Economic Analysis of Social Security Survivors Insurance

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Abstract

This paper develops a heterogeneous agents model to analyze the effects of Social Security survivors insurance. The model features a negative mortality-income gradient, asymmetric information of individual mortality rates, and a warm-glow bequest motive that varies by age and family structure. The model matches lifecycle changes in life insurance coverage, and generates advantageous selection in the insurance market. For male agents, reducing survivors benefits for dependent children generates welfare losses, while reducing survivors benefits for aged spouses produces welfare gains. The opposing welfare results are explained by differences in the timing of benefits and in the funding cost.

JEL: D15, D82, E21, G22, H55

Keywords: Social Security, bequest motive, life insurance, asymmetric information

1 Introduction

The Social Security trust fund is expected to be depleted in 2035, and major changes in the Social Security program are anticipated to resolve its long-term solvency issue (Social Security Administration, 2015a). There is large and expanding literature that uses heterogeneous agents models to study Social Security Old-Age Insurance (OAI) reforms, but considerably less attention has been given to Social Security survivors insurance, which composes 13

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percent of total benefit outlays in 2014.[1] In particular, none of the previous analyses of survivors insurance have used a framework where mortality rates and the probability of receiving survivors benefits are decreasing with income (Kitagawa and Hauser, 1973; Duleep, 1986; Deaton and Paxson, 2001; Cristia, 2009; Chetty et al., 2016).[2] To fill the gap in the literature, this paper extends the Bewley-Huggett-Aiyagari framework to include a negative income-mortality gradient and the opportunity to purchase life insurance, and uses it to study the long-term effects of reducing survivors benefits.

The model assumes that male agents make decisions for the household and derive a warm-glow utility from leaving bequests.[3] The baseline bequest motive is allowed to vary by age and across four types of family structures: single men without children, single men with children, married men without children, and married men with children. In response to changes in survivors benefits, agents can adjust their holdings of life insurance and risk-free assets to reach the desired amount of bequests. The insurance firm observes an imperfect measure of individual mortality risks, and offers a one-sided long-term life insurance contract with a fixed uniform unit price for all agents with the same risk measure. Consistent with findings of Cawley and Philipson (1999) and McCarthy and Mitchell (2010), the model generates advantageous selection in the life insurance market: conditional on observed risk factors, insured agents have a lower average mortality rate than the uninsured. This is because bequests are luxury goods, and agents with lower mortality rates have higher income and are more likely to purchase life insurance to increase the size of (potential) bequests. Under the alternative assumption that bequests are normal goods, there is adverse selection in the insurance market.

To understand the economic implications of providing survivors insurance, I implement

[1] In 2014, the total benefit outlays of the Social Security program were \$848.4 billion, among which \$19.2 billion were paid to surviving children and \$93.2 billion were paid to surviving aged spouses.

[2] For example, see Chambers et al. (2011), Hong and Ríos-Rull (2012), Kaygusuz (2015) and Bethencourt and Sánchez-Marcos (2016).

[3] The demand for life insurance is derived from a warm-glow bequest motive rather than a household joint decision, because I want to capture the empirical finding that many individuals, especially young fathers, do not hold sufficient life insurance to protect survivors from consumption drops upon their death (Auerbach and Kotlikoff, 1987, 1991; Hurd and Wise, 1996; Bernheim et al., 2003a,b).

two counterfactual experiments that separately reduce survivors benefits for dependent children (SBDC) and survivors benefits for aged spouses (SBAS) by 23 percent, the projected reduction in Social Security benefits in 2035 when the trust fund is depleted (Social Security Administration, 2015a). In these experiments, labor tax rates and insurance unit prices are adjusted, respectively, to balance the government budget and to satisfy the zero-profit condition of the insurance firm. The model suggests that reducing SBDC causes a 0.03 percent increase in consumption, a 2.38 percent increase in insurance premium expenditures, a 0.25 percent decrease in bequests left by deceased agents, a 0.04 percent increase in risk-free assets, and a 5.29 percent increase in insurance face values. The change in premium expenditures is different from the change in insurance face values, because the unit price varies substantially across agents. Reducing SBAS causes a 0.45 percent increase in consumption, a 0.63 percent increase in premium expenditures, a 0.41 percent fall in bequests left by deceased agents, a 1.46 percent increase in risk-free assets, and a 1.96 percent fall in insurance face values. Reducing SBAS has a much larger impact on most aggregate variables mainly because the funding cost for SBAS is 10 times as large as the funding cost for SBDC.

Turning to welfare, reducing SBDC generates a welfare loss equivalent to a 0.28 percent reduction in lifetime consumption. The magnitude of the welfare loss falls with respect to permanent income, indicating that low-income agents who have high mortality rates and high marginal utilities of consumption lose more from reducing SBDC than high-income agents. In addition, reducing SBDC reallocates resources away from young agents and from agents with children, both of whom tend to have a high marginal utility of consumption. Under the veil of ignorance, the benefits from redistribution outweigh the cost of funding SBDC. On the contrary, reducing SBAS generates a welfare gain equivalent to a 0.40 percent increase in lifetime consumption, with agents of different permanent income levels benefiting from the experiment to a similar extent. The opposing welfare implications of reducing SBDC and reducing SBAS are robust to alternative assumptions about the behavior of life insurance firms and alternative specifications of the bequest motive. This is because a new generation always discounts heavily the value of insurance obtained later in life under the SBAS program but discounts little the value of insurance obtained earlier in life under the SBDC program, and because the funding cost for SBAS is always much greater than the funding cost for SBDC.

This paper complements three strands of existing research. The first strand is the structural analysis of Social Security reforms.[4] Within this literature, Chambers et al. (2011) and Hong and Ríos-Rull (2012) are the two other papers that consider survivors benefits in a framework that includes the life insurance market: Hong and Ríos-Rull (2012) evaluate the effect of eliminating SBAS; Chambers et al. (2011) study the effect of simultaneously eliminating SBDC and SBAS. This paper differs from the previous literature by studying a setting where: 1) mortality rates decline with income; 2) insurance firms have imperfect information about individual mortality rates; and 3) the amount of survivors benefits varies by the agent's income and by the age of survivors.

The second strand studies the demand for life insurance using two alternative approaches. The first approach specifies a bequest preference independent of life insurance holdings (Chambers et al., 2003, 2011; Love, 2010; Hubener et al., 2013, 2016), and concludes that it is hard to match the observed life-cycle profile of insurance coverage. The second approach takes actual insurance coverage as data targets to discipline the preference (Hong and Ríos-Rull, 2007, 2012) or the income loss associated with death (Krebs et al., 2015). In this paper, I take the second approach, and use actual insurance coverage to discipline the bequest motive. The contribution of this paper is to examine life insurance demand in a setting with a negative income-mortality gradient. This innovation allows the model to generate advantageous selection in the life insurance market.

The third strand studies selection in insurance markets.[5] The framework developed in this paper is similar in spirit to two models developed by Lockwood (2014), who studies the

[4]see Feldstein and Liebman (2002) for a review.

[5]See Cohen and Siegelman (2010) and Einav et al. (2010) for a summary. Within this literature, Fang and Kung (2012) develop a structural model to study lapsation of life insurance among individuals aged 50 and older.

annuity and long-term care markets, and Hosseini (2015), who studies the annuity market. Compared to their work, this paper studies a different market and adds two margins of adjustments—individuals can purchase insurance at different points of life and can reduce or cancel existing coverage.

The remainder of the paper is organized as follows: Section 2 provides institutional context; Section 3 describes the model; Section 4 presents the calibration; Section 5 shows the benchmark economy; Section 6 conducts policy experiments; and Section 7 concludes.

2 Institutional Context

2.1 Survivors Benefits

Under the SBDC program, each surviving child under the age of 18 is eligible to receive 75 percent of the deceased father's Primary Insurance Amount (PIA), the amount of OAI benefits a worker would receive if claimed at the Normal Retirement Age (NRA). In 2014, the average monthly SBDC payment for each surviving child was $841 (Social Security Administration, 2015b), and the average benefit for an eligible single-parent family with two dependent children was $1,682. In comparison, as of July 2015, the monthly benefit from the Temporary Assistance for Needy Families (TANF) program for the same type of families ranged from $170 (Mississippi) to $923 (Alaska) (Center on Budget and Policy Priorities), about 10 to 55 percent of the average benefit received from SBDC.

The rules for SBAS are more complicated since the benefit amount depends on the amount the spouse would receive if the husband was still alive. When the husband is alive, an aged wife could claim workers benefits based on her own work history, or claim spousal benefits based on her husband's work history. Spousal benefits equal 50 percent of husband's PIA if a claim is made at the NRA. In 2014, for the average female beneficiary, the amount of retired workers benefits was $1,167, and the amount of spousal benefits was $682. Upon her husband's death, the aged widow will receive the maximum of her own benefits and the deceased husband's benefits. In 2014, the average monthly SBAS payment for widows was \$1,280. In comparison, in 2014, the monthly maximum federal amount from the Supplemental Security Income program for an eligible elderly individual was \$721. The total amount of SBAS could be decomposed into the amount of benefits received if the husband was still alive and the amount of additional benefits received contingent on the husband's death. This paper counts *only* the second amount, *the death contingent payments*, as SBAS.

2.2 Types of Life Insurance Policies

There are three types of life insurance policies: individual insurance, group insurance, and credit insurance. Individual insurance is the most widely used form of insurance contract, and accounts for 58 percent of all life insurance in force in the year of 2013 (ACLI, 2014). Individual insurance has two basic forms: term policies that offer death contingent protections for a specified period of life, and permanent policies that allow policy holders to build up cash values and offer death contingent protections until death. Permanent policies are a combination of a saving component, which accumulates tax-deferred investment returns and pays the cash value upon policy surrender, and an insurance component, which pays the face value upon death. Of new individual policies sold in 2013, 66 percent of face amount is issued in the form of term insurance. Level term insurance, which has a fixed price for the duration of the contract, is the most popular form of term insurance and composes 93 percent of the total face value of term insurance that is issued (ACLI, 2014).

Group life insurance is a term contract between an insurance firm and a particular group, and group insurance premiums are rated based on the group's mortality risks for a specified period of time. Typically, the purchase of group life insurance does not require underwriting and may be subsidized or compulsory, e.g., employer-provided life insurance. Credit life insurance is a part of consumer credit contracts, and is a term contract used to cover the amount of outstanding balance on a loan if the borrower dies. Credit life insurance comprises about 0.4 percent of all life insurance in force in 2013 (ACLI, 2014).

2.3 The Underwriting Process for Life Insurance Contracts

Insurance firms use underwriting to place applicants into groups with roughly equivalent risk levels. A typical underwriting process involves two steps. First, applicants provide information on age, sex, current physical conditions, family medical history, occupation, drug and alcohol use, and driving violations. Second, the insurance firm verifies information using Motor Vehicle Department Records, Pharmacy Records, and a medical examination. The information collected in both steps is stored at the Medical Insurance Bureau and shared among insurance firms to check against potential errors, omissions or misrepresentations made on insurance applications.

