cdot \left(1 - h_{s,t}\right) \end{aligned} \tag{8}$$

The indicator variables $\mathbb{I}_t^x$ and $\mathbb{I}_t^y$ are equal to one if the corresponding spouse is alive at time t and zero otherwise. Other cash flows might result due to family state transitions. If one of the spouses i dies, the remaining spouse j receives the payment from the life insurance contract L_t^i. If a child leaves the household, we assume the parents must pay college fees (here designed as a lump sum). Furthermore, a divorced woman with children receives child

[14] See for instance Cocco et al. (2005) and Love (2010). Chai et al. (2011) do incorporate a flexible retirement age and a delayed retirement credit, but their study does not track lifetime earnings. Also it takes the perspective of a single representative worker instead of a multi-person household with uncertain family status, as here.

support payments, while a divorced husband with children must devote a certain fraction of his income for child support.

2.7 Preferences and optimization

We posit that the household has a time-additive utility function with constant relative risk aversion γ, so utility derives from a composite good consisting of consumption C_t and effective leisure l_t. Depending on the number of adults and children present in the household, total consumption is normalized by a scaling factor ϕ_s (see Love, 2010 and Hubener et al., 2013). For a single adult, effective leisure is identical to time devoted to leisure, whereas for a couple, effective leisure is given by the geometric mean of both spouses' leisure times:[15]

$$l_t = \sqrt{l_t^x \cdot l_t^y} \tag{9}$$

The relative importance between consumption and leisure is given by a modified Cobb-Douglas function, whereby the preferences for leisure are governed by the parameter α. The higher is α, the less the family is willing to increase work hours and reduce leisure time in order to raise consumption.[16] The household's expected lifetime utility can be expressed by the recursive Bellman equation:

$$\begin{aligned} J_t\left(W_t, P_t, PIA_t^x, PIA_t^y, s_t\right) &= \max_{C_t,\, \tau_t^x, \tau_t^y, S_t, B_t, LP_t^x, LP_t^y} \left\{ \frac{1}{1-\gamma} \left(\frac{C_t}{\phi_s} \cdot l_t^\alpha \right)^{1-\gamma} \right. \\ &\quad \left. + \beta\, E_t\left[J_{t+1}\left(W_{t+1}, P_{t+1}, PIA_{t+1}^x, PIA_{t+1}^y, s_{t+1}\right) \right] \right\}, \end{aligned} \tag{10}$$

where β represents the time preference rate. The value function is governed by the state variables financial wealth W_t, the permanent income component P_t, PIA_t^x and PIA_t^y, and the family state s_t. The controls are consumption C_t, working time τ_t, investments in stocks S_t or bonds B_t, and premiums for life insurance purchases LP_t^x and LP_t^y.

The expectation of the household's future value function is the sum over all possible family states weighted using the transition probability $\Pi_{s_t, s_{t+1}}$.

$$E_t[\, J_{t+1}(W_{t+1}, A_{t+1}, s_{t+1})\,] = \sum_s \Pi_{s_t, s}\; E_t[\, J_{t+1}(W_{t+1}, A_{t+1}, s_{t+1} = s)\,] \tag{11}$$

[15] Just as total consumption of the couple is normalized to the individual level using a scaling factor, Formula (9) scales both spouses' total leisure time to an individual level. Instead of taking an arithmetic mean, by using the geometric mean we ensure a finite elasticity of substitution between the leisure times of both partners. This avoids corner solutions (i.e., that only partner works with no own leisure time at all) and ensures that partners seek to balance their individual time devoted to leisure.

[16] Such a formulation ensures that the elasticity of substitution between consumption and leisure is equal to one; see Chai et al. (2011) and Gomes et al. (2008).

An exception is the case of divorce, the only instance in which a household is split into two separate units, each with a different utility function. In this case, the individual value functions are equally weighted:

$$E_t[J_{t+1}] = \frac{1}{2}E_t[J_{t+1}(s_{t+1} = \text{divorced woman})] + \frac{1}{2}E_t[J_{t+1}(s_{t+1} = \text{divorced man})] \qquad (12)$$

If one spouse dies, the desire to provide for the surviving partner is reflected in the corresponding value function of the surviving spouse. If the last or both spouses die, they may wish to provide for their children or leave a bequest. The strength of this bequest motive is given by the parameter $B_{s,t}$. The corresponding utility is given by remaining wealth normalized by the bequest parameter and multiplied by the available time budget:[17]

$$\left.\begin{array}{ll} J_t = \dfrac{1}{1-\gamma}\left(\dfrac{W_t}{b_{s,t}} \cdot \Theta^{\alpha}\right)^{1-\gamma} & \text{for } b_{s,t} > 0 \\ J_t = 0 & \text{for } b_{s,t} = 0 \end{array}\right\} \text{if both spouses have died} \qquad (13)$$

Between ages 62 and 69, each spouse has the opportunity to claim his Social Security benefits. At age 70, no further delayed retirement credit can be earned and claiming is mandatory. Table A1 in Appendix A lists the possible retirement states to which transitions by claiming benefits are possible. If the utility of a retirement state exceeds the utility of the current state calculated from equation (10), the utility of the current state is replaced by the higher value and the couple switches to the retirement state.[18]

3. Model Calibration and Parameterization

3.1 Family process calibration

The drivers of family state transitions are marriage hazards, divorce hazards, fertility, children leaving the household, and mortality. We calibrate our probabilities for marriages and divorces using the Urban Institute's MINT model (Smith et al., 2010). In this model, current age and sex are related to marriage and divorce hazard rates, the number of previous marriages, and the duration of the current marriage time since last marriage. To parameterize the transition probability matrix, we simulate a population of 1,000,000 people with an initial

[17] The multiplication with some leisure is necessary for the bequest utility being measured in the same units as the utility from consumption and leisure. To use the time budget Θ is equivalent to normalizing $\Theta = 1$ and using $J_t = \frac{1}{1-\gamma}\left(\frac{W_t}{B_{s,t}}\right)^{1-\gamma}$ as utility from bequest.

[18] If there are several retirement states to which the couple could switch, the state with the highest utility is chosen.

marriage rate of 20%,[19] for which we track the number and duration of marriages. These then evolve according to the MINT hazard rates. We derive the transition probability $\Pi_{ij,t}$ by dividing the number of transitions in our simulated population from state i to state j at age t by the number of paths in state i. In the MINT model, the number of children does not affect hazard rates, so these transitions are independent of the number of children. Fertility-driven transitions probabilities are determined in a subsequent step.

For the transitions between family states with different numbers of children, we use 2009 values of the all-race fertility rates from the National Vital Statistics Reports (Martin et al., 2011). Reported fertility rates are adjusted for the fact that in our model only married couples have children.[20]

We assume that children leave the household when they turn age 18. Since our state variables track only the numbers of children but not their ages, we again simulate a population with the already-calibrated fertility, marriage, and divorce transitions, and we track the ages of the children and have them leave the household after 18 years. The transition probability to states with one fewer child $\Pi_{ij,t}$ is given by the number of paths at age t with a child turning 18 in state i, divided by the total number of paths in state i.

Mortality transitions to widow or widower states are given by sex and age-dependent one-year survival probabilities, for which we use the U.S. 2009 population life table in the National Vital Statistics Report (Arias, 2014). We assume survival probabilities are independent of family status.

3.2 Time budget and child care time

Each spouse is assumed to have a time budget of $\Theta = 16$ hours per day, and the possible work week consists of five days (relevant for distinguishing between full, part-time, and overtime work). We further assume a year to have 52 weeks (relevant for transformation to annual values) and a month to be 1/12th of a year (relevant for determining the AIME and PIA).

To calibrate state and age dependent child care time $\theta^i_{s,t}$ we use data from 2003-2011 waves of the American Time Use Survey.[21] The U.S. Census Bureau conducts the ATUS as

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[19] A marriage rate of 20% for 20 year old women and 24 year old men is in line with the MINT study and a bit higher than the National Health Statistics Report (Copen et al., 2012), which reports a marriage rate of 17.3% for women and 11.3% for men age 20-24. But if we add the cohabitation rates (most comparable to the *married couple* family state) of 18.7% and 15.0%, our assumption is on the low side.

[20] The National Vital Statistics Reports give the fertility rate of the complete population f_{tot}, the fertility rate of unmarried women f_u, and the fraction r of unmarried births to all births. The fertility of married women is then derived by: $f_m = \frac{1-r}{\frac{1}{f_{\text{tot}}} - \frac{r}{f_u}}$.

[21] A good description of the ATUS can be found in Hamermesh et al. (2005).

an extension to the Current Population Survey (CPS). Two to five months after households complete the last CPS interview, they are eligible for the ATUS. One adult per household is randomly selected to do the interview; this structure precludes us from analyzing empirically the interaction of couples' time allocations. The 24-hour time diaries are collected using telephone interviews, when the respondents report each activity of the previous day and its corresponding duration. The interviewer assigns each reported activity a code categorized into 17 top-level categories with several sub-categories. After the first wave of 2003, which had 20,720 respondents, there were about 13,000 respondents in each subsequent wave.[22]

In prior life cycle studies with endogenous labor supply (e.g., Gomes et al., 2008; Chai et al., 2011), time is divided only into (income-generating) working time versus nonwork. Yet in that context, nonwork time cannot be viewed as exclusively recreational since it incorporates both pure leisure and home production (Gronau, 1977). Similar to children's effects on consumption, represented in our model by a consumption scaling factor ϕ_s, child care time $\theta^i_{s,t}$ is intended to capture the effect of children on the parents' time budgets. But considering only time directly devoted to children would be incomplete, since other activities may take longer with children present in the household (for example, cleaning the house or cooking for more people). In this sense, $\theta^i_{s,t}$ cannot be viewed as child care alone, but rather it is the marginal effect of children on all activities related to home production.