Based on the observed characteristics, applicants are classified into one of the acceptable risk pools or the rejected risk pool. Hendren (2013) argues that private information held by potential applicants explains rejections. Using the underwriting guideline of several major insurance firms, he finds that for individuals aged 65 and above in the Health and Retirement Study (HRS) sample, 20 percent would be rejected if they applied for new life insurance coverage. Among the group who have rejection conditions, 63.3 percent are currently insured, most likely because they purchased a long-term insurance contract prior to the onset of rejection conditions or because they have a group policy. As shown below, the model assumes that insurance firms deny coverage to individuals aged 85 and above to capture the use of rejection conditions, and that insurance firms receive a noisy signal about individual mortality risks to capture the information collected from the underwriting process.

3 Model

The economy is composed of heterogeneous agents, an insurance firm, and a government. Each period, agents choose consumption, risk-free assets, the renewal of existing insurance and the purchase of new insurance. The insurance firm observes an imperfect measure of individual mortality risks, and offers a one-sided long-term life insurance contract with a fixed uniform unit price for all agents with the same risk measure. The government collects taxes and provides the Social Security program and means-tested social insurance.

3.1 Demographics

The economy is populated by overlapping generations of a constant size. Let $j \in \{1, 2, \ldots, J\}$ denote the age of agents, where J represents the maximum life span. Agents supply one unit of labor from periods 1 to $Jr - 1$ and retire at period Jr. Let $s_j(e_j)$ denote the probability of survival to the next period for an agent of age j and with earnings index e_j, which summarizes earnings history.

3.2 Family Structure

The model assumes that the male agent makes decisions for the household. Let m_j denote marital status ($= 1$ for married and $= 0$ for singles) and n_j^n denote the number of children. Marital status changes stochastically over the life cycle, following a Markov process with transitions $\Pi_j^m(m_{j+1}|d, m_j, n_j^n)$, where d is an indicator that records whether the agent has a bachelor's degree ($d = 1$) or not ($d = 0$).

To maintain tractability, I assume that agents face uncertainty only about whether and when to have the first child, and that the birth of the second child is deterministic (contingent on the agent's survival).[6] This assumption makes it possible to use one state variable—the agent's age when the first child was born (n_j^a)—to record both the number of children (n_j^n) and the age of each child. n_j^a equals 0 for agents without children. The number of children follows a process with transitions $\Pi_j^n(n_{j+1}^n|d, m_j, n_j^n)$.

[6] In the Survey of Income and Program Participation 2001 Panel, 32 percent of fathers aged 20-64 have 3 or more children, and their average life insurance coverage is $1,908 less (insignificantly) than that for fathers with 2 or fewer children (after controlling for the difference in marital status, age, and log income). Given this small difference, I truncate the number of children to a maximum of 2, although it is possible that the observed similar level of insurance coverage is a result of two offsetting channels: 1) fathers with more children may have a greater bequest motive than fathers with fewer children and so demand more insurance; 2) the additional number of children lowers adult equivalent consumption and so depresses insurance demand.

3.3 Earnings and The Earnings Index

Household earnings are:

$$w_j = \chi_j(m_j, n_j^a)\tilde{w}(d)\varepsilon_j \eta \iota_j \tag{1}$$

where $\chi_j(m_j, n_j^a)$ denotes the ratio of household earnings to personal earnings of male agents, and is an exogenous parameter. $\tilde{w}(d)$ is the unit wage for agents with education d, and ε_j represents an age specific productivity component. η is a permanent productivity component that is determined before entering the economy, and ι_j is a transitory productivity component that changes stochastically over time according to transitions $\Pi^{\iota}(\iota_{j+1}|d, \iota_j)$.

Agents enter the economy with an earnings index of zero ($e_0 = 0$). The value of the earnings index is updated each period according to:

$$e_j = \begin{cases} ((j-1)e_{j-1} + \tilde{w}(d)\varepsilon_j \eta \iota_j)/j & 1 \leq j < Jr \\ e_{j-1} & j \geq Jr \end{cases} \tag{2}$$

3.4 Government

Tax Collection and Direct Spending: Taxes are collected from three sources: earnings at a rate of τ^l, consumption expenses at a rate of τ^c, and interest income at a rate of τ^k. Direct spending G equals the amount of tax revenue that is in excess of transfer payments in the benchmark economy, and is kept unchanged in all counterfactual economies.

Social Security Program: Upon reaching the retirement age of Jr, each agent receives an OAI benefit that equals his Primary Insurance Amount (PIA), which is a piece-wise linear function of the earnings index ($PIA(e_j)$).[7] The spouses' OAI benefits are a fixed fraction of the agent's OAI benefits, and this fraction varies by the number of children. Let $R_j(e_j, m_j, n_j^a)$ denote the total OAI benefits for a household.[8]

[7]In practice, $\max\{2, x - 21 - 5\}$ years of earnings are used for the basis of calculating PIA, where x equals 61 for OAI and SBAS and equals the age of death for SBDC.

[8]For the aim of simplicity, the model abstracts from the earnings test, the benefit taxation of Social

Under the SBDC program, each child under the age of 18 will receive 75 percent of the deceased father's PIA.[9] Under the SBAS program, each aged spouse will receive the maximum of her own OAI benefits or the deceased husband's OAI benefits. Let $S_j(e_j, m_j, n_j^a)$ denote the present value of *additional* Social Security benefits that survivors will receive if an agent dies in the next period, which is the amount that agents count towards bequests.

Means-tested Social Insurance: Means-tested social insurance can be thought as a combination of TANF, Supplemental Nutrition Assistance, Supplemental Security Income, and Medicaid. Following the practice established by Hubbard et al. (1995), means-tested social insurance supports an adult equivalent consumption floor of $\underline{c}$ by providing a lump-sum transfer at the beginning of each period.

3.5 Insurance Firm

A representative insurance firm provides life insurance contracts to all agents under age J^I. This age limit reflects the unwillingness of insurance firms to offer contracts to older agents who often have rejection conditions (Hendren, 2013). I further assume that the firm knows the applicant's age and receives a noisy signal about his earnings index. This signal can be thought of smoking status, obesity, and morbidity, which are observed through underwriting and are known to have a strong association with the earnings index (Adler et al., 1994; Case et al., 2002; Truong and Sturm, 2005; Kim and Leigh, 2010; Agaku et al., 2014). The firm uses this information to derive the risk measure ϱ_j and assigns agents into different risk pools. All agents in one risk pool share the same risk measure. The firm offers a one-sided long-term life insurance contract with the fixed uniform unit price $p_j^{new}(\varrho_j)$ for all agents

Security, and the choice of retirement and of claiming Social Security benefits. See, for example, İmrohoroğlu and Kitao (2012) and Jones and Li (2017) for a model that incorporates these features.

[9] SBDC eligibility requires a person to be "fully insured" *or* "currently insured"; OAI and SBAS eligibility requires a person to be "fully insured". "Fully insured" means that the person has earned one credit for each year after age 21 and before the year of death, with a minimum of 6 credits. "Currently insured" means that the person has earned 6 credits in the last 13 quarters ending in the quarter of death. In 2016, a person must earn \$1,260 in covered earnings to get one credit and \$5,040 to get the maximum of four credits for the year.

with the risk measure ϱ_j.[10] Contracts expire with probability δ in each future period. All remaining contracts expire when age J^I is reached.[11]

The unit price of life insurance for agents with risk measure ϱ_j has the following form:

$$p_j^{new}(\varrho_j) = (1+\omega)p_j^{new*}(\varrho_j) \tag{3}$$

where ω is an adjustment factor that lets the insurance firm earn zero profits in equilibrium and is the same for all risk pools. $p_j^{new*}(\varrho_j)$ is the base price, the actuarially fair price for an agent who has the average mortality rate of the risk pool and keeps the coverage until it expires.[12] The underlying pricing assumption is in line with the current state of life insurance predictive models—insurance firms mainly rely on estimates of life expectancy to price their products (Batty et al., 2010).

3.6 Agent Problem

Agents differ by their age j and a nine-element state vector $\mathbf{z}_j = \{a_j, e_j, d, \eta, \iota_j, m_j, n_j^a, p_j^p, q_j^p\}$, where a_j denotes risk-free assets held at the beginning of each period, e_j denotes the earnings index, d denotes education, η denotes permanent productivity, ι_j denotes transitory productivity, m_j is current marital status, n_j^a is the age when the first child was born, p_j^p is the unit price for existing insurance coverage, and q_j^p is the quantity of existing insurance coverage.

[10] Cawley and Philipson (1999) find evidence for bulk discounts in the coverage amount: for the contracts offered by the Teachers Insurance and Annuity Association, the bulk discount was 25 percent for an award between \$0.25-0.5 million, and 30 percent for an award between \$0.5-1.0 million. Since the magnitude of the discount is moderate, for the aim of simplicity, the model abstracts from this feature.

[11] I would like to thank the anonymous referee for the suggestion to incorporate asymmetric information and to consider one-sided long-term contracts. As discussed in Section 2, this form of contract best resembles the most popular type of life insurance policies.

[12] The base price is derived from the following equation:

$$\sum_{k=j}^{J^I-1} p_j^{new*}(\varrho_j)(1-\delta)^{k-j}\Pi_{l=j}^{k-1}\overline{s}_l(\varrho_j) = \sum_{k=j}^{J^I-1}(1-\delta)^{k-j}(1-\overline{s}_k(\varrho_j))\Pi_{l=j}^{k-1}\overline{s}_l(\varrho_j)$$

where $\overline{s}_l(\varrho_j)$ is the average one period survival rate for all agents of age l who received the risk measure ϱ_j at age j. A common markup is needed, because imposing a break-even condition for each risk pool individually may cause trading in some pools to collapse to zero.

(The risk measure (ϱ_j) can be expressed as a function of other state variables.)

At the beginning of each period, agents choose aggregate household consumption (c_j) for the current period, risk-free assets (k_{j+1}) for the next period, the fraction (x_j) of existing life insurance they want to renew, and the amount (q_j^{new}) of new life insurance they want to purchase. Agents cannot borrow ($k_{j+1} \geq 0$) or sell life insurance ($q_j^{new} \geq 0, x_j \geq 0$). At the end of each period, a survival shock is realized: agents who die receive a warm-glow utility from leaving bequests (b_{j+1}), and agents who survive learn their next period state vector $\mathbf{z}_{j+1} = \{a_{j+1}, e_{j+1}, d, \eta, \iota_{j+1}, m_{j+1}, n_{j+1}^a, p_{j+1}^p, q_{j+1}^p\}$.