Accordingly, for the calibration of $\theta^i_{s,t}$, we consider the following ATUS activities as home production time: Caring For & Helping Household Members[23], Household Activities, Consumer Purchases, Caring For & Helping Nonhousehold Members, Professional & Personal Care Services,[24] Household Services, Government Services & Civic Service, and all travel related to those activities.[25] We divide the ATUS respondent sample into four subgroups: married women, married men, single women, and single men, and we drop observations older than age 66. Next, we include only those observations where the age difference to the youngest child is at least 18 years and at most 45 (55) years for women

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[22] Slightly more than half the diaries are recorded on the weekend or a holiday.

[23] This includes all 19 activities related to children like physical care, supervising children's activities, and playing with them. Even though the latter can be seen as recreational leisure, we choose not to exclude it due to its direct reference to the effect of children on available time.

[24] Note that these are the time costs to make use of the service, as for example waiting on a babysitter.

[25] We exclude the following activities: Personal Care, Work & Work-Related Activities, Education, Eating & Drinking (without food preparation), Socializing, Relaxing, & Leisure, Sports, Exercise, & Recreation, Religious & Spiritual Activities, and Volunteer Activities. Our model assumes a day has 16 waking hours and hence we exclude personal care, which is mainly sleeping time besides washing, dressing, and grooming. Education is excluded due to its close relation to work and all the other activities are recreational leisure.

(men).[26] Finally, we exclude the time diaries filled out on holidays or weekends. Naturally, we include observations with and without children to identify the effect of children. We then regress time spent on the aforementioned activities on a set of dummies for the number of children (with one dummy representing three or more children), and a second/third[27] order polynomial in the number of years until the youngest child turns age 18. The estimated OLS coefficients appear in Table 1, accompanied by a graphical representation of the results in Figure 1. In general, women allocate more time than men to home production. Also children boost women's time devoted to non-market activities more than men's. Single women do spend less time on these activities than married women, but the effect of (at least the first two) children is about the same for both female groups.

Table 1 and Figure 1 here.

For someone with no children, the set of child dummies and the age of the youngest child are set to zero, so the regression constant term reflects time spent on home production when no children are present. As mentioned above, $\theta_{s,t}^{i}$ captures only the marginal effect of children on home production time, so rather than setting $\theta_{s,t}^{i}$ to the estimated home production time for each family state s, we set $\theta_{s,t}^{i}$ to the *difference* in home production time with reference to someone having a similar marital status but with no children (e.g., married couple with two children versus a married couple with no children).

As noted above, our state variables do not directly track the ages of children at home. Instead, for the calibration of transition probabilities, we simulate a population keeping track of the children's ages. For each path, child care time is calculated according to the regression results,[28] and the value $\theta_{s,t}^{i}$ is derived by computing the mean over all paths for corresponding family state s at (parent's) age t.

We also use the ATUS for calibrating the time needed to commute to work. The sample mean for those who worked at least an hour for pay and travelled to work less than four hours on the diary day is $\tau_{\text{t, trav}}^{x} = 0.64$ hours for women and $\tau_{\text{t, trav}}^{y} = 0.79$ hours for men.

3.3 Wage rate calibration

We estimate the deterministic component of the wage rate process $w_{s,t}^{i}$ and the variances of the permanent and transitory wage shocks η_t and ε_t, using the 1975-2011 waves

[26] There is no indicator as to whether the children in the home are the biological children or not. These restrictions should minimize the observations of people looking after their underage siblings and grandparents looking after their grandchildren.

[27] For all subgroups except married women, the coefficient of third order in child age is not significantly different from zero so we reduce the order of the polynomial used for them.

[28] Since the number of single men with children is small, we use the regression results of single women for widowed men with children.

of the Panel Study of Income Dynamics. Besides age, sex, and education, we are especially interested in the effect of the family status and work hours on the hourly wage. In our dataset, some respondents directly report a wage in terms of dollars per hour; for the remainder of the observations, we infer the hourly wage by dividing annual income by annual work hours. Annual work hours are given by the hours worked per week[29] multiplied by 52. (All money values are in $2011).

For the explanatory variables in the wage rate equation, we use a polynomial up to third order in the respondent's age, a vector of dummy variables for the number of children under 18 in the household, whether a spouse is present in the household, and a set of dummies representing work levels: full time for pay (between 20 and 40 hours per week), part time (more than zero but less than 20 hours per week), or overtime (over 40 hours per week).

For couple households, we treat spouses as separate observations. By using wage or inferred wage as the dependent variable, we automatically limit the sample to the working population for which we can infer this quantity. We also eliminate all observations with hourly wage rates below $5 (which would be contrary to minimum wage laws) and extreme observations above the 99th percentile of each wave. Furthermore, we divide the sample into four subgroups by sex and education: men with a high school education, women with a high school education, men with a college education, and women with a college education.

Table 2 shows OLS regression results of the factors associated with (the natural logarithm of) hourly wages.[30] In Figure 2, the age dependence is presented for the four subgroups who work full time and have spouses but no children. For both education groups, men have higher wages than women[31] and the gap widens with age. For all subgroups, living with a spouse is significantly associated with higher wages, of more than 10% for men and from 3.4-7% for women. Having children only slightly decreases men's wages (significant only for those with a college education), while it significantly decreases women's wages. For women with high school (college) education one, two, or three+ children decrease wage rates by 6.4%, 9.4%, and 17% respectively (9.1%, 11%, and 18.1%). For all four groups, there are large wage reductions for part-time work (up to 12.3%), while working overtime yields a significant bonus.

Table 2 and Figure 2 here

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[29] For waves 75-07, hours worked in the individual's Main Job were reported; in waves 09 and 11, only hours worked in All Jobs were reported so Main Job could not be inferred. Yet there is no significant difference in the sample means and standard deviations of hours worked in those two waves compared to the others.

[30] Dummies for each wave are also included as explanatory variables (results available on request).

[31] There is an exception for single women, who earn slightly more than single men between ages 20-30.

For estimating the variances σ_η^2 and σ_ε^2 of shocks η_t to permanent income and ε_t, to transitory income, we follow the well-established procedure of Carroll and Samwick (1997). The idea is that the residual of the observed log wage in the PSID and the predicted log wage from our regression results can be attributed to permanent income and transitory shocks $\ln P_t + \ln \varepsilon_t$. Let $r_{i,d} = (\ln P_{t+d} + \ln \varepsilon_{t+d}) - (\ln P_t + \ln \varepsilon_t)$ be the difference of these residuals of waves for individual i, d years apart. Under the assumption of serially uncorrelated and independent shocks, this difference has a variance of $\sigma_\eta^2 + 2\sigma_\varepsilon^2$. Regressing the squared differences $r_{i,d}^2$ on the time span d between waves and a constant vector of 2's yields an estimate for these variances.

The results of our calibration appear at the bottom of Table 2. Since we assume identical shocks for both spouses, we split the sample by education but not by sex. Compared to Love (2010) who based his empirical analysis on a broader definition of household income (including public transfers and unemployment compensation, as well as labor income), our estimate of the variance of permanent shocks σ_η^2 is about the same for the less educated and slightly higher for the college educated. Our variance of transitory shocks σ_ε^2 is considerably lower for both educational groups. For retirement income, which is purely a public transfer in our model, these conceptual differences no longer apply. Therefore, for the variance of transitory shocks to retirement income we set $\sigma_{\varepsilon ret}^2 = 0.0784$ (as in Love, 2010).

3.4 Other parameters

Emulating several other studies in the life cycle literature, we use the household consumption scaling factors proposed by Citro and Michael (1995), $\phi_s = (A + 0.7 \cdot K)^{0.7}$, with A being the number of adults and K being the number of children in the household. Our calibration of bequest strength $b_{s,t}$ is motivated by a provisional motive, that is, to provide for children's consumption and education costs. We set $b_{s,t}$ to zero for any family states without children present which applies to all retirement states, among others. Otherwise, we assume that an annuity must be purchased that finances the consumption for each left-behind child until his 18th birthday, plus four years of college.[32] As childrens' ages are not explicitly tracked in our model, we again use the same simulation technique as before for the family transition probabilities and child care times to derive mean values of $b_{s,t}$ for family state s at each age t.

[32] Abstracting from discounting with the riskless rate, a 15- and a 17-year old child yield bequest factors of $b = 5 \cdot (0.7 \cdot 2)^{0.7} + 2 \cdot (0.7 \cdot 1)^{0.7} = 7.89$, since consumption must be financed for five years for both children and another two years for the youngest child.

In our baseline case, we use a relative risk aversion of $\gamma = 5$ and set the time discount factor to $\beta = 0.96$. The leisure preference parameter is given by $\alpha = 0.8$, since for this value, the optimal life cycle profiles for hours worked per week roughly match the average work hours in the PSID data used for the calibration of the wage rate (also see Appendix B). The risk-free rate is set to $R_0 = 1.02$, and we assume an equity premium for stock returns of $E[R_t] - R_0 = 4\%$ with a standard deviation of stock returns of 20%. Life insurance contracts are priced according to the 2001 Commissioners Standard Ordinary (CSO) Mortality Table, which was developed by the Society of Actuaries and the American Academy of Actuaries (2002). As in Gomes et al. (2008), labor earnings are taxed at a rate of $\vartheta_{\text{labor}} = 30\%$ and retirement benefits at $\vartheta_{\text{ret}} = 15\%$.

Several other parameters are calibrated following Love (2010): for instance, we use his estimation of housing costs $h_{s,t}$ from PSID data; for child support, divorced men are assumed to pay 17%/25%/30% of their labor income for 1/2/3+ dependent children; divorced women with children receive the corresponding fraction of a single man's income as if he works for 40 hours per week; when a child turns age 18, the household pays 40% of its permanent income resulting from full time work for college costs[33] upon his departure; in the case of divorce, wealth is split evenly between spouses after deducting 10% of assets for divorce costs.

When a single individual marries, we must make some assumptions about the new partner. First, we posit that the new partner has the same permanent wage rate component P_t as the single individual had before marriage. Second, the PIA of the new husband is an age-dependent multiple of the wife's PIA, ranging from 1.06 in their early 20's, to 1.09 just before retirement. Third, the financial wealth brought by the husband into the couple's wealth is also an age-dependent multiple of the wife's wealth, ranging from 1.08 early on, and 1.12 late in life.[34]

When a couple divorces, the partner with lower retirement benefit claims is entitled to spousal benefits, and after the former partner's death, to widow(er) benefits. Our model does not track the PIA of former partners, so we increase the PIA of a divorced woman (man) to 70.85% (58.23%) of the former partner if her (his) own PIA is smaller. This is motivated by the following consideration: an annuity paying $50 per year to a woman as soon as her former

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[33] Based on a study by Turley and Desmond (2006), Love assumes college costs of 10% of the family's income for four years. Since the family states in our model do not contain any information on the number or even the ages of children already having left the household, we have to model this payment as a lump sum upon the child's leaving.

[34] We derive these multiples by assuming that both partners have worked full time up to this age. The ratio of the PIAs resulting from this work history yields the first multiple. Similarly, the second multiple is calculated from the ratio of corresponding average lifetime income.

husband reaches full retirement age, and $100 after his death, as long as the woman lives, has the same actuarially fair present value as an annuity paying the woman $70.85 per year (because of the age difference and the asymmetry in the mortality rates, the corresponding value for men is only $58.23).

For the piecewise linear function converting the AIME into the PIA, we use the official specification for the Social Security bend points. For the first $749 of the AIME, 90 cents per dollar are transferred into the PIA, for values over this and up to $4,517, 32 cents per dollar are transferred and for every additional dollar earned, on average, the PIA increases by 15 cents (in $2011). We set the exempt amount of annual income for the Retirement Earnings test to $14,160.[35] The deduction (bonus) for claiming early (late) old age retirement benefit is calculated according to Social Security claiming rules. As of the Full Retirement Age, defined here as age 66, retirement benefits as a fraction of the PIA are given by Table 3.

Table 3 here

4. Optimal Decisions on Saving, Work, Claiming, Life Insurance, and Investments

In this section, we first analyze the household's optimal behavior over the life cycle. In particular, we are interested in how family status affects financial decisions (stocks, bonds, life insurance demand), work effort, and the optimal time to exercise the Social Security claiming option. Next, we discuss the simulation method for the life cycle model with changing family status. In Section 4.2, we present patterns of average consumption, wealth, holdings in stocks, work hours, and Social Security claiming ages. We discuss these patterns for women and men in single and couple households. Further analysis on how education and the number of children influence optimal decisions appears in Section 4.3. Finally, we investigate whether the predictions on claiming patterns from our model are consistent with empirical data.

4.1 Simulations

We use the optimal controls of the baseline parameterization of our life cycle model to generate 100,000 simulated life cycles reflecting realizations of stock returns, wage rates, and marital status. We assume that 59.3% (40.7%) of the simulated households have a wage rate profile corresponding to the high school (college) educated (as in in the 2011 wave of the PSID). We divide the sample of simulated life cycles equally into *female* and *male* paths. At the start of the simulations, 80% are singles and 20% are already married, while later in life, each individual randomly moves between the 35 family states. Each household is endowed

[35] For additional information on Social Security benefit rules, see Myers (1985) and http://www.socialsecurity.gov/OACT/COLA/rtea.html.

with a starting financial wealth as if each household member would have worked 40 hours per week in the previous period. We present the results in the usual way as in the life cycle literature, so we generate simulated paths conditional on survival. To do so, we modify the transition matrix $\Pi_{ij,t}$ for the simulation by setting the mortality of women in female paths and men in male paths to zero[36] and rescale the other probabilities such that they sum up to 1. This procedure keeps the same number of paths even at high ages. If a single agent marries, we make the same assumptions about the new spouse as in the optimization regarding age difference, permanent income, wealth, and PIA. In the case of divorce, we follow only the ex-wife (ex-husband) in a female (male) path and ignore the other spouse.

For the reporting of aggregate quantities over all paths, such as for example average wealth, each path is weighted with the survival probability to the age in question. This gives female paths a slightly higher weight in comparison to male paths, especially at older ages. When sex-dependent quantities like hours worked by women (men) are considered, we only report the average over female (male) paths. We also report results for subsamples, e.g. single or couple households. In this case, we use averages over all paths in that family state at the reported age. Thus the samples are not constant at all different ages. For example, an individual who is seen to be a single woman at one age will drop out of the single sample when she marries. She can also reenter the single subsample at a later age, if a divorce occurs. Table 4 provides some basic information about the average composition of the simulated population dynamics at different ages.

Table 4 here

4.2 Optimal life cycle profiles

Figure 3 reports the average life cycle profiles for the complete population of singles and couples with either a high school or a college education. Panel A shows average consumption, life insurance demand, wealth level, and investments in equities. Panel B reports average work hours for men and women, and Panel C the frequency of claiming Social Security benefits. Here we see that financial wealth builds up gradually until age 55 when it amounts to about $189,000 on average, and thereafter people start to draw down their assets. The average wealth profile generated from our life cycle model is reasonably consistent with empirical data. For example, in the PSID (see Appendix B), the average financial wealth of households between age 25 and 75 is about $140,000 (in $2011), while households in our model have an average wealth of $149,000 in the same age bracket. But in

[36] However, the optimal decisions of the agents take mortality into account. The mortality of the spouses in couple states is not zero and states of widowhood are thus possible in the simulation.

our model, the wealth profile is shaped slightly differently, as younger households have higher and older households have lower wealth in comparison to their empirical counterparts.

Figure 3 here

Levels of financial wealth and how much people invest in risky stocks are highly correlated. Compared to other papers in the life cycle literature,[37] our model generates a relatively low and stable fraction invested in the stock market. For instance, during the first decade of the life cycle, stock allocation rises from about 20% at age 20, to 61% at age 35. Subsequently the average allocation to stocks is quite stable, in a range of 44% to 61%. After age 62, when households start to claim Social Security benefits and receive their riskless benefits, the fraction invested in stocks increases slightly, to 54%. There are two reasons for these low levels of equity exposure. First, adding family status uncertainty on top of permanent/transitory income and mortality shocks, forces households to select safer bond investments to cover own and children's consumption needs, as noted by Love (2010). Second, the portion of cash-on-hand dedicated to this period's consumption is assumed to be held in a transaction account of non-risky assets.[38] The portfolio allocation generated by our life cycle model fits the empirical data quite well. For instance, several studies on U.S. household portfolio allocations report a relatively constant, non-decreasing equity share by age conditional on participation, of around 40-60%.[39]

Our results also show that the average level of consumption increases over the worklife. Thereafter, consumption drops sharply from about age 66, when many households retire and begin to consume more leisure. This profile is consistent with other life cycle models with endogenous work hours and flexible retirement ages (Chai et al., 2011);[40] it is also in line with empirical studies documenting a substantial drop in spending around the retirement point. Thus Bernheim et al. (2001) and Aguiar and Hurst (2005) report a drop of consumption expenditures after retirement for U.S. households of 35-38 percent (depending on wealth levels). Their explanation is that retirees are more willing to increase time for home production, and concurrently curtail their consumption expenditures. This is in line with our findings, since home production is a major part of non-labor force time, in our model (see Section 3.2).

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[37] See Cocco et al. (2005), Gomes and Michaelides (2005), Gomes et al. (2008). Love (2010), or Chai et al. (2011).

[38] This is in line with recent work by Abel et al. (2013). Drawing on early work by Baumol (1952), that study uses a dynamic consumption and portfolio choice model where a liquid riskless asset is held in a special transaction account to cover consumption expenditures until the next period.

[39] See, for example, Guiso et al. (2002), Ameriks and Zeldes (2004), Gomes and Michaelides (2005), Love (2010), and Wachter and Yogo (2010).

[40] By contrast, life cycle models with exogenous labor income and retirement age, such as Cocco et al. (2005) and Love (2010), generate a quite smooth average consumption profile before and after working life.

Figure 1B shows that men start off with an average of 45 work hours per week which they gradually reduce to around 40 hours right before the earliest possible retirement age. Women also work for pay more than 40 hours a week in their early 20's, but they reduce this to about 32 hours per week in their late 30's. Thereafter, they remain at this level until reaching the earliest retirement age. Compared to empirical data, our model predicts slightly lower values of work hours with a bigger gap between men and women. (Thus Appendix B reports average work hours for those age 25 to 55 using PSID data of 45 hours per week for men, and 38 hours per week for women.) Our model also implies that men will claim Social Security benefits slightly later than women (Figure 3C). Additionally, their demand for life insurance is much higher (Figure 3A). To gain more insight into what drives these results, we turn next to separate analyses of single versus couple households.

Figure 4 presents the expected life cycle profiles for singles. Panel A shows that wealth builds up gradually until age 58, when it amounts to about four times average consumption. Thereafter, the singles begin to draw down assets to compensate for fewer hour of work. Between age 60 and 80, wealth levels are relatively flat (besides a slight bump around age 66), for two reasons. First, the singles gradually claim their Social Security benefits between age 62 and 70 but they need not fully leave the labor force. Instead they work part time up to the earnings test exempt amount. Depending on education, this corresponds to about 19 hours per week for high school graduates and 14 hours for college graduates. This explains relatively flat wealth levels up to age 70. Second, though households do start to decumulate their assets post-age 70, mortality is also rising. For this reason, the pool of singles is increasingly subject to an influx of widows and widowers holding higher wealth levels from their coupled state. Accordingly, the transition from couple to single tends to neutralize the aggregate effect of dissaving, which accounts for the relatively flat overall wealth levels to age 80.

Figure 4 here

For singles, the share of financial wealth in stocks is relatively constant over the life cycle (at 40-60%), similar to the overall population. Singles' average consumption is lower, but the same overall pattern prevails as in the aggregate. We also see that singles have virtually no demand for term life insurance; they have no provisional and bequest motives as generally they have no children or partners to provide for after death (Hubener et al., 2013) and they gain no (altruistic) utility from the transfer of wealth to the next generation. Only for single women age 30-40 is there a small positive demand for life insurance; this is generated by divorced women who must cover their children's consumption and college education costs should they die young. There is very little life insurance demand among single men, since the only case for which single men must take care of children is when they are widowers. Since young women's mortality is very low, the few such cases do not change average life insurance demand overall.