In recursive form, the agents' problem is:

$$\begin{aligned} V_j(\mathbf{z}_j) = \max_{c_j, q_j^{new} \geq 0, x_j \in [0,1], k_{j+1} \geq 0} & \{u_j(c_j, m_j, n_j^a) + \beta(1 - s_j(e_j))v_j(b_{j+1}, m_j, n_j^a) \\ & + \beta s_j(e_j) E_j V_{j+1}(\mathbf{z}_{j+1})\} \end{aligned}$$

subject to equations (1), (2) and:

(4) $$tr_j = \max\{0, (1+\tau^c)\zeta_j(m_j, n_j^a)\underline{c} - [(1 + r(1-\tau^k))a_j + (1-\tau^l)w_j + R_j - h_j]\}$$

(5) $$(1+\tau^c)c_j = (1 + r(1-\tau^k))a_j + (1-\tau^l)w_j + R_j - h_j + tr_j - k_{j+1} - p_j^{new} q_j^{new} - x_j p_j^P q_j^P$$

(6) $$b_{j+1} = (1 + r(1-\tau^k))k_{j+1} + q_j^{new} + x_j q_j^P + S_j,$$

(7) $$a_{j+1} = A(k_{j+1}, m_j, n_j^a, m_{j+1}, sd_{j+1})$$

(8) $$p_{j+1}^P = \begin{cases} \frac{q_j^{new} p_j^{new} + x_j q_j^P p_j^P}{q_j^{new} + x_j q_j^P} & \text{w/p. } 1-\delta \text{ and } j+1 < J^I \\ 0 & \text{w/p. } \delta \text{ or } j+1 \geq J^I \end{cases}$$

(9) $$q_{j+1}^P = \begin{cases} q_j^{new} + x_j q_j^P & \text{w/p. } 1-\delta \text{ and } j+1 < J^I \\ 0 & \text{w/p. } \delta \text{ or } j+1 \geq J^I \end{cases}$$

where $V_j(\mathbf{z}_j)$ denotes the value function for an agent with state vector $\mathbf{z}_j$ at age j. β is a discount factor. $u_j(c_j, m_j, n_j^a)$ denotes the utility from consumption, and $v_j(b_{j+1}, m_j, n_j^a)$

denotes the utility from bequests.

Equation (4) defines the amount of means-tested transfers tr_j, where $\zeta_j(m_j, n_j^a)$ is a scale factor that converts adult equivalent consumption into household aggregate consumption and h_j is exogenous medical expenses, which vary by age and family structure. Equation (5) describes the budget constraint. Equations (6) describes the three components of bequests: after-tax gross return of risk-free assets, life insurance payments, and the present value of survivors benefits.[13] Equation (7) is a law of motion for risk-free assets, which incorporates the effect of marriage and divorce on household wealth. sd_{j+1} is an indicator function that takes the value of 1 if the termination of marriage is due to the death of a spouse, in which case $a_{j+1} = k_j$, and 0 otherwise. Equations (8) and (9) describe the law of motion for the price and the quantity of existing life insurance. Agents enter the economy with zero insurance holdings ($q_1^P = 0$).

3.7 Stationary Equilibrium

Definition A stationary equilibrium is a collection of government policies, life insurance prices, policy functions, and a distribution $\mu(\tilde{\mathbf{z}})$ of agents, where $\tilde{\mathbf{z}} = [\mathbf{z}_j', j]'$, such that the following conditions hold.

1. Given government policies and life insurance prices, policy functions are the solution to the agent problem described in Section 3.6.

2. The government budget is balanced:

$$\int (\tau^l w + \tau^c c + \tau^k ra)\mu(\tilde{\mathbf{z}})d\tilde{\mathbf{z}} = \int (R + S + tr)\mu(\tilde{\mathbf{z}})d\tilde{\mathbf{z}} + G \tag{10}$$

[13]The model abstracts from estate taxes, since bequests left for spouses are not taxable and the vast majority of single agents in the model have a bequest amount smaller than the exclusion cap, which was $1 million in 2003, and was raised to $5 million (with provisions to increase with inflation) in 2013.

3. The insurance firm operates in a competitive market and earns zero profits:

$$\int (p^{new}q^{new} + xp^P q^P)\mu(\tilde{\mathbf{z}})d\tilde{\mathbf{z}} = \int (1+o)(1-s)(q^{new} + xq^P)\mu(\tilde{\mathbf{z}})d\tilde{\mathbf{z}} \tag{11}$$

   where o is a loading factor used to cover the cost of underwriting and other operating expenses, e.g. the cost of marketing and processing claims.

4. The distribution of agents is stationary.

4 Calibration

This section discusses the parameter choice. Most parameters are specified without solving the model, while the discount factor and the six parameters that determine the bequest motive are jointly calibrated to match seven data moments about life insurance and risk-free assets. In this section, all reported flow variables are for one model period (three years), unless otherwise noted.

4.1 SIPP Data

The main data source is the Survey of Income and Program Participation (SIPP) 2001 Panel, which was surveyed in 2001-2003, and was the last panel that includes questions on individual life insurance face values. Due to this data constraint, the benchmark economy is set to be the 2003 US economy, and all nominal values presented below are denominated in 2003 constant dollars unless otherwise noted. The 2001 panel is composed of nine waves of interviews, with approximately four months between two interviews. Each wave has one core module and one or several topical modules. For each core module, the same set of information on demographics, income, and public program participation is collected. For each topical module, a specific set of information is collected. The same topical module may be conducted once (e.g. fertility history) or several times on a rotating basis (e.g. assets and liabilities).

I use the topical module on assets and liabilities in wave 9 to construct the life-cycle profile of household net worth (risk-free assets in the model) and males' life insurance coverage. The effect of marriage and divorce on asset accumulation (see equation (7)) is estimated by evaluating the change in net worth and marital status between waves 3 and 9. To create a measure for the number of children that includes children who live in separate households, I use the answer to the question "How many children is the respondent the father of?" in the topical module on fertility history in wave 2 to identify the number of children in wave 2. The number of children in other waves is calculated by adding the number of newborn babies between wave 2 and the targeted wave (subtracting if wave 1 is the targeted wave).

4.2 Demographics

One period in the model is defined as three years. Agents enter the economy at age 22, and may live to be 102 years old ($J = 27$). The retirement age is 64 ($Jr = 15$).

Panel A of Table 1 reports the income gradient in mortality risks estimated by Cristia (2009). To capture this gradient, I specify the mortality rate in the following form:

$$1 - s_j(e_j) = \begin{cases} (1-\tilde{s}_j)\left[1 + \min\{\beta_{s1} + \beta_{s2}(j-1), 0\}\left(\frac{e_j - \overline{e}_j}{\overline{e}_j}\right)\right] + \gamma_{sj} & \text{if } e_j > \overline{e}_j \\ (1-\tilde{s}_j)\left[1 + \min\{\beta_{s3} + \beta_{s4}(j-1), 0\}\left(\frac{e_j - \overline{e}_j}{\overline{e}_j}\right)\right] + \gamma_{sj} & \text{otherwise} \end{cases} \tag{12}$$

where $1 - \tilde{s}_j$ is the average mortality rate from the 2003 US period life table for males of age j. The β_ss are parameters that govern the process of transforming income differences into mortality differences. The minimum operator guarantees that the income gradient is non-positive. $\overline{e}_j$ is the average of the earnings index (e_j) among surviving agents of age group j. γ_{sj} is an adjustment factor that equalizes model produced average survival rates to those in the data. Table 2 reports the values of β_ss, which are picked such that the distance between the model generated mortality ratios and those found in Cristia (2009) is minimized.[14]

[14] Appendix Figure A4 reports the values of $\overline{e}_j$ and γ_{sj}, and the generated difference in cumulative survival

[Insert Table 1 and Table 2]

4.3 Family Structure

To partially capture the income gradient in marriage and fertility, the initial distribution and transitions of these two events are estimated separately for individuals with and without a bachelor's degree. I make the following five assumptions to make the model tractable. First, the wife is in the same age group as the husband, since the average age difference between husbands and wives is less than three years. Second, after retirement, the death of a spouse is the only cause for a change in marital status, because marriage and divorce are rare events for the retired population. Third, the birth of the second child follows the birth of the first child with a one period lag (contingent on the survival of agents), reflecting that the average age difference between the first two children is 2.8 years in the data. Fourth, the probability of having the first child after age 42 is 0. In the data, less than 1 percent of fathers have their first child after that age. Last, agents have at most one child when they enter the economy.

The initial distribution is estimated using males who were aged 22-24 in wave 1 reference month 1. As reported in Table 3, upon entering the economy, agents without a bachelor's degree are more likely to be married and to have children than agents with a bachelor's degree. The probabilities for being married and having the first child are specified as follows:

$$Pr(m_{j+1}=1)=\begin{cases}\Phi(Constant_m+\sum_{k=1}^{Jr-1}\beta_{mk}\mathcal{I}_{j=k}+\beta_{md}d+\beta_{mm}m_j+\beta_{mc}\mathcal{I}_{n_j^n>0}) & \text{if } j\leq Jr-1\\ s_j^f m_j & \text{otherwise}\end{cases}$$

$$Pr(n_{j+1}^n=1)=\begin{cases}\Phi(Constant_c+\sum_{k=1}^{6}\beta_{ck}\mathcal{I}_{j=k}+\beta_{cd}d+\beta_{cm}m_j) & \text{if } j\leq 6, n_j^n=0\\ 0 & \text{otherwise}\end{cases}$$

where m_j is the marital status for a male of age group j in the current period, n_j^n is the number of children, and d is an indicator function for college education. $\mathcal{I}_{\mathcal{A}}$ is an indicator

rates for two agents with different history of income. Mortality rates are bounded between 0.001 and 1.000.

function that takes the value of 1 if $\mathcal{A}$ is true and 0 otherwise. Φ is the cumulative distribution function of a standard normal distribution. s_j^f is the rate at which a female of age group j will survive to the next period, and is calculated from the 2003 US period life table for females. m_{j+1} and n_{j+1}^n are, respectively, the marital status and the number of children for the same male in the future period. The β_ms and β_cs are estimated from changes between wave 1 reference month 1 and wave 9 reference month 4 (approximately 35 months after) using a Probit model. The two constant terms $(Constant_m, Constant_c)$ are jointly calibrated to match the average marriage rate and the number of children among working-age males. Figure 1 plots transition probabilities of remaining or becoming married (left panel) and of having the first child (right panel). This figure shows that college education (high income) increases the probability of being married but reduces the probability of having children.

[Insert Table 3 and Figure 1]

4.4 Labor Endowments

The permanent productivity η is a random variable from a log-normal distribution with a mean of zero and a standard deviation of $\sigma_\eta(d)$. The logarithm of the transitory productivity ι_j follows an AR(1) process with persistence $\rho(d)$ and a conditional variance $\sigma_\iota^2(d)$:

$$\ln \iota_{j+1} = \rho(d) \ln \iota_j + \xi, \quad \xi \sim N(0, \sigma_\iota^2(d)).$$

Agents enter the economy with transitory productivity $\iota_1 = 1$. Conditional on education, with an equal probability, they are assigned to one of the following two states: low permanent productivity ($\eta = e^{-\sigma_\eta(d)}$) and high permanent productivity ($\eta = e^{\sigma_\eta(d)}$). These six parameters ($\sigma_\eta^2(d)$, $\rho(d)$, and $\sigma_\iota^2(d)$, where $d \in \{0, 1\}$) are jointly calibrated to match the increasing variance of log annual personal earnings from ages 22 to 60, separately for males of two educational levels.[15] As reported in Table 4, males with and without a bachelor's degree have a very similar level of variance in log earnings when they enter the economy, but the variance in log earnings increases at a faster rate for males with a bachelor's degree.