Turning to labor supply patterns, Figure 4B shows that single men work for pay 42 hours per week at the beginning of their life cycles. Thereafter, they gradually reduce their time on the job to 32 hours just before retirement. From age 62 onward, men begin to claim Social Security benefits which provide them with a safe income stream for life. In conjunction with the possibility of receiving Social Security benefits and working without tax penalties up to the earnings test exempt amount, most men reduce their average work hours sharply and work only part time (to 16-27 hours per week) after claiming. Average paid work hours for women are lower than for men, since women have, on average, lower wage rates. Accordingly, they are less willing to curtail their leisure time for higher consumption afforded by more work. An additional explanation is that the single sample includes divorced women with children who are financially supported by their ex-husbands and have lower time budgets due to child care responsibilities. The consequence is that these women work less for pay, compared to single women without children. This explains the slightly increasing gap of paid work hours between men and women age 35-45. In this age group, about 30% of single women have children. From age 45-55, this gender gap decreases, because the children become older and require less time (or leave home). After age 60, when children are out of the house, men and women exhibit very similar work patterns.

Panel C of Figure 4 displays Social Security claiming patterns by age. Single women claim slightly later than their male counterparts: thus the mean claiming age is 65.2 for men and 66.8 for women, and about 34% (20%) of single men (women) claim Social Security benefits at the earliest possible age of 62. These households are unwilling to take advantage of the additional life annuity benefits from delayed claiming. After a claiming peak at age 62, 7% additional singles on average claim their benefits at each subsequent age until 69. More detailed analysis shows that early claiming households build up relatively low wealth during their working lives and have low permanent wage rates in their 60's. Since the replacement rates under the U.S. Social Security system are progressive, lifetime poor households have low PIAs receive a higher replacement rate. This enhances their incentives to claim Social Security benefits early and work part time up to the earnings test exempt amount, to augment overall income. About 15% (33%) of single men (women) delay claiming to age 70, when claiming becomes mandatory. On average, these households have a higher permanent wage rate and consequently build up more financial wealth than do poorer, earlier claiming, households. This later claiming pattern arises because they can take advantage of the increased real annuity income from the delayed retirement credits. Moreover they take advantage of still high wage rates and work longer; claiming later avoids the penalty from the earnings test.

Next we turn to life cycle profiles for couples; Panels A – C in Figure 5 highlight several important differences compared to singles. Most importantly, wealth and consumption levels are much higher for couples than singles, due to the fact that couple households have multiple members. Interestingly, younger couples build up wealth more quickly than singles: between age 20 and 30, the average level of wealth for couples increases by about 13% per year, but by only by 8.5% annually for singles. Also, wealth relative to family size is higher for younger couples: for instance, at age 30 the ratio of average wealth to consumption for couples is 3.5, but only 2 for singles. This is because of couples' higher precautionary saving motives due to uncertainty in family status (divorce, death), as well as having to save for college education. After the mid 50's, household wealth peaks and children start to leave the home, and these differences between singles and couples shrink.

Figure 5 here

Couples' demand for life insurance is hump-shaped, with insurance purchased mainly on the husband's life: average face values peak at around $143,000 at age 37, when most couples have children and many women reduce their paid work hours substantially because of childcare demands. Demand for life insurance on the wife's life is clearly lower than on the husband's, topping out at $44,000. One reason is that female mortality is substantially lower than men's; another is that men have higher wages than women, so a widower can more easily provide for the family than can a widow. In addition, the re-marriage rate of widowers with children is more than twice as high as for widows, so widowers are much more likely to find a new partner to help with child care and provide a second income. The demand for life insurance on women age 30-50 is driven by couples with more than two children. In this instance, the wife's death would impose a substantial burden on the husband, because he would need to curtail his work hours to care for the young children. Life insurance purchases of both partners combined with accumulated liquid savings cover the risk that both parents might die at once.

Interestingly, the demand for life insurance during retirement is zero for both partners. Because of generous Social Security widow benefits, retirement income proves to be rather symmetrically distributed between both partners, so only a minor portion of retirement income is lost when one spouse dies. If the husband dies first, his surviving widow receives 100% of his Social Security benefit as his widow, an amount typically higher than her own (and her spousal) benefit. In addition, the surviving spouse retains the household's remaining liquid wealth, and as a single she requires lower consumption. Therefore the death of one partner need not cause a large consumption shortfall that would need to be hedged by life insurance purchases.[41]

The work hour pattern for couples differs distinctly from that of singles. During their early 20's, both husbands and wives work for pay up to 50 hours/week. In contrast to single men, husbands reduce work to 44 hours around age 40, and they maintain this level until retirement, effectively working about 5 hours per week more than single men. Wives, on the other hand, reduce their paid work hours in their late 30's to about 30/ week. Between age 40-55, women gradually boost their paid work to 32 hours/week, when children are older and require less home time. Despite their high work hours at younger ages, wives work for pay about 3 fewer hours per week over the life cycle, compared to single women. This specialization of work hours within the family is due to the fact that women's wage rates are lower than men's, on average, and they fall further on the arrival of children. Thus the wife shoulders most of the unpaid burden of child care and home production time, and she works less for pay than the husband. Similar to the situation for singles, both husband and wife start to reduce their market work substantially in their 60's.

Interestingly, couples' Social Security claiming patterns differ remarkably from those of singles. About 55% of married women claim their own old-age Social Security benefits at the earliest possible age of 62. Their mean claiming age is 64.8, about 2 years earlier than single women. By contrast, 41% of married men delay claiming up to age 70 and their mean claiming age of 66.5 is 1.3 years higher than for single men. There are several explanations for these differences. First, married women's PIAs are considerably lower than those of their husbands.[42] In addition, married women are eligible for spousal benefits and later to relatively generous widow benefits (100% of their husbands' benefits). The Social Security claiming rules also permit the wife to switch from her own old age retirement benefits to spousal benefits and/or to widow benefits when the husband passes away. Spousal benefits increase for every year of delaying after age 62 by about 8% (up to the normal retirement age 66).

[41] This result supports Hubener et al. (2013) who also found no demand for life insurance when the couple's retirement income flows were symmetrically distributed; that study however did not incorporate retirement patterns.

[42] Since our model assumes the same permanent income for both spouses with the husband's deterministic component being higher and the work hours of women being lower, our simulations do not have any wife with a higher PIA than her husband.

Because of these switching possibilities and particularly due to the generous widow benefits, early claiming for married women only reduces their retirement benefits up to the point of the husband's death.[43]

As a result, for most couples, the optimal strategy to maximize lifetime benefits is for the wife to claim her relatively lower own benefits early, and to claim spousal benefits later if they are higher. In addition, the husband will claim his own old age benefits relatively late in life. This increases his own benefits and also his potential widow's benefits after his death. Because of the high probability that the wife outlives her husband, better widow benefits are important to maximize the couple's joint lifetime utility.

Such a strategy also effectively hedges longevity risk. If one partner dies, the surviving spouse receives the high benefits of the husband (either directly or as widow benefits) for the rest of his or her life. If both spouses survive for a long time, they continue to receive both incomes, i.e., the own benefit of the husband and the spousal or own benefits of the wife. Even though the benefits for the wife are smaller, the couple profits from the consumption scaling of not having to consume twice as much as a single person.

Coincident with the results for single men, married men's higher permanent wage rates on average produce later claiming patterns. The few households (some 26%) in which wives delay claiming to age 70 also have very high wage rates. These high-earning women seek to remain in the workforce to generate high labor income and take advantage of the delayed retirement credit by claiming later.

Having seen how married couples specialize, with the husband being the major earner and wives devoting more time to home production, we revisit the retirement behavior of single women. These can be categorized in two subgroups: divorced and never married. Women that never marry have an average claiming age of 66, while divorced women claim on average 1.1 years later. Being the only one receiving income in a household, never married women average almost 40 hours/week in paid work. By contrast, divorced women average

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[43] The change in the actuarial present value of retirement benefits caused by the timing of claiming is very different for single and married women, as illustrated in the present value calculations by Coile et al. (2002) and Shoven and Slavov (2012). For instance, assume a single woman claiming retirement benefits at age 62 would receive $7500 per year for the rest of her life; this would generate an actuarial present value of $130,224 (at a discount rate 2% and with survival probabilities as in the text). Delaying claiming to age 66 produces higher benefits of $10,000 per year (see Table 3) with a present value 4% higher, of $135,367, computed as of age 62. By contrast, a married woman's benefits consist of two portions: her own old age benefits (or spousal benefits if greater), and her widow benefits when her husband dies. Accordingly, for a married woman with a lower PIA than her husband, the relevant time frame over which she will receive her own old age benefits is not her life expectancy, but rather that of her husband's lifetime, after which she will switch to her higher widow benefits. Assuming the husband is four years older than his wife, if she claimed at 62 this yields a present value of the wife's retirement benefits until his date of death of $85,772; by contrast if she were to postpone claiming to 66, her present value would be only $77,318, or 10% less.

32.4 hours/week due to reductions in labor market hours while married, much of it due to child care. This results in lower earnings histories and in lower retirement benefits compared to never married women of the same age. Consequently, divorced women postpone claiming and work longer in order to increase their Social Security benefits. By contrast, no such difference emerges between divorced and never married men, as both were the major earners in their households all their lives. Because of the specialization within a partnership, divorced women are less well prepared for retirement in comparison to never married women, while divorced men do not face this problem.

4.3 Effects of education and children on key financial outcomes

Next we explore how differences in education and children influence optimal claiming patterns and portfolio allocations (stocks, bonds, and life insurance). We use our simulation results and distinguish between lesser versus more educated households, and couples with no children versus those with at least two children. Results appear in Tables 5, 6 and 7, which illustrate findings for, respectively, claiming ages, stock fractions, and life insurance demand.