[Insert Table 4]

The age-efficiency productivity profile $\varepsilon(j)$ is from Hansen (1993) (see Appendix Figure A5(b)). The per period unit wage for males without a bachelor's degree is set to $61,106 (=$20,369 per year) to match the average wage of males aged 22-24 in this educational level. Following Goldin and Katz (2009), the unit wage for males with a bachelor's degree is 60 percent greater than that for males without a bachelor's degree. Males with a bachelor's degree compose 27.3 percent of those who enter the economy to match the share of college graduates in the working-age population. The ratio of household earned income to husband's earnings ($\chi_j(m_j, n_j^a)$ in equation (1)) is approximated using a quadratic function of age, and is estimated separately for households with and without children (see Appendix Figure A5(c)).

4.5 Medical Expenses

Medical expenses for a household with a male head of age j are:

$$h_j(m_j, n_j^a) = h_j^m + m_j h_j^f + n_j^{n18}(n_j^a) h^c,$$

[15]The variance of log personal earnings for an agent of age group j and education d has the following form:

$$V(\log(\tilde{w}(d)\varepsilon_j \eta \iota_j)|d) = V(\log(\eta \iota_j)|d) = \sigma_\eta^2(d) + \sum_{l=2}^{j} \rho(d)^{2(l-2)} \sigma_\iota^2(d).$$

Appendix Figure A5(a) compares the model variance with the data. To incorporate income flows from several transfer programs that are abstracted in the model, the data "earnings" include personal earned income, unemployment benefits, workers compensation, sickness benefits, and disability income. Males who receive less than $5,150, earnings of a part time worker receiving a federal minimum wage ($5.15 per hour × 1,000 hours per year), are excluded from the sample.

where the superscript indicates whether the expenditure is for a male (m), a female (f) or a child (c), and $n_j^{n18}(n_j^a)$ is a function that returns the number of children under age 18. The amounts of individual medical expenses ($h_j^i, i \in \{m, f, c\}$) are set to match per capita total personal health care spending of the corresponding age group in the National Health Expenditure Survey and are reported in Table 5. I assume medical expenses do not change within these five age categories. Note that the large amount of post-retirement medical expenditure is a primary reason why households decumulate their assets and receive means-tested transfers.

[Insert Table 5]

4.6 Risk-free Assets

Following Cooley (1995), risk-free assets earn a pre-tax interest rate of 5 percent per annum. To capture savings before age 22, the initial value of risk-free assets is set to the average household net worth for males aged 22-24 who do not live with their parents: it is \$10.3k for males with a bachelor's degree, and \$21.5 for males without a bachelor's degree. The effect of marriage and divorce on household net worth is estimated using the following equation:

$$\begin{aligned}\frac{a_{ijt+1}}{a_{ijt}} =& Constant + \beta_{a1}\mathcal{I}_{n_{ijt}^n=0, m_{ijt}=1, m_{ijt+1}=0, sd_{ijt+1}=0} + \beta_{a2}\mathcal{I}_{n_{ijt}^n>0, m_{ijt}=1, m_{ijt+1}=0, sd_{ijt+1}=0} \\ &+ \beta_{a3}\mathcal{I}_{m_{ijt}=0, m_{ijt+1}=1} + \beta_{a4}j + \beta_{a5}j^2 + \epsilon_{ijt}\end{aligned}$$

where a_{ijt} is the net worth for a household with a male head i of age group j at time t, n_{ijt}^n is the number of children, and m_{ijt} is an indicator function for being married. sd_{ijt} is an indicator that equals 1 if the spouse is dead at time t, and 0 otherwise. ϵ_{ijt} is an error term. Regarding the time dimension, subscripts t and $t+1$, respectively, are used for observations from wave 3 and from wave 9. Concerned about outliers, I estimate the equation using a median regression.

The identification utilizes a difference-in-differences approach, for which the treatment group is males who are newly married or divorced, while the control group is the rest of the population, including males who remain with the same marital status and males who are newly widowed. Estimated coefficients imply that divorce reduces household net worth by 20 percent ($\beta_{a1} = -0.20$) for males without children and by 61 percent for males with children ($\beta_{a2} = -0.61$), while marriage increases net worth by 9 percent ($\beta_{a3} = 0.09$).

4.7 Government

Tax Collection and Direct Spending: In the benchmark economy, the capital tax rate (τ^k) and the labor tax rate (τ^l) are set to 26 percent (NBER Taxsim), and the consumption tax rate (τ^c) is set to 6 percent (Mendoza et al., 1994). Direct spending is a residual that balances the government budget (equation (10)) in the benchmark economy, and takes the value of \$7k per household per annum in all economies.

Old-Age Insurance Program: The $PIA(e_j)$ is calculated using the 2003 Social Security benefit rules, and total OAI benefits for a household are:

$$R_j(e_j, m_j, n_j^a) = (\mathcal{I}_{m_j=0} + \chi_c^R \mathcal{I}_{m_j=1,n_j^a>0} + \chi_{nc}^R \mathcal{I}_{m_j=1,n_j^a=0}) PIA(e_j)$$

where χ_c^R equals 1.54 as the average ratio of household Social Security benefits to the husband's benefits among households with children. χ_{nc}^R equals 1.73 as the same ratio among households without children. For calculating these two ratios, the sample is households with both members reaching the retirement age and receiving positive Social Security income. The ratio is greater for the latter group, because child rearing reduces the lifetime earnings of wives (see Appendix Figure A5(c)).

Survivors Insurance Program: Under the SBDC program, each surviving child is entitled to receive 75 percent of the deceased father's PIA as long as the child is under the age of 18. The present value of survivors benefits paid to all children if the father dies at age $j+1$ is:

$$S_j^c(e_j,,m_j,n_j^a) = 0.75PIA(e_j)\big(\sum_{i=1}^{2}\mathcal{I}_{j_c^i(n_j^a)\leq Jc}\sum_{l=0}^{Jc-j_c^i(n_j^a)}(1+r(1-\tau^k))^{-l}\big)$$

where $j_c^i(n_j^a)$ returns the age of the ith child, and Jc is the maximum age that a child is eligible to receive SBDC if the father dies in the following period.

Under the SBAS program, an aged widow is entitled to receive the greater of the deceased husband's OAI benefits and her own OAI benefits. Given that both χ_c^R and χ_{nc}^R are less than 2, the husband's death increases the wife's benefit amount by $2PIA(e_j) - R_j(e_j, m_j, n_j^a)$ $(= PIA(e_j) - \big[R_j(e_j, m_j, n_j^a) - PIA(e_j)\big])$. The present value of these additional benefits is:

$$S_j^s(e_j,m_j,n_j^a) = (2PIA(e_j) - R_j(e_j,m_j,n_j^a))\sum_{j'_f=j+1}^{J}\frac{\prod_{l=j}^{j'_f-1}s_l^f}{(1+r(1-\tau^k))^{j'_f-(j+1)}}\mathcal{I}_{m_j=1,j\geq Jr-1}$$

where $\prod_{l=j}^{j'_f-1}s_l^f$ is the probability of a female of age j to survive to age j'_f.

To illustrate the size of survivors benefits, Figure 2 plots the ratio of survivors benefits to (annual) PIA by the age of each surviving child (left panel) and by the age of each surviving spouse (right panel). As shown in this figure, survivors benefits can amount to as much as 9.2 years of PIA for each surviving child and 6.8 years of PIA for a surviving spouse. The total amount of survivors benefits is the sum of SBDC and SBAS: $S_j(e_j, m_j, n_j^a) = S_j^c(e_j, m_j, n_j^a) + S_j^s(e_j, m_j, n_j^a)$.[16]

[Insert Figure 2]

Means-tested Social Insurance: Transfers from means-tested social insurance allow each household to afford an adult equivalent annual consumption of $4,000. This amount is slightly higher than the values used by Kitao (2014) ($3,432 in 2003 dollars) and De Nardi

[16]The maximum family benefits each household can receive based on a worker's earnings record range from 150-180 percent of the PIA, and are not a binding constraint for any household in the model.

et al. (2010) ($2,994 in 2003 dollars), but is lower than the values discussed in Kopecky and Koreshkova (2014).

4.8 Insurance Firms

Insurance contracts are offered to agents under age 85 (J^I=22). Through underwriting, the insurance firm knows the agent's age j and whether the agent's earnings index is above the age group average ($e_j > \overline{e}_j$). Conditional on age, agents are classified into a high-risk pool if $e_j \leq \overline{e}_j$, and into a low-risk pool if $e_j > \overline{e}_j$. There are a total of 42 (= 2×21) risk pools. An insurance contract expires on average after 7 periods (or 21 years, $\delta = 0.14$) or when the maximum eligibility age of 85 is reached. Following Hong and Ríos-Rull (2012), the loading factor (o) is 25 percent, which is within the range of expense-premium ratios (9 to 38 percent) reported in Mulligan (2003). In the baseline economy, the adjustment factor ω takes the value of 1.11. This is smaller than 1.25 (= 1 + 0.25), because, as detailed in section 5.3, agents who purchase insurance on average have a lower mortality rate than the remaining population; selection is advantageous.

4.9 Preferences

The utility from consumption is:

$$u_j(c_j, m_j, n_j^a) = \frac{1}{1-\sigma}(c_j/\zeta_j(m_j, n_j^a))^{1-\sigma}, \tag{13}$$

where σ measures the relative risk aversion, and is set to 1.5 as the common value used in the literature (Attanasio, 1999; Blundell and MaCurdy, 1999). $\zeta_j(m_j, n_j^a)$ is a scale factor that converts adult equivalent consumption into household aggregate consumption. Following Greenwood et al. (2000), this function is specified as follows:

$$\zeta_j(m_j, n_j^a) = (1 + m_j + \lambda_1 n_j^{n18}(n_j^a))^{\lambda_2}$$

λ_1 measures the adult equivalence of child consumption and is set to 0.4. λ_2 measures economies of scale in household consumption and is set to 0.5.[17]

Agents derive the utility from bequests via a warm-glow motive:

$$
\begin{aligned}
v_j(b_{j+1}, m_j, n_j^a) = &\max\{0, \max\{0, \lambda_3 + \lambda_J(j-1)\} + \lambda_4 \mathcal{I}_{n_j^a>0} + \lambda_5 \mathcal{I}_{m_j=1} + \lambda_6 \mathcal{I}_{n_j^a>0, m_j=1}\} \\
&\times \frac{(b_{j+1}+\kappa)^{1-\sigma}}{1-\sigma},
\end{aligned} \tag{14}
$$

where $\big(\lambda_3 + \lambda_J(j-1)\big)$ represents the concern of a single man without children to leave bequests to his parents or to the society. λ_4 and λ_5, respectively, capture the additional concern to leave bequests to children and to a wife who does not raise children. The bequest motive does not change when children leave households at age 18, since the data show there is no discrete change in insurance coverage at children's adulthood. The sum of λ_4, λ_5, and λ_6 captures the additional concern to leave bequests to both children and their mothers. The two maximum operators guarantee that the concern to leave bequests is non-negative. $\kappa > 0$ is a preference shifter that measures the extent to which bequests are a luxury good.

I calibrate the six parameters in equation (14) and the discount factor (β) to jointly match seven data moments about life insurance and risk-free assets, as summarized in Table 6. The data targets are averages over three adjacent age groups to minimize measurement errors. I choose the insurance coverage for age group 40-48 as the primary target to discipline the bequest motive for two reasons. First, as shown Appendix Figure A3, the amount of life insurance for men in their 30s and 40s reaches a steady level after year 2000 and is less likely to be affected by cohort differences than insurance amounts for other age groups. Second, this age group has the largest amount of life insurance, and I want to test whether a model calibrated to match insurance demand in the period with the largest amount of coverage is able to capture the demand for other periods.

[17]Male agents are responsible for the cost of their children's consumption regardless of their current marital status, capturing that nonresident fathers are responsible for child support, and that the child support enforcement office can request employers to withhold the amount of child support from the father's paychecks if it is not paid voluntarily.

[Insert Table 6]

As reported in Table 6, κ equals \$450k, close to that of \$500k used in De Nardi (2004) and French (2005). The positive value of κ suggests that bequests are luxury goods: the demand for bequests increases more than proportionally as income rises. For a single male without children, the incentive to leave bequests declines with age, which is likely a response to the aging of his parents, and drops to zero when he reaches the age of 71 ($\approx 22 + (126.78/7.7) \times 3$). The relative magnitude of λ_4, λ_5 and λ_6 implies that conditional on age and current adult equivalent consumption, the strength of the bequest motive has the following rank order: married men with children > single men with children > married men without children > single men without children.

5 Benchmark Economy

As described in Table 6, the model is calibrated to match seven empirical targets about life insurance coverage and risk-free assets. We can use other moments that are not listed in Table 6 to evaluate the success of the model.

5.1 Consumption and Risk-free Assets

Figure 3(a) displays the life cycle profile of household consumption (solid line) and of adult equivalent consumption (dash-dot line). Average household consumption rises between ages 20 to 40 due to the need to accumulate precautionary savings and the increase in the household size. From ages 40 to 60, as children enter adulthood and leave the household, household consumption drops while adult equivalent consumption keeps rising. There are two explanations why adult equivalent consumption reaches the highest level right before retirement. First, anticipating the large amount of deterministic medical expenses (see Table 5), about 30 percent of agents deplete their precautionary savings at the last period of working life and choose to consume at the consumption floor after retirement. Second, the destruction of risk-free assets from divorce incentivizes agents who face divorce risks to consume more than they would if facing no risk. As divorce rates fall to zero after retirement, married agents, especially those with a large amount of assets, consume less. The rise of consumption after age 94 is a result of heterogeneous mortality rates: agents with high permanent income live longer than agents with low permanent income (see Appendix Figure A4).[18]

[Insert Figure 3]

Figure 3(b) presents the life-cycle profile of risk-free assets, and shows that the model is capable of replicating the general pattern of asset accumulation and decumulation. The small gap between data and model is likely explained by that the model abstracts from services provided by certain types of assets, e.g., housing and vehicles, and that the model assumes medical expenses are deterministic.[19] As shown in the figure, for young and older households, the model numbers are close to the data net worth excluding the value of housing and vehicles.

5.2 Life Insurance Profiles

Figure 4(a) shows that the model is capable of generating the inverted-U shape of life insurance demand. Young agents demand very little insurance because the opportunity cost of purchasing life insurance is high when consumption is low (see Figure 3(a)). The impact is amplified by the front-loaded insurance price and the availability of SBDC for young fathers. Men in their 40s demand the greatest amount of life insurance because they have a lower opportunity cost and have not yet accumulated enough risk-free assets to self-insure

[18] The model reasonably well matches the increasing variance of log consumption before retirement, but it generates a large increase of variance at retirement, because about 30 percent of agents choose to consume at the consumption floor right after retirement. This figure is available upon request.

[19] For example, see Ho and Zhou (2015) for a model with housing and tax-deferred saving accounts; see De Nardi et al. (2010) and French and Jones (2011) for a model with stochastic medical expenses and different types of health insurance. Similar to De Nardi et al. (2010), I find the incentive to accumulate assets differs by permanent income. In the model, low-income agents save little for retirement: the average assets held by those aged 64-67 (the first period of retirement) without a bachelor's degree and with low permanent productivity is $23k; while high-income agents hold on to their assets to a very old age: the average assets held by those aged 97-99 with a bachelor's degree and with high permanent productivity is $682k.

against mortality risks. The average amount of life insurance decreases monotonically from age 50 primarily due to the accumulation of risk-free assets. Post retirement, the drop in consumption and the availability of SBAS further contribute to the decline in insurance coverage.

[Insert Figure 4]

As shown in Figure 4(b), the model matches well the participation rate in the life insurance market for young and middle-aged males. The slight fall in participation from ages 22-24 to ages 25-27 is explained by the coverage of SBDC causing some young fathers to stop renewing existing policies: the participation rate falls from 46 percent to 19 percent among those who have children by the age of 27, and rises from 54 percent to 60 percent among the remaining population.[20] There are two likely reasons why the model under-predicts the participation rate for older males. First, these people may purchase permanent life insurance policies to accumulate tax-deferred investment returns. Second, under the influence of mental accounting (Thaler, 1999), older men may purchase life insurance with the intention of using the proceeds to pay for death-related expenses (Brown, 2001). Figures 4(c) and 4(d) display the life cycle profile for the four types of family structures.[21] From these figures, we see that the model may understate the bequest motive for young fathers and for married elderly men without children. The potential impact of this issue on the evaluation of survivors benefits is discussed in the next section.

5.3 Selection in the Life Insurance Market

Following the literature on testing adverse selection (Cohen and Siegelman, 2010), I test whether risk is correlated with coverage controlling for observed characteristics to the insurer

[20] In the model, 2.3 percent of policies are canceled and 6.9 percent of policies are reduced every year. In the data, the share of lapsed policies is 5.7 percent, and the share of surrendered policies is 1.9 percent (ACLI, 2014).

[21] Note that households will change their structures due to marriage and fertility dynamics, and cross-age comparisons are not informative.

by estimating the following equation:

$$1 - s_{ij} = Constant + \beta_x \mathcal{I}_{x_{ij}>0} + \beta_q \mathcal{I}_{q_{ij}^{new}>0} + \gamma_{\varrho_{ij}} + \epsilon_{ij} \tag{15}$$

where $1 - s_{ij}$ is the mortality rate for agent i of age j. $\mathcal{I}_{x_{ij}>0}$ records whether agent i renews existing insurance contracts, and $\mathcal{I}_{q_{ij}^{new}>0}$ records whether agent i purchases a new insurance contract. The $\gamma_{\varrho_{ij}}$ are risk measure fixed effects, controlling for observed characteristics to the insurer. ϵ_{ij} is the error term. The coefficients of interest are β_x and β_q, representing the correlation of insurance coverage and individual risks. The insurance market is adversely selected if these correlations are positive; and is advantageously selected if these correlations are negative.

As reported in Column (1) of Panel A in Table 7, consistent with the findings of Cawley and Philipson (1999) and McCarthy and Mitchell (2010), agents who renew existing contracts or purchase new insurance have lower mortality rates than the uninsured.[22] With mortality decreasing with income, the key to generating advantageous selection is the assumption that bequests are luxury goods, which makes bequests more attractive relative to consumption as income rises. As shown in Column (4) of Appendix Table A2, assuming bequests are normal goods leads to adverse selection in the life insurance market.

[Insert Table 7]

Turning to heterogeneity, the difference between Columns (2) and (3) shows that advantageous selection is stronger in the segment of markets for workers than in the segment of the markets for retirees. In particular, retirees who purchase new coverage have higher mortality rates than the uninsured, reflecting that as agents age and accumulate more risk-free

[22] The reported selection pattern is robust to replacing the coverage dummies with the amount of coverage. Appendix Table A4 reports the correlation analysis separately for those who face actuarially favorable and adverse prices based on individual mortality rates. Due to the loading factor of 25 percent, the vast majority of agents face an actuarially adverse price, and the reported pattern of advantageous selection in Table 7 mostly reflects the behavior of this group. Within the group of agents facing an actuarially favorable price, those who renew existing coverage still have lower mortality rates than the uninsured, although those who purchase new coverage have higher mortality rates.

assets (see Figure 3(b)), they are less willing to purchase or renew an insurance contract at actuarially unfair prices. (As reported in Appendix Table A4, 91.4 percent of agents face actuarially unfair prices.) This finding has empirical support: 1) Cawley and Philipson (1999) show that the ratio of the mortality risk of insured males in the US to that of the overall population of males is less than one for most adult years but has a steady upward trend starting from around age 60, and crosses the threshold of 1 around age 85; 2) He (2009) demonstrates that among individuals without existing coverage in the HRS (a sample of elderly households), those who obtain new coverage are more likely to die than those who do not. The comparison between Columns (4) and (5) reveals that in the high-risk pool (agents with $e_j \leq \bar{e}_j$), the insured have much lower mortality rates than the uninsured, but there is little difference between these two groups in the low-risk pool (agents with $e_j > \bar{e}_j$). This is because the luxury nature of bequests dissuades the poorest agents, who have the highest mortality rate in the high-risk pool, from demanding life insurance. For instance, among agents who face actuarially favorable prices based on their individual mortality rates, 69 percent in the low-risk pool are insured, while 4 percent in the high-risk pool are insured.

5.4 Financial Protection for Survivors

To understand how survivors are protected against the income loss associated with the agent's death, I calculate the ratio of total bequests left in the next period by a dying agent to his annual earnings index. Table 8 reports characteristics of this ratio by the age of the first child (columns 1-4), and by the age of a retired spouse (columns 5-6). It is clear that there is substantial dispersion in the extent to which do survivors are financially protected from the death of agents: the amount of bequests ranges from zero to 20 times of the earnings index. Survivors, both children and aged spouses, at the bottom of the distribution will receive little bequests upon the death of agents, consistent with the empirical observation that many survivors, especially children of young fathers, are not financially protected against the income loss associated with the death of breadwinners (Auerbach and Kotlikoff, 1987, 1991; Hurd and Wise, 1996; Bernheim et al., 2003a,b)

[Insert Table 8]

6 Policy Experiment

This section aims to understand the effect of reducing survivors benefits. Experiments 1 and 2, respectively, reduce the amount of SBDC and SBAS by 23 percent, the projected reduction in Social Security benefits in 2035 when the trust fund is depleted. Experiment 3 introduces a community rating regulation to the life insurance market, forcing the firm to offer a uniform price to all agents in one age group. Experiments 4 and 5 reexamine the effect of reducing survivors benefits under community rating. In each experiment, I modify the value of the labor tax rate (τ^l) to satisfy the government budget constraint (equation (10)), and the value of the adjustment factor (ω) to satisfy the insurance firm's zero profit condition (equation (11)).

To explore the heterogeneous response within the population, I also separately report the effect for two permanent productivity groups (low/high) and for two educational groups (no college/college).[23] Table 9 illuminates two main differences across these groups. First, given age, the earnings index is increasing in permanent productivity and in educational level. Second, across groups, there is a larger difference in the probability of receiving SBDC than in the probability of receiving SBAS, because agents with low permanent income are more likely to die at a young age than agents with high permanent income and because agents without a bachelor's degree are much more likely to have children than agents with a bachelor's degree. Since the difference across the two permanent productivity groups is greater than the difference across the two educational groups, the following analysis will focus on comparing the effects on two permanent productivity groups to explain the distributional consequences of survivors benefits.

[23] I would like to thank the anonymous referee for the suggestion to present these statistics to illuminate the welfare implications.