Tables 5-7 here

Turning first to the claiming decision, Table 5 indicates the fraction of persons who take Social Security benefits between ages 62 and 70, arrayed by education and number of children. Here we see that the model predicts that less-educated women claim much earlier, with an expected claiming age of 65 versus 66.7 for the college-educated, By contrast, men's patterns are more similar, with nearly-identical average claiming ages of 66.1 and 65.9, respectively. The relatively high replacement rate under Social Security is particularly generous for low-wage women, whereas higher earning men and college-educated women have more of an incentive to remain employed. Again it is worth noting that men's optimal claiming age is much higher than for women, driven by the availability of spousal and survivor benefits for married women. Next we compare childless couples and those with children, where we see that claiming patterns are remarkably similar: about 55% of the women claim as early as possible in both groups, and women's expected claiming ages are also nearly identical with mothers of two or more children who claim only 0.1 year later than childless wives. For men, having two or more children has only a small effect, reducing the average claiming age by 0.2 years. Overall, the model implies that education has a stronger effect than do children, on when people exercise their benefit claiming options.

The results for the share of financial wealth held in equity are reported in Table 6, which displays differences by education. Here we see that both education groups hold nearly the same portion of their portfolios in equities during their worklives. Prior to retirement, the less educated dissave faster than the college educated, since Social Security offers them a higher replacement such that they need less liquid savings. As a result, they hold relatively more of their overall financial wealth in non-risky transaction accounts to finance their current consumption, which reduces the funds available to invest in stocks. Turning to couples, we see that the young and the old hold similar stock fractions. But couples with children are much less invested in equity during middle age. Specifically, couples age 45-64 with children hold 8-9 percentage points less in equities. This can be explained by the fact that, compared to childless couples, they hold more non-risky assets in the transaction account to finance higher consumption expenditures. Also they must use part of their saving to pay for the children's college education, which further reduces the relative amount of overall financial wealth available for stock investments.[44] Overall, though the equity share does vary with education and family status, the profile is rather smooth by age, in contrast to other studies of optimal portfolio choice typically generating decreasing equity profiles over the life cycle (e.g. Cocco et al. 2005; Love 2010; and Gomes et al. 2008).

Life insurance holdings vary across the life cycle and by household type. The peak age for purchase is clearly when children are young; after age 65, there is effectively no demand for further insurance since Social Security benefits provide a generous replacement rate to those losing their spouses. Those with lower wages also purchase relatively more life insurance, as a multiple of their full-time labor income, than do the college-educated. This is because high school educated couples with children seek to insure against the loss of the husband's income in the event of his death. While wives could return to the labor market, their low wages would be less than required to smooth consumption, compared to the college-educated women. Couples without children buy little insurance on wives, but they do carry an insurance face value of up to 227% of the full-time labor earnings on the husbands. This is because the wife's low wage rates induce her to spend more time at home; the loss of her husband may induce more work on her part, but his demise still imposes substantial financial risk on the couple, driving her to require more insurance on his life. By contrast, couples with 2+ children demand much more insurance while the children are young, particularly on the husbands, inasmuch as the wives are devoting much of their time to home production and not earning much. In contrast to childless couples, a substantial amount of life insurance is also bought on wives, since their possible death is a major risk to the husbands with dependent children.

[44] If we focus only on the allocation of savings (i.e. excluding the non-risky assets held in the transaction account), we find a slightly increasing equity exposure for couples with children (in line with Love's 2010 finding).

4.4 Empirical evidence on claiming patterns

As noted above, four key results flowed from our normative model regarding Social Security claiming patterns. First, married women claim much earlier than single women. Second, married women claim much earlier than married men. Third, more educated women claim later than less educated women. Finally, children have little impact on men and women's claiming patterns. To evaluate whether these predictions are in line with empirical behavior, we have conducted an empirical analysis of actual Social Security claiming patterns in the Health and Retirement Study (HRS), a nationally representative longitudinal survey of Americans over the age of 50, followed over the period 1992-2010.[45]

In this dataset, we define the Social Security claiming age as the number of months elapsed between turning age 62 and benefit receipt. We then regress this outcome on a vector of arguably exogenous explanatory variables that our model indicates should be importantly associated with claiming patterns. These include sex, marital status, number of living children (0, 1, 2, 3+), and educational attainment (at least some college versus none). To test whether claiming patterns are differentiated by sex, we interact all variables with a Male coefficient, implying that the basic estimates refer to women. Our Tobit coefficient estimates and standard errors are reported in Table 8.

Table 8 here

While the average claiming age in the HRS dataset is 63.4,[46] we see that married women claim substantially earlier (-6.92 months) than do single women, and the result is statistically significant. This is exactly what our theoretical model predicts though the magnitude is a bit smaller than in our simulations. We also see that more educated women claim later than less educated women (+4.53 months), again a statistically significant finding consistent with our hypotheses. Married men claim later than married women (+6.89 months) again a statistically significant result compatible with our predictions. Finally, we find no significant effects of children on women's (or men's) claiming patterns, a result that again confirms to our model predictions. In sum, the key variables having an influential effect in our model simulations also matter empirically as well.

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[45] For more information on the HRS, see http://hrsonline.isr.umich.edu/. Our dataset is similar to that of Shoven and Slavov (2012, 2013) who kindly provided their computer code for the extract and variable definitions. Since that study could not differentiate between retired worker, spouse/survivor, and disability benefits, the authors excluded all persons who claimed younger than age 62, older than age 70, who never claimed age 62-70, who reported being widowed prior to claiming Social Security, or who ever received disability benefits. Our sample size is slightly larger due to the addition of the 2010 wave.

[46] The HRS average claiming age is lower than that in our simulation model of 65.7, but we are interested in the qualitative rather than the exact quantitative magnitudes here. Moreover, the HRS dataset includes different birth cohorts that experienced quite different economic environments through time.

5. Policy Simulations

We also use our calibrated theoretical model to examine the impacts of two potential Social Security benefit reforms on key outcomes of interest. One is the elimination of spouse benefits, and the other is the elimination of widow benefits under the program rules. These two policy experiments follow from Gustman and Steinmeier's (2001) demonstration that such benefits substantially undermine the progressivity of the Social Security system.

Table 9 reports results from two simulations: one of which evaluates the life cycle impact of eliminating spouse benefits, while the other curtails widow benefits. Compared to the base case, the first row shows that wives' claiming ages are unaffected by eliminating spouse benefits. The reason is that most women have acquired substantial retirement benefits themselves and do not depend on spousal benefits. By contrast, if widow benefits were eliminated, this would have a substantial impact on claiming patterns: married women would delay 4 years later (at 68.8 instead of 64.8), on average, and they also work 16% more hours. This is due to the fact that wives would now be exposed to a substantial risk of uninsured widowhood, if they only had their single annuity on which to rely over a relatively long old age period.

Table 9 here

Moreover, the Social Security delayed retirement credit would now become more salient for women, since under the law the own benefit adjustment for deferral is computed using a unisex table. If no widow benefit were available, women could do better by deferring their claiming age, compared to when they can rely on the widow benefit. As noted above, when widow benefits are available, the typical woman's rewards from delaying claiming are only relevant until the death of her husband, so deferring benefits increments her benefit flow for a relatively short period. If widow benefits were eliminated, the time period expands over which the woman receives the deferral increment, making delayed claiming more influential for retiree income.

Table 9 also shows that men's claiming patterns and work hours would be relatively unaffected by cutting spouse benefits, since few men receive spousal benefits in any event. By contrast, if widow benefits were eliminated, men would claim quite a bit earlier, by 1.2 years, and they would work 4% fewer hours. This is because the husband's additional work and deferred claiming would no longer contribute to enhanced widow benefits after his death. Moreover, the household would optimally buy 28% more life insurance on the husband; this would continue until the wife claimed her Social Security benefit, since her own benefit thereafter would be sufficient to support her in old age.

Interestingly, neither policy simulation has any measurable impact on the household's equity share. This is intuitive, inasmuch as the household can change Social Security claiming patterns and in effect "purchase" a higher annuity benefit over the remaining lifetime. In other words, the structure of Social Security options interacting with claiming and work patterns provides the household an alternative to saving more and changing its stock allocation.

6. Conclusions

This paper show how incorporating family and Social Security in a life cycle setting is crucial for household saving and asset allocation patterns, work/retirement decisions, and life insurance purchases. Our model builds on previous research by including stochastic equity returns and labor income, as well as mortality risk. We extend prior studies by incorporating the impact of demographic transitions on household budgets, such that the costs of children include peoples' direct as well as indirect time and money constraints. Additionally we track men and women prior to, during, and after marriage, and we evaluate the impacts of having children as well as college education costs. Most importantly, our formulation of Social Security benefit options is more realistic than previous studies which assumed retirement benefits were a fixed proportion of the last labor income as of some pre-specified date. Not only do we model own benefits as a function of individuals' lifetime earnings histories and benefit claiming ages, but we also model spousal and survivor payments. These factors interact in complex ways with Social Security benefit optionalities, which in turn shape optimal saving, portfolio, and work decisions over the life cycle.

We realistically calibrate the model, drawing on empirical evidence on time use, demographics, and wage rates, drawing on the PSID and ATUS. Our findings show that having children reduces household equity holding, and married women optimally work much less for pay compared to their single counterparts. The model generates reasonable saving and wealth profiles, along with low and stable equity fractions consistent with empirical evidence. We also predict and confirm using the HRS that current Social Security rules induce married women to claim retirement benefits much earlier than single women and married men. Finally, we conduct two policy simulations altering Social Security rules, and we show how each would change optimal household behavior. Specifically, our policy simulation shows that eliminating widows' Social Security benefits would substantially increase women's claiming ages, by 4 years on average, but men would claim a year earlier. Hence the policy would narrow claiming age differences between men and women. Men's life insurance demand would rise by 28%, with a negligible impact on women's life insurance purchases.

Such a policy would have a negligible impact on the share of risky assets held by the household, since adjusting work and claiming patterns offers an alternative to altering the household financial portfolio.

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Table 1: Child Care Time Regression Results.

This table presents regression results of hours spent on home production per working day using the American Time Use Study (ATUS) data from waves 2003-2011. Standard errors are given in brackets and the number of stars indicates levels of significance (10%, 5%, 1%). The regression constant represents the time a person without children would dedicate to home production. The coefficients for the different child dummies give the increase of this time by the number of children under 18 present in the household. The effect of children's ages is captured by the polynomial in *18-aoy* (18 minus age of the youngest child), which is the number of years until the youngest child will turn 18 years old (*18-aoy* equals zero, if no child is present).

	Married Women		**Married Men**		**Single Women**		**Single Men**	
Constant	3.282	***	1.939	***	2.462	***	1.805	***
	(0.047)		(0.04)		(0.036)		(0.033)	
(18-aoy) / 10	3.928	***	0.299		-0.677		2.531	***
	(0.975)		(0.301)		(0.565)		(0.796)	
$(18\text{-aoy})^2 / 100$	-4.622	***	0.126		0.842	***	-1.103	**
	(1.118)		(0.142)		(0.279)		(0.432)	
$(18\text{-aoy})^3 / 1000$	1.857	***						
	(0.375)							
1 child	-0.073		0.171		1.379	***	-0.037	
	(0.237)		(0.135)		(0.247)		(0.311)	
2 children	0.585	**	0.359	**	1.947	***	0.155	
	(0.261)		(0.155)		(0.281)		(0.381)	
3+ children	1.181	***	0.518	***	2.293	***	-0.129	
	(0.273)		(0.17)		(0.313)		(0.481)	
Number of obs.	10828		11757		7806		5730	
Number of obs. with children	6707		8122		2953		815	
R squared	12.09%		2.64%		14.08%		3.20%	

Table 2: Wage Rate Regression Results.

This table shows regression results of the natural logarithm of the wage rate using Panel Study of Income Dynamics (PSID) data for respondents age 20-69 from waves 1975-2011 and the corresponding estimates of variances of permanent and transitory shocks to the log wage rate. Standard errors are given in brackets and the number of stars indicates levels of significance (10%, 5%, 1%). The coefficients for wave dummies are not shown. The independent variables are a second order polynomial in the worker's age, dummies for the number of children under 18 present in the household, presence of a spouse in the household, and dummies for part time work (less than 20 hours per week) and overtime work (more than 40 hours a week). Shock variances are estimated by regressing the squared difference in unexplained log wage between waves on the time lag between waves and a constant vector.

Coefficient Estimates	Men, High School		Women, High School		Men, College		Women, College	
Constant	1.216	***	0.696	***	0.382	***	-0.201	*
	-0.069		-0.077		-0.138		-0.112	
Age / 100	6.850	***	12.801	***	13.953	***	20.128	***
	-0.559		-0.621		-1.072		-0.883	
Age^2 / 10000	-7.472	***	-26.505	***	-21.113	***	-39.336	***
	-1.439		-1.559		-2.666		-2.227	
Age^3 / 1000000	0.577		17.466	***	9.565	***	24.657	***
	-1.178		-1.237		-2.130		-1.796	
1 child	-0.024	***	-0.064	***	-0.021	***	-0.091	***
	-0.005		-0.005		-0.008		-0.007	
2 children	-0.002		-0.094	***	0.015	*	-0.110	***
	-0.005		-0.005		-0.008		-0.008	
3+ children	-0.039	***	-0.170	***	-0.013		-0.181	***
	-0.006		-0.006		-0.010		-0.011	
Spouse present	0.118	***	0.034	***	0.104	***	0.070	***
	-0.006		-0.004		-0.009		-0.006	
Part time work	-0.092	***	-0.123	***	-0.097	***	-0.083	***
	-0.023		-0.007		-0.030		-0.012	
Overtime work	0.049	***	0.080	***	0.064	***	0.058	***
	-0.004		-0.005		-0.005		-0.006	

Shock variances	High School		College	
Permanent	0.0105	***	0.0151	***
	(0.0003)		(0.0006)	
Transitory	0.0297	***	0.0401	***
	(0.0010)		(0.0017)	

Table 3: Early Claiming Reductions and Delayed Retirement Credits

The second line reports the old age retirement benefits as a multiple of the Primary Insurance Amount in dependence of the claiming age. The third line reports the spousal benefits in relation to the partner's benefits (excluding delayed retirement credit) in dependence of the age when the spousal benefits are claimed. All values are calculated according to U.S. Social Security rules (Myers, 1985) with a Full Retirement Age of 66.

Claiming age	62	63	64	65	66	67	68	69	70
Old age retirement benefits	75%	80%	86.7%	93.3%	100%	108%	116%	124%	132%
Spousal benefits	35%	37.5%	41.7%	45.8%	50%	50%	50%	50%	50%

Table 4. Average Relative Frequencies of Family States generated from Simulation of Transition Matrix $\Pi_{ij,t}$.

The simulation starts with 40% single women, 40% single men, and 20% couples (all without children present in the household). The given categories encompass the following family states numbers as given in the appendix (table A1): single women without children – 1,7,15,34; single women with children – 8-10,16-18; single men without children – 2,11-14,19,35; single men with children: 20-22 (note: for divorced men children stay with their mother, only widowers have children present in the household); couple without children – 3,23,24-28,28-33; couple with children – 4-6. All life cycle simulations are based on this population model.

Age	20-29	30-39	40-49	50-59	60-69	70-79	80+
Single women							
without children	27%	13%	11%	16%	20%	28%	66%
with children	1%	3%	5%	1%	<0.1%	0%	0%
Single men							
without children	30%	19%	16%	16%	16%	17%	16%
with children	<0.1%	<0.1%	<0.1%	<0.1%	<0.1%	0%	0%
Couples							
without children	24%	21%	31%	59%	65%	55%	19%
with children	17%	43%	37%	8%	<0.1%	0%	0%

Table 5: Effect of Education and Children on Social Security Claiming Decisions

This table shows the frequency of claiming ages for Social Security benefits by sex. The life cycle simulation method is identical to that used in Section 4.2 (see notes to Figure 3). Results are shown for the different education subgroups (high school and college) as well as couples without children and with two or more children (the corresponding households either never had any children or had two or more children at some point in their life cycles).

	High school education		College education		Couples without children		Couples with 2+ children	
Claiming age	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*
62	49%	28%	28%	38%	55%	30%	55%	30%
63	3%	4%	4%	4%	3%	3%	3%	4%
64	5%	7%	5%	5%	4%	4%	4%	5%
65	4%	6%	4%	4%	3%	3%	3%	4%
66	2%	9%	2%	3%	2%	9%	2%	5%
67	4%	5%	3%	3%	2%	1%	1%	3%
68	6%	6%	4%	4%	2%	3%	2%	5%
69	6%	6%	9%	4%	4%	4%	3%	6%
70	21%	28%	43%	35%	25%	44%	27%	37%
Avg. claiming age	65,0	66,1	66,7	65,9	64,7	66,6	64,8	66,4

Table 6: Effect of Education and Children on Stock Holdings as a Fraction of Financial Wealth

This table shows average stock holdings as a fraction of financial wealth for persons in different age groups. The life cycle simulation method is identical to that used in Section 4.2 (see notes to Figure 3). Results are shown for the different education subgroups (high school and college) as well as couples without children and with two or more children (the corresponding households either never had any children or had two or more children at some point in their life cycles).

Age	High school education	College education	Couples without children	Couples with 2+ children
25-34	51%	50%	60%	61%
35-44	60%	61%	64%	59%
45-54	54%	55%	58%	50%
55-64	45%	52%	53%	44%
65-74	46%	52%	53%	48%
75-84	45%	48%	49%	47%

Table 7: Normalized Life Insurance Values
This table shows average life insurance face values by sex for different age groups. The values are given as multiples of the spouse's income assuming full time work (40 hours per week). The life cycle simulation method is identical to that used in Section 4.2 (see notes to Figure 3). Results are shown for the different education subgroups (high school and college) as well as couples without children and with two or more children (the corresponding households either never had any children or had two or more children at some point in their life cycles).

	High school education		College education		Couples without children		Couples with 2+ children	
Age	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*	*Women*	*Men*
25-34	0.32	1.19	0.32	1.16	0.00	1.39	0.84	2.86
35-44	0.81	1.92	0.63	1.75	0.15	2.23	1.70	3.37
45-54	0.58	1.77	0.41	1.62	0.26	2.27	1.16	2.75
55-64	0.04	1.35	0.02	1.25	0.02	1.84	0.07	2.03
65-74	0.00	0.17	0.00	0.19	0.00	0.26	0.00	0.29

Table 8: Empirical Analysis of Social Security Claiming Age Behavior
Our analysis is based on the Health and Retirement Study (HRS) sample constructed by Shoven and Slavov (2012, 2013) and extended for the 2010 wave. The dependent variable refers to the number of months after age 62 that the respondent claimed Social Security benefits. The regression approach uses Tobit estimation since the lower bound of the dependent variable is zero. Explanatory variables are measured as of age 62 and include *Married*: self-reported being married (versus single); *College*: at least some college (versus none); *Children*: number of living children (versus 0); *Male* (versus Female); other terms are interactions as indicated. The mean of the dependent variable is 16.9 months, for an average claiming age of 63.4. Standard errors are given in brackets below the coefficients and the number of stars indicates levels of significance (10%, 5%, 1%). See text for further discussion.

Married	-6.915	***
	(1.183)	
College	4.527	***
	(0.944)	
1 child	3.239	
	(2.698)	
2 children	3.159	
	(2.208)	
3+ children	2.100	
	(2.07)	
Male	-0.525	
	(3.183)	
Male × married	6.888	***
	(1.925)	
Male × college	1.077	
	(1.343)	
Male × 1 child	-1.862	
	(3.969)	
Male × 2 children	-2.982	
	(3.304)	
Male × 3+ children	-0.860	
	(3.136)	
Constant	15.235	***
	(2.023)	
Number of observations	3542	

Table 9: Simulated Behavioral Effects of Eliminating Social Security Spouse or Survivor Benefits

This table shows average claiming age, life insurance face values, paid work hours, and asset allocations for the base case parameterization, a case with no spousal benefits, and a case with no survivor benefits. The same simulation method is used as in Section 4.2 (see notes to Figure 3). The simulations for the latter two cases are based on new optimal feedback controls which account for the removal of the corresponding benefits. Averages are shown for the subgroup of couples in the 50-69 age bracket.