[Insert Table 9]

6.1 Reducing SBDC

Table 10 provides summary statistics for different economies, with column numbers corresponding to experiment numbers. The comparison between columns (0) and (1) shows that a 23 percent reduction in SBDC causes a 0.03 percent increase in consumption, a 2.38 percent increase in insurance premium expenditures, a 0.25 percent decrease in bequests left by deceased agents, a 0.04 percent increase in risk-free assets, and a 5.29 percent increase in insurance face values.[24] The increase in premium expenditures is smaller than the increase in face values, as most of the increasing demand is from young agents who face a low unit price. The estimates from the correlation analysis and the unit price of life insurance are almost the same as those in the benchmark economy, and the labor tax rate falls slightly by 0.03 percentage points. Table 11 shows the change in the composition of bequests by age group and by permanent productivity. As reported in Panel B, reducing SBDC causes all groups to increase insurance holdings, but has mixed impact on the holdings of risk-free assets: the lower tax rate allows young agents to build up risk-free assets at a slightly quicker rate, but the greater insurance coverage carried over from early periods incentivizes older agents to spend down their assets at a faster rate than they would in the benchmark economy.

[Insert Table 10 and Table 11]

For welfare analysis, I compute the consumption equivalent variation (CEV), which measures the proportional increase of consumption needed in current and all future periods and for all contingencies in the benchmark economy so that a type of agents is indifferent between living in the benchmark and in the counterfactual economy. The primary measure of welfare is the CEV for a new generation under the veil of ignorance (line 11). To illuminate the distributional consequences across income groups, lines 12-15 of Table 10 report the

[24] Slavov et al. (2017) empirically examine the effect of reducing SBDC under the 1981 reform, and find a positive but insignificant increase of premium expenditures.

CEV for a new generation after knowing their permanent productivity or education. These calculations find that reducing SBDC by 23 percent causes a welfare loss equivalent to a 0.28 percent reduction in lifetime consumption. The magnitude of the welfare loss falls with respect to permanent income, indicating that low-income agents who have high mortality rates and high marginal utilities of consumption lose more from reducing SBDC than high-income agents. In addition, reducing SBDC reallocates resources away from households with children who tend to have high marginal utilities of consumption due to child-rearing costs, and away from young households who also have high marginal utilities of consumption due to the borrowing constraint and the hump-shaped earnings profile. Figure 5(a) displays the CEV for agents of different ages, showing that reducing SBDC makes younger and older agents worse off and middle-aged agents better off. This is because younger agents value SBDC coverage more than the fall in payroll taxes; older agents lose from the reduction in risk-free assets (Columns 5-6 in Panel B of Table 11); and middle-aged agents benefit a lot from the labor tax reduction due to their high earnings and lose little from the SBDC reduction since they have older children.

[Insert Figure 5]

As revealed in section 5.2, the model may understate the bequest motive for young fathers. To understand the impact of this issue on welfare, I double the utility from bequests for SBDC recipients and recalculate the CEV using the same decision rules. Under this alternative assumption, the welfare loss of reducing SBDC is equal to a 0.55 percent fall of lifetime consumption, 100 percent greater than that in the baseline.

6.2 Reducing SBAS

The difference between Columns (0) and (2) of Table 10 shows that reducing SBAS by 23 percent causes a 0.45 percent increase in consumption, a 0.63 percent increase in premium expenditures, a 0.41 percent fall in bequests left by deceased agents, a 1.46 percent increase in risk-free assets, and a 1.96 percent fall in insurance face values. The fall in average insurance demand is a result of two competing forces: the reduction in SBAS and the increase in after tax income encourage agents to purchase more insurance, while the increase in risk-free assets has the opposite effect. As reported in Panel C of Table 11, for agents aged 22-48 with high permanent productivity, the latter force dominates, causing a large fall in insurance face values; for the remaining groups, the former force dominates, causing a small increase in insurance face values. Insurance premiums and insurance face values move in the opposite directions, because the additional premiums collected from older agents (who pay a much higher unit price) is greater than the premium loss from younger agents. In equilibrium, the labor tax rate falls by 0.32 percentage points, 9 times more than in the previous experiment; the extent of advantageous selection in the life insurance market is weakened, causing a 0.11 percent increase in insurance unit prices.

Reducing SBAS generates a welfare gain that is equivalent to a 0.40 percent increase in lifetime consumption, and agents of different levels of permanent productivity and education all benefit from the policy change to a similar extent. This result about welfare gains is consistent with that of Hong and Ríos-Rull (2012), who find that eliminating SBAS increases the utility of male agents. Regarding the age dimension, as shown in Figure 5(b), only agents with low permanent productivity who are around the retirement age lose from reducing SBAS.

One concern is that the model may overvalue the welfare gain of reducing SBAS, since it understates the insurance holdings of married elderly men without children (see section 5.2). Adopting the same approach discussed before, I find that after doubling the utility from bequests for SBAS recipients, reducing SBAS produces a welfare gain equivalent to a 0.33 percent increase of lifetime consumption, 17 percent smaller than that in the baseline. Alternatively, we can calculate how large an increase in the utility from bequests is needed to make agents to be indifferent between the benchmark economy and the counterfactual economy under the veil of ignorance. This calculation shows that the utility from bequests for SBAS recipients needs to be increased by 590 percent.

6.3 Community Rating

Community rating forces high-earning, low-mortality agents to pay higher premiums, and allows low-earning, high mortality agents to pay less. The change from columns (0) to (3) of Tables 10 shows that community rating causes a 0.34 percent decrease in consumption, a 12.85 percent increase in premium expenditures, a 1.77 percent increase in bequests left by deceased agents, a 0.09 percent increase in risk-free assets, and a 4.93 percent increase in insurance face values. Among agents who purchased new insurance in the benchmark economy, 92 percent of those with high permanent productivity face a greater unit price under community rating, leading the majority of them to purchase less insurance and accumulate more risk-free assets; in contrast, only 11 percent of agents with low permanent productivity face a greater price, and so the majority of them take the opposite actions (Panel D of Table 11). Turning to welfare, community rating causes a welfare gain equivalent to a 0.27 percent increase of lifetime consumption, since the benefit to agents with low permanent productivity outweighs the cost to agents with high permanent productivity. The comparison between columns (3)-(5) of Tables 10 makes it clear that the effect of reducing SBDC and SBAS under community rating is very similar to those under risk rating. In particular, under community rating, the welfare loss of reducing SBDC for a new generation equals a 0.26 percent fall of lifetime consumption, and the welfare gain of reducing SBAS equals a 0.39 percent increase of lifetime consumption (Panel A of Appendix Table A5).

6.4 Difference between reducing SBDC and reducing SBAS

In addition to varying the risk classification, to check the robustness of the welfare results, I make a number of other changes to the model: 1) reduce the loading factor to zero; 2) vary the specification of the utility function for the warm-glow bequest motive (equation (14)) by separately imposing $\lambda_J = 0$, $\lambda_4 = \lambda_5 = \lambda_6$ and $\kappa = 0$; and 3) re-calibrate the model to match voluntary insurance holdings, which exclude the face value of those who have only group coverage.[25] As reported in Tables A3 and A5, in all alternative specifications, I find that reducing SBDC always generates welfare losses, with the CEV ranging from -0.38 percent to -0.18 percent; while reducing SBAS always produces welfare gains, with the CEV ranging from 0.30 percent to 0.43 percent. These findings suggest that the substantial difference in welfare results is robust to alternative assumptions about the behavior of insurance firms and the bequest motive.

To illuminate the benefits and costs of the two types of survivors benefits, I examine the welfare results under alternative assumptions about tax rates and insurance prices (Table 12). There are three findings. First, with the two general equilibrium variables fixed at their benchmark economy levels, reducing SBDC and reducing SBAS both generate welfare losses. The magnitude of the loss is greater for SBDC than for SBAS, primarily because a new generation discounts heavily the loss of insurance obtained later in life under the SBAS program but discounts little the loss of insurance obtained earlier in life under the SBDC program. Without changing decision rules, under the counterfactual assumption of a discount factor of 1, the welfare loss from reducing SBAS would equal a 0.30 percent fall in lifetime consumption, greater than the 0.24 percent fall in lifetime consumption from reducing SBDC. Second, after considering the associated tax reduction, I find that the CEV for reducing SBDC rises from -0.33 to -0.28 percent, and the CEV for reducing SBAS rises from -0.08 to 0.40 percent. The latter change is much greater than the former change, because the funding cost for SBAS is 10 times as large as that for SBDC. Last, the change in equilibrium insurance prices plays a minor role in determining the level of CEV.

[Insert Table 12]

This analysis focuses on the welfare implications of reducing survivors benefits on insured persons. To shine light on how reductions would affect SBDC and SBAS beneficiaries, Table 13 reports changes in the ratio of bequests to the annual earnings index from the

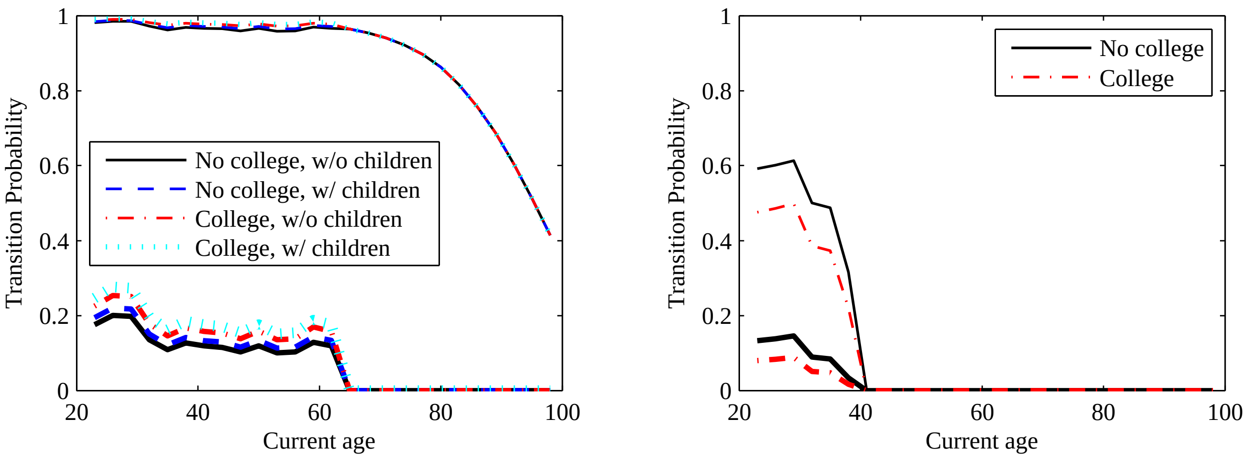
[25] I am grateful to Dirk Krueger for this suggestion.

benchmark economy for different age and (benchmark) ratio groups. The table shows that reducing SBDC has differential effects on child survivors of different ages, with the largest negative impact on younger child survivors and with a small negative or even positive effect on older child survivors. Reducing SBAS generally decreases the amount of bequests received by widows, although the oldest widows at the top of the distribution receive more bequests due to the increase of risk-free assets (Column 6 in Panel C of Table 11). Considering this impact on survivors is likely to strengthen the welfare loss from reducing SBDC and to weaken the welfare gain from reducing SBAS.