	Base Case	No Spousal Benefits	No Widow Benefits
Wife's avg. claiming age	64.8	64.8	68.8
Husband's avg. claiming age	66.5	66.5	65.3
Average over Ages 50-69			
Wife's life insurance ($000)	3.8	3.8	3.7
Husband's life insurance ($000)	66.3	66.2	84.7
Wife's work hours	28.3	28.4	32.8
Husband's work hours	36.8	36.7	35.3
Stock allocation	50%	50%	50%

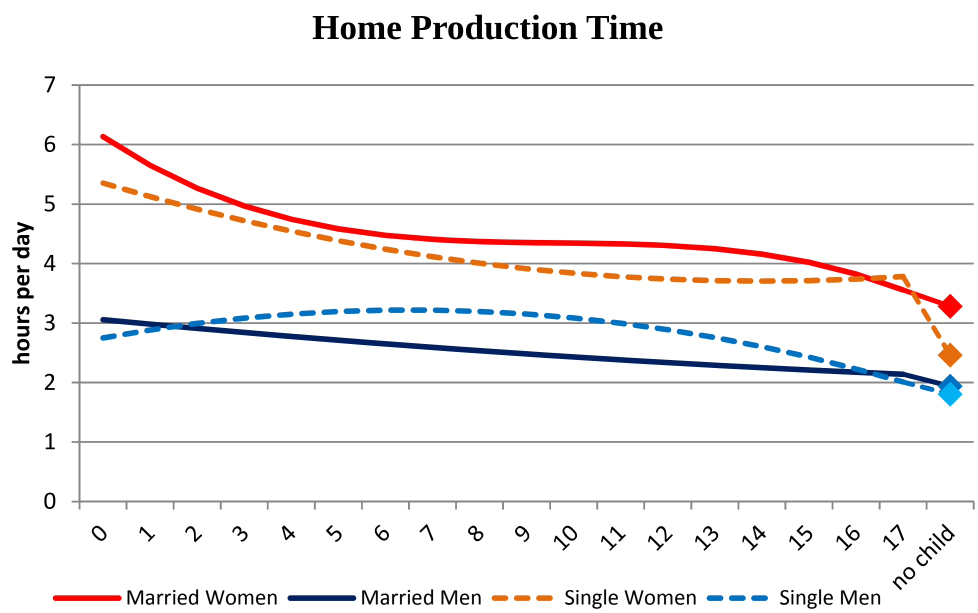

Figure 1: Time Spent on Home Production by Age of Youngest Child: by Sex and Marital Status.

This is a graphical representation of results from the wage regression in Table 1. Time spent on home production is shown for the case of one child in the household. For each of the four subsamples, the last data point gives the home production time if no child is present. In the life cycle model, only the difference in these levels is used for the parameterization of child care time $\theta^{i}_{s,t}$.

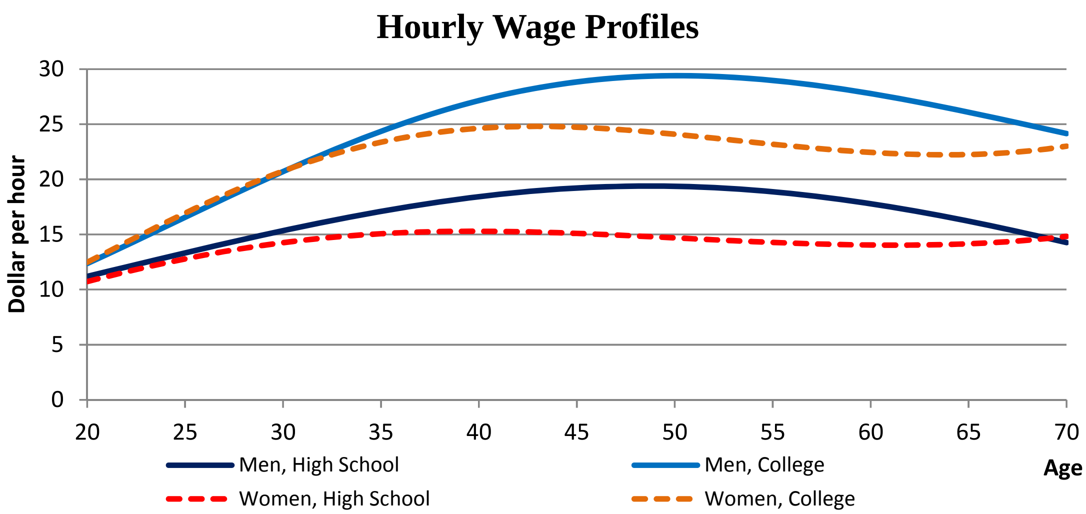

Figure 2: Hourly Wage Rate by Sex, Marital Status, and Education

This is a graphical representation of results from the wage regression in Table 2. For the four subgroups, the mean wage in dollars per hour in dependence of age is shown for the specification of working full time, living together with a spouse, and no children under 18 present in the household.

Figure 3: Expected Life Cycle Profiles: Entire Population

The three panels show simulated life cycle profiles for the complete population (singles and couples with high school or college education) at various ages: (Panel A) average levels of wealth, consumption, stock holdings, and face value of life insurance holdings (men and women); (Panel B) average work hours for men and women; and (Panel C) percentage of men and women claiming Social Security benefits at each age from 62 to 70. Averages are generated from 100,000 independent simulations. Simulation paths are based on optimal feedback controls from the baseline specification of the life cycle model. Averages for wealth, consumption and stock holdings in Panel A aggregate across men and women weighted with survival probabilities. Parameters of the model include the following: risk aversion $\gamma = 5$, discount rate $\beta = 0.96$, leisure preference $\alpha = 0.8$, (uncertain) consumption scaling factor ϕ depends on family size, equity risk premium 4%, initial fraction of couples 20%, fraction of college education 40.3%.

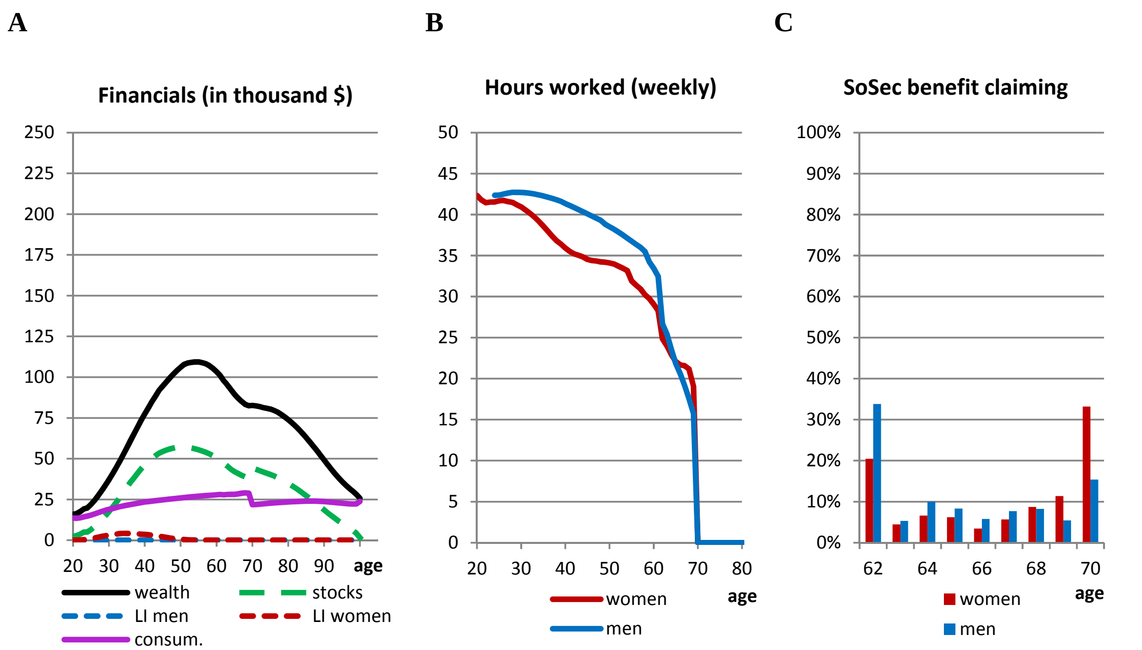

Figure 4: Expected Life Cycle Profiles: Single Men and Women

The three panels show simulated life cycle profiles for singles at various ages: (Panel A) average levels of wealth, consumption, stock holdings, and face value of life insurance holdings (men and women); (Panel B) work hours (men versus women); and (Panel C) percentage of households claiming Social Security benefits (men versus women) at each age from 62 to 70. Averages are generated from 100,000 independent simulations based on optimal feedback controls. At each age, we extract the subgroup of singles (women or men). All reported values are calculated as (conditional) mean from the subgroup of singles. Averages for wealth, consumption and stock holdings (Panel A) aggregate across men and women. See also Figure 3.

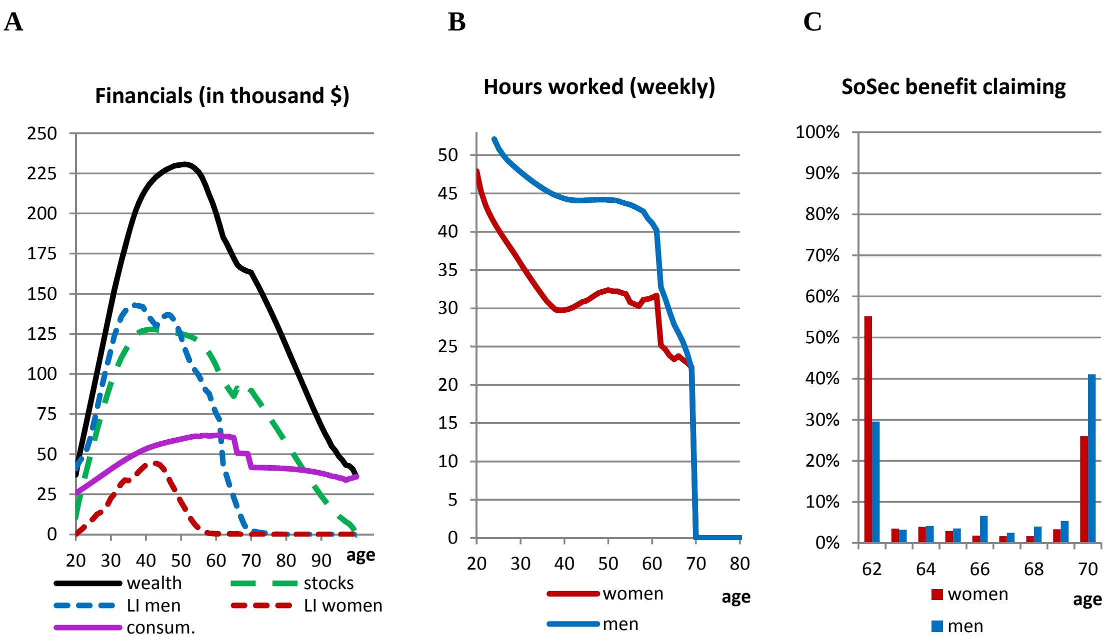

Figure 5: Expected Life Cycle Profiles: Couples

The three panels show simulated life cycle profiles for couples at various ages: (Panel A) average levels of wealth, consumption, stock holdings, and face value of life insurance holdings (men and women); (Panel B) work hours (men versus women); (Panel C) percentage of households claiming Social Security benefits (men versus women) at each age from 62 to 70. Averages are generated from 100,000 independent simulations based on optimal feedback controls. At each age, we extract the subgroup of couples. All reported values are calculated as (conditional) mean from the subgroup of singles. Averages for wealth, consumption and stock holdings (Panel A) are reported for couples, sorted according to the wife's age. See also Figure 3.

Appendix A: Family States Modeled in Our Study

This table shows the different family states in our model. The third column lists the states to which stochastic transitions are possible. The fourth column lists states to which transitions are possible by one or both spouses claiming retirement benefits.

State number	Description	Possible stochastic transitions	Possible claiming transitions
1	single woman (never married)	1, 3	34
2	single man (never married)	2, 3	35
3	couple without children	3-4, 7-8, 11-12, 15-16, 19-20	23,24-28, 29-33
4	couple with 1 child	3-5, 7-9, 11-13, 15-17, 19-21	-
5	couple with 2 children	4-6, 8-10, 12-14, 16-18, 20-22	-
6	couple with 3 or more children	5-6, 9-10, 13-14, 17-18, 21-22	-
7	divorced woman without children	3,7	34
8	divorced woman with 1 child	3-4, 7-8	-
9	divorced woman with 2 children	4-5, 8-9	-
10	divorced woman with 3 or more children	5-6, 9-10	-
11	divorced man without children	3, 11	35
12	divorced man with 1 child	3-4, 11-12	-
13	divorced man with 2 children	4-5, 12-13	-
14	divorced man with 3 or more children	5-6, 13-14	-
15	widow without children	3, 15	34
16	widow with 1 child	3-4, 15-16	-
17	widow with 2 children	4-5, 16-17	-
18	widow with 3 or more children	5-6, 17-18	-
19	widower without children	3, 19	35
20	widower with 1 child	3-4, 19-20	-
21	widower with 2 children	4-5, 20-21	-
22	widower with 3 or more children	5-6, 21-22	-
23	couple with retired wife	19, 23, 34	29-33
24	couple with retired husband (claimed at 66 or before)	15, 24, 35	29
25	couple with retired husband (claimed at 67)	15, 25, 35	30
26	couple with retired husband (claimed at 68)	15, 26, 35	31
27	couple with retired husband (claimed at 69)	15, 27, 35	32
28	couple with retired husband (claimed at 70)	15, 28, 35	33
29	retired couple (husband claimed at 66 or before)	29, 34, 35	-
30	retired couple (husband claimed at 67)	30, 34, 35	-
31	retired couple (husband claimed at 68)	31, 34, 35	-
32	retired couple (husband claimed at 69)	32, 34, 35	-
33	retired couple (husband claimed at 70)	33, 34, 35	-
34	single retired woman	34	-
35	single retired man	35	-

Appendix B: Summary Statistics on Wealth and Work Hours for the PSID

Besides the claiming decision, the life cycle profiles of financial wealth and work hours are the central results of our model (see Section 4.1). In the Table below, we present the corresponding empirical data from the Panel Study of Income Dynamics (PSID) for comparison purposes. For work hours, which we also use for inferring the wages in Section 3.3, we use the more recent subsample of waves '95 to '11 limit to observations with positive work hours excluding all unemployed persons. We use waves '99 to '11 (wealth supplement) for financial wealth and include in its definition liquid wealth (checking, savings, stocks, mutual funds, bond funds, life insurance), balances in Individual Retirement Accounts (IRA), and the household's labor income for one year. We do not explicitly model illiquid Individual Retirement Accounts, but as retirement income in our model only comprises Social Security, Individual Retirement Accounts are represented in our model as part of financial wealth. In the real world, there is a gap between the time of receiving income and consumption. In our life cycle model, we report wealth before a full year of consumption is complete, and thus annual consumption should be included in the definition of financial wealth for comparability. Nevertheless, these data are not available in the PSID, so we use annual salary as a proxy. We exclude real estate net wealth, since in our model expenditures on housing are directly subtracted from labor income and do not contribute to wealth (see Formula (10)). If a household has two or more observations in the same age bracket, we treat it as only one observation using its mean wealth over the relevant waves.

Summary Statistics for Wealth Measures and Work Hour Profiles by Marital Status and Sex, in the Panel Study of Income Dynamics. Authors' tabulations ($2011).

	Age Group				
	30	40	50	60	70
Average Wealth (in thousand $)					
Complete Pop.	50.3	90.4	141.4	187.9	229.6
Singles	37.4	47.0	70.5	86.0	114.8
Couples	69.5	123.9	193.4	256.1	304.7
Average Work Hours (Weekly)					
Complete Pop.					
Men	44.4	44.9	44.5	42.6	33.9
Women	38.4	37.9	38.4	37.1	27.3
Singles					
Men	43.7	42.5	42.7	39.6	34.1
Women	39.4	39.6	39.9	38.6	28.4
Couples					
Men	44.7	45.4	44.8	43.1	33.9
Women	37.9	37.2	37.7	36.3	26.2

Appendix C: Additional Details on the Model Structure

The optimization problem is homothetic in the permanent wage component P_t. To decrease computational effort, we normalize all in dollar denoted quantities by P_t. Accordingly, utility can be written as

$$J_t\left(W_t, P_t, PIA_t^x, PIA_t^y, s_t\right) = (P_t)^{1-\gamma} j_t\left(w_t, pia_t^x, pia_t^y, s_t\right) \quad \text{(C1)}$$

and the permanent wage component is effectively eliminated as a state variable (lower case symbols denote their normalized counterparts, e.g. $w_t = W_t/P_t$). We discretize the state space $\left[w_t, pia_t^x, pia_t^y\right]$ on a 20x18x18 grid for couple family states and on a 20x18 grid for single family states. The model is solved by backward induction, as on every grid point, the optimal control variables are solved by evaluating the expectation of the future value function using Gaussian quadrature integration over the stock returns, shocks to permanent wage, and transitory wage shocks.

Regarding the calculation of the PIA, we make two simplifications to keep the model tractable. The first regards the Average Indexed Monthly Earnings which is the average over the best 35 years. Hence we would need 35 state variables (per spouse) to track the AIME correctly. In our model, the AIME is the average income in the first 35 years and after that it is only increased if the current income is higher than the previous AIME. As already mentioned, we use the PIA as a state variable instead. Let f denote the concave, piece-wise linear function that converts the AIME into the PIA. Then the evolution equations for the PIA are:

$$PIA_{t+1}^i = f\left(\frac{(t-1)\cdot f^{-1}\left(PIA_t^i\right) + Y_t^i}{t}\right) \quad \text{for } t \leq 35 \quad \text{(C2)}$$

$$PIA_{t+1}^i = \max\left(PIA_t^i, f\left(\frac{34\cdot f^{-1}\left(PIA_t^i\right) + Y_t^i}{35}\right)\right) \quad \text{for } t > 35 \quad \text{(C3)}$$

The second problem arises from the normalization by the permanent wage component. Since all quantities denoted in dollar values are denoted in *normalized* dollars, the bend points in f set by the Social Security rules cannot be exactly determined. For the purpose of the calculating the PIA we make the assumption that the permanent wage component is 1 (i.e., the household has an average wage rate).[47] Because of the concavity of f, this has the effect that the contribution of the current income Y_t^i to the PIA is overestimated for households with higher permanent wage and underestimated for lower permanent wage.

In contrast to the optimization, it is easily possible to track the permanent wage component and the correct PIA without simplifications during the simulations. When comparing the correct PIA (with the permanent wage component used as a state variable) to the PIA used in the model for the simulated population, their ratio at the earliest retirement age has a mean very near to one (1.0065) and the standard deviation of the logarithm of the ratio is 14.9%. This means that there is no systematic over- or underestimation caused by our assumptions; roughly speaking, the PIAs in our model differ, on average, by 14.9% from actual values. Even with this approximation error, the retirement benefits captured by our model are much less distorted by shocks to permanent wage/income than in models where retirement benefits are a fixed fraction of the last year's labor income. This is because, in our model, a negative shock to permanent wage shortly before retirement would produce only a slight underestimate of this period's income to the PIA (which may be only one of 35 incomes or not considered at all, if the average is high enough). In previous models, a negative shock to permanent income directly decreases the retirement income by the same (relative) amount, which is clearly an overstatement of the actual rules.

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[47] We make the same simplification for the retirement earnings test. The exempt amount in normalized dollars is assumed to be equal to the amount in real dollars, resulting in households with higher permanent wages being taxed slightly less than and low wage households being taxed slightly more under the retirement earnings test.