[Insert Table 13]

7 Conclusion

This paper develops a lifecycle model with heterogeneous agents to study the effect of reducing survivors benefits. The model has three key features. First, conditional on age, mortality rates decline with income. Second, agents have private information about individual mortality risks; and they purchase life insurance based on individual risks, the amount of risk-free assets, survivors insurance coverage, and the bequest motive. Third, the bequest motive varies by age and household structure. Model simulations suggest that for male agents reducing SBDC produces welfare losses, while reducing SBAS produces welfare gains. As reducing both types of survivors benefits decreases the average amount of bequests left by deceased agents, an obvious next step is to assess the extent to which reducing survivors benefits affects survivors. To answer this question, a model needs to carefully consider two things: 1) other cash and in-kind transfer programs that are available for dependent children and for aged spouses, and 2) the opportunity for parents and spouses to remarry. I leave this extension for future studies.

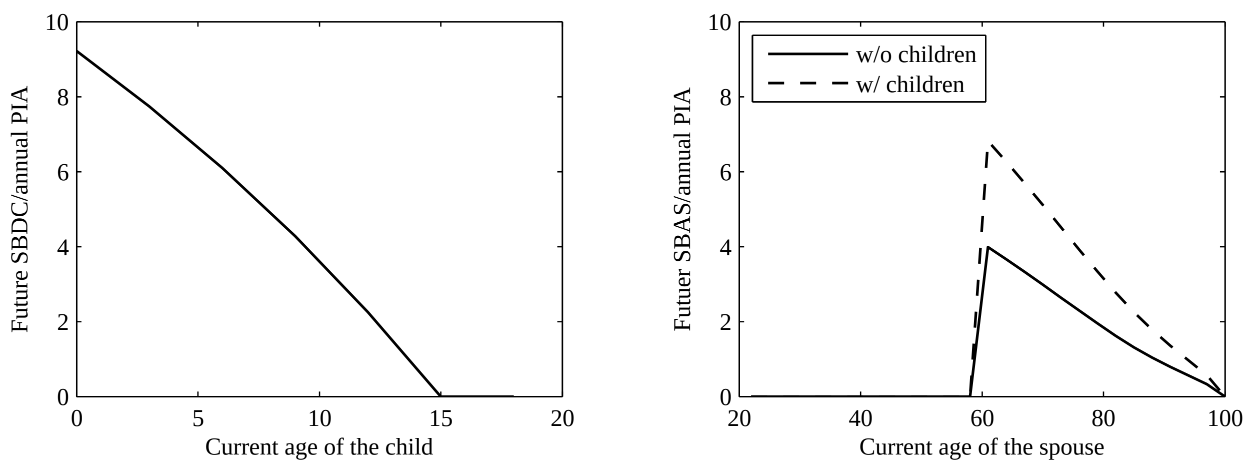


(a) Remaining or becoming married

(b) Having the first child

Figure 1: Transition probabilities by age, education, and family structure

Note: Thicker lines refer to single agents, and thinner lines refer to married agents.

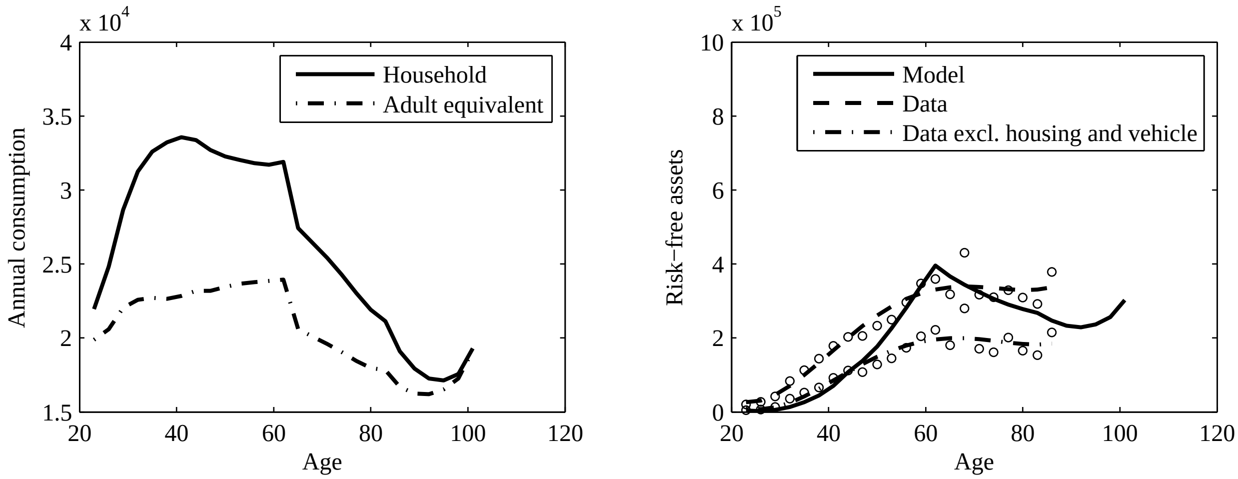


(a) Dependent child

(b) Aged spouse

Figure 2: The ratio of survivors benefits to per period PIA

Note: A child of age 15 in the current period will be of age 18 in the next period and be ineligible for SBDC; a spouse of age 61 in the current period will be of age 64 in the next period and be eligible for SBAS.

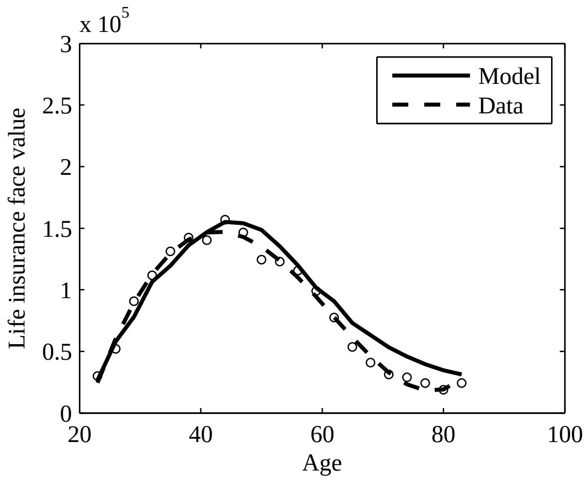


(a) Annual consumption

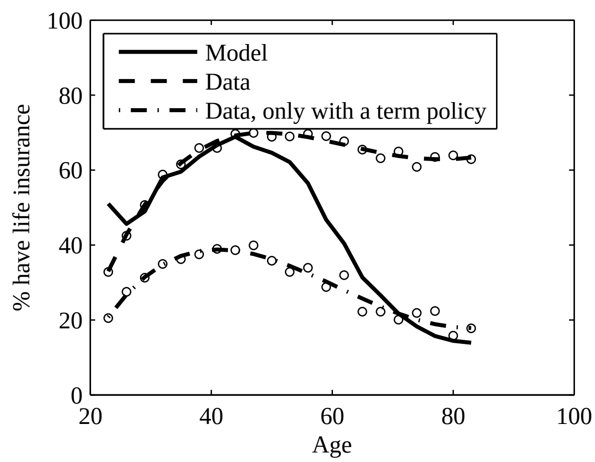
(b) Risk-free assets

Figure 3: Consumption and risk-free assets by age group

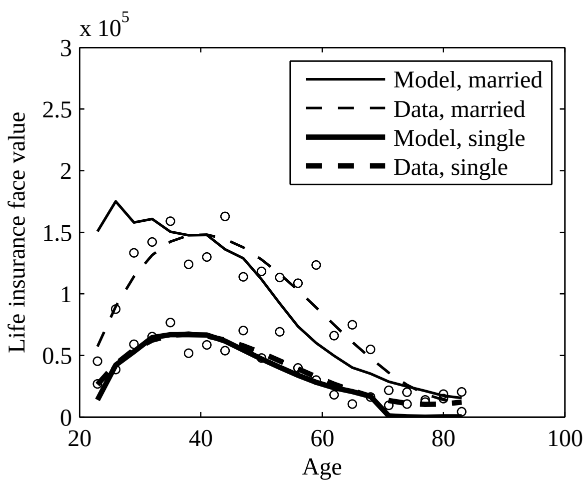
Note: Figure 3(b) has two data series, with the larger series being total household net worth, and the smaller series being total net worth excluding the value of housing and vehicles.



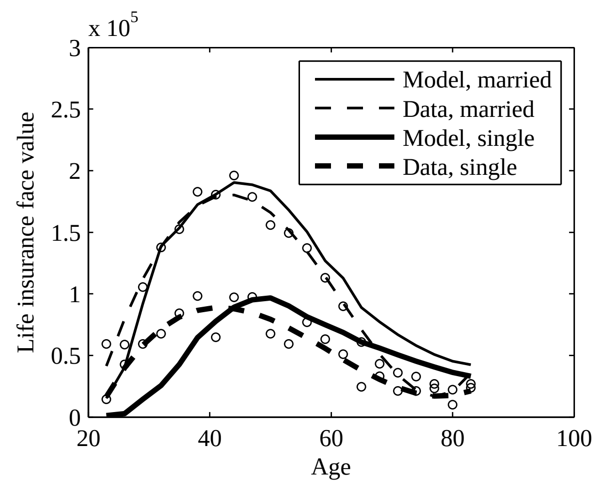
(a) Amount for all agents



(b) Participation for all agents

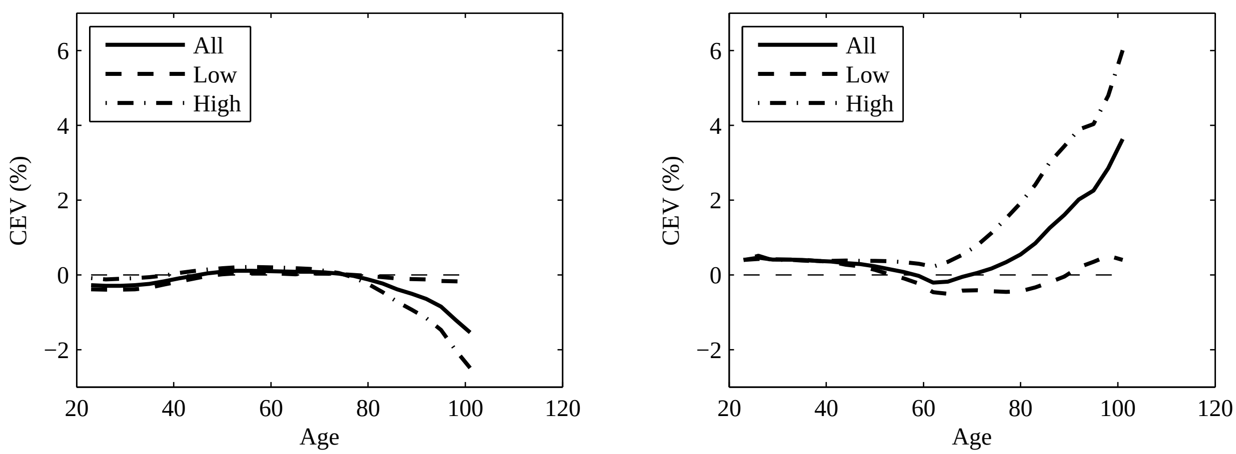


(c) Amount for non-fathers



(d) Amount for fathers

Figure 4: Life insurance coverage by age group



(a) Reduce SBDC

(b) Reduce SBAS

Figure 5: CEV by age and permanent productivity level

Table 1: Mortality ratios for male agents

	Panel A: Data			Panel B: Model		
	35-49	50-64	65-75	35-49	50-64	65-75
Earning quintile	(1)	(2)	(3)	(4)	(5)	(6)
Bottom	2.25	1.63	1.10	1.86	1.51	1.16
Second	1.13	1.10	1.14	1.51	1.28	1.11
Third	0.73	0.99	1.08	0.79	0.90	1.02
Fourth	0.56	0.68	0.94	0.51	0.70	0.93
Top	0.35	0.61	0.74	0.38	0.63	0.79

Note: Mortality ratios are the mortality rate of one age-earning group divided by the average mortality rate of that age group. Data ratios are from Cristia (2009), and model ratios are constructed from the simulated sample using the same method of Cristia (2009).

Table 2: Parameters for the survival function (equation (12))

β_{s1}	β_{s2}	β_{s3}	β_{s4}
-0.1601	-0.0057	-3.7045	0.2158

Table 3: Composition of family structure of age group 22-24

	No college	College
Singles w/o children	0.64	0.82
Singles w/ children	0.11	0.02
Married w/o children	0.10	0.11
Married w/ children	0.15	0.05

Table 4: Parameters for permanent and transitory productivity shocks

	σ_η^2	ρ	σ_ι^2
No college	0.2375	0.9457	0.0267
College	0.2344	0.9693	0.0455

Table 5: Per capita (annual) personal health care spending

	19-44	45-64	65-84	85+
Adult male	2,126	6,266	12,415	21,977
Adult female	3,546	7,014	12,367	25,167
Child	2,069			

Source: Center for Medicare and Medicaid Services

Table 6: Calibrated preference parameters

Para.	Meaning	Value	Target	Data	Model
λ_3	Basic motive	126.87	ins. for singles w/o children, 40-48	60.48	61.31
λ_J	Age effect	-7.70	ins. for singles w/o children, 31-39	65.13	65.91
λ_4	Child effect	34.31	ins. for singles w/ children, 40-48	86.87	87.21
λ_5	Spouse effect	7.10	ins. for married w/o children, 40-48	136.67	136.75
λ_6	Mother effect	7.50	ins. for married w/ children, 40-48	185.06	186.58
κ (000's)	Luxury shifter	449.66	% have ins., 40-48	0.68	0.67
β	Discount factor	0.85	risk-free assets, 61-69	366.10	368.45

Table 7: Coverage-mortality correlation analysis

		Age		Risk	
	All	Workers	Retirees	High	Low
	(1)	(2)	(3)	(4)	(5)
Renew coverage	-0.00231	-0.00254	-0.00148	-0.00471	-0.00004
	(0.00001)	(0.00001)	(0.00004)	(0.00001)	(0.00002)
Purchase new coverage	-0.00067	-0.00078	0.00304	-0.00065	0.00007
	(0.00001)	(0.00001)	(0.00014)	(0.00002)	(0.00002)

Note: Table presents estimates of β_x (renew coverage) and β_q (purchase new coverage) from equation (15). Column (1) reports the estimates using all agents who are eligible to purchase life insurance ($j < J^I$). Columns (2)-(4) report estimates for different subgroups: (2) for workers ($j < Jr$), (3) for retirees ($j \geq Jr$), (4) for agents in the high-risk pool ($e_j \leq \overline{e}_j$), and (5) for agents in the low-risk pool ($e_j > \overline{e}_j$). Standard errors in parentheses.

Table 8: Ratio of bequests to the annual earnings index for deceased agents

	By first child's age				By spouse's age	
	0-5	6-11	12-17	18-23	64-84	85-102
	(1)	(2)	(3)	(4)	(5)	(6)
Bottom 5%	3.95	4.69	1.21	0.00	1.25	0.34
Bottom 10%	4.13	5.13	1.27	0.01	1.50	0.43
First quintile	4.75	5.56	1.81	0.12	1.88	0.54
Second quintile	6.27	6.66	3.96	2.46	3.34	0.93
Third quintile	8.28	8.18	6.36	6.01	7.65	1.44
Fourth quintile	10.03	9.90	9.06	9.07	12.93	6.40
Fifth quintile	12.33	13.06	12.93	14.30	19.77	14.18
All	8.33	8.67	6.82	6.39	9.11	4.70

Table 9: Differences across permanent productivity groups and educational groups

		Annual earnings index	Prob. of coverage		Prob. of receipt	
	Share	When retire	SBDC	SBAS	SBDC	SBAS
	(1)	(2)	(3)	(4)	(5)	(6)
All	100%	44,422	79%	68%	3%	81%
Permanent productivity						
– Low	50%	24,764	78%	63%	6%	85%
– High	50%	61,010	80%	73%	1%	76%
– Low/high		0.41	0.99	0.86	3.68	1.11
Education						
– No college	73%	38,499	82%	64%	4%	79%
– College	27%	59,243	71%	76%	3%	84%
– No college/college		0.65	1.15	0.85	1.52	0.95

Table 10: Summary statistics for different economies

	Risk rated			Community rated		
	No change (0)	Reduce SBDC (1)	Reduce SBAS (2)	No change (3)	Reduce SBDC (4)	Reduce SBAS (5)
Panel A: Average over the life cycle, per capita per annum						
1. Consumption	28,830	28,839	28,961	28,732	28,735	28,842
2. Premium exp.	754	772	759	851	867	861
3. Bequests|decease	16,958	16,915	16,888	17,258	17,249	17,186
4. Risk-free assets	175,777	175,841	178,346	175,943	176,024	178,088
5. Insurance face value	93,310	98,249	91,484	97,911	100,537	99,393
6. Survivors benefits	53,326	44,817	49,571	53,326	44,817	49,571
Panel B: Coverage-mortality correlation analysis and general equilibrium variables						
7. Renew	-0.0023	-0.0024	-0.0023	-0.0017	-0.0018	-0.0017
8. Purchase new	-0.0007	-0.0007	-0.0006	-0.0005	-0.0006	-0.0006
9. Price adjustment	1.1138	1.1138	1.1150	0.9536	0.9541	0.9548
10. Labor tax rate	0.2567	0.2564	0.2535	0.2573	0.2569	0.2543
Panel C: Welfare CEV (%)						
11. All		-0.28	0.40	0.27	0.01	0.67
Permanent productivity						
12. Low		-0.39	0.40	0.55	0.20	0.94
13. High		-0.09	0.40	-0.19	-0.30	0.21
Education						
14. No college		-0.31	0.40	0.28	0.00	0.67
15. College		-0.16	0.39	0.24	0.07	0.67

Note: Lines 7 and 8 presents estimates of β_x (renew coverage) and β_q (purchase new coverage) from equation (15) using all agents who are eligible to purchase life insurance ($j < J^I$). Lines 9 and 10 report two general equilibrium variables derived from equations (10) and (11). Line 11 reports the CEV for a new generation under the veil of ignorance. Lines 12-15 report the CEV for a new generation after knowing their permanent productivity or education.

Table 11: The composition of bequests by age group and by permanent productivity

	22-48		49-75		76-102	
	Low	High	Low	High	Low	High
Panel A: Levels in the benchmark economy						
Bequests	96,964	367,077	140,641	752,639	68,205	544,469
Risk-free assets	23,071	76,599	94,966	546,034	48,049	478,070
Life insurance	19,614	194,453	20,007	161,617	3,450	38,603
Survivors benefits	54,279	96,025	25,667	44,988	16,707	27,796
Panel B: Effect of reducing SBDC						
Bequests	-10,321	-6,879	+475	+2,780	-153	-1,292
Risk-free assets	+85	+394	+96	+417	-249	-2,033
Life insurance	+2,079	+14,813	+801	+3,023	+96	+741
Survivors benefits	-12,484	-22,086	-422	-660	0	0
Panel C: Effect of reducing SBAS						
Bequests	+1,017	-7,582	-3,056	-2,748	-2,374	+2,281
Risk-free assets	+366	+1,414	+1,939	+6,518	+1,361	+8,481
Life insurance	+650	-8,996	+487	+421	+108	+193
Survivors benefits	0	0	-5,481	-9,687	-3,843	-6,393
Panel D: Effect of community rating						
Bequests	+69,706	-53,573	+24,355	-15,654	+247	+2,943
Risk-free assets	-2,590	+2,786	-8,500	+6,027	-2,557	+7,713
Life insurance	+72,297	-56,360	+32,855	-21,681	+2,804	-4,770
Survivors benefits	0	0	0	0	0	0

Note: Panel A reports the levels in the benchmark economy, and Panels B-D report the level change from the benchmark economy. In each panel, line 1 reports the average value of (possible) bequests before survival shocks are realized. Following equation (6), the value of bequests are decomposed into three components: the value of risk-free assets (line 2), the value of life insurance (line 3), and the value of survivors benefits (line 4).

Table 12: CEV (%) for a new generation under different labor taxes and insurance prices

	Reduce SBDC			Reduce SBAS		
	PE	+new tax	GE	PE	+new tax	GE
	(1)	(2)	(3)	(4)	(5)	(6)
All	-0.33	-0.28	-0.28	-0.08	0.40	0.40
Permanent productivity						
– Low	-0.43	-0.39	-0.39	-0.09	0.40	0.40
– High	-0.17	-0.09	-0.09	-0.07	0.41	0.40

Note: Table reports the CEV of a new generation for reducing SBDC by 23 percent (Columns 1-3) and for reducing SBAS by 23 percent (Columns 4-6) under three alternative assumptions of the two general equilibrium variables. Columns 1 and 4 assume both levels equal those in the benchmark economy. Columns 2 and 5 add the change in labor tax rates between the benchmark economy and the corresponding counterfactual economy. Columns 3 and 6 add the change in both insurance prices and labor tax rates between the benchmark economy and the corresponding counterfactual economy.

Table 13: Change in the ratio of bequests to the annual earnings index from the benchmark economy

	Panel A: Reduce SBDC				Panel B: Reduce SBAS	
	By first child's age				By spouse's age	
	0-5	6-11	12-17	18-23	64-84	85-102
	(1)	(2)	(3)	(4)	(5)	(6)
Bottom 5%	-0.25	-0.54	-0.25	+0.00	-0.27	-0.07
Bottom 10%	-0.54	-0.76	-0.26	+0.00	-0.32	-0.09
First quintile	-0.52	-0.93	-0.23	+0.01	-0.40	-0.11
Second quintile	-0.98	-0.98	-0.60	+0.09	-0.56	-0.19
Third quintile	-1.02	-1.49	-0.18	+0.13	-0.22	-0.17
Fourth quintile	-1.87	-0.72	-0.22	+0.10	-0.19	+0.10
Fifth quintile	-1.08	-0.73	-0.25	+0.07	-0.19	+0.08
All	-1.10	-0.97	-0.30	+0.08	-0.31	-0.06

Appendices

Alternative Specifications of the Bequest Motive

To understand the necessity of each characteristic of the bequest motive (see equation (14)) for matching the empirical life-cycle profile of insurance coverage, I consider the following three alternative specifications. First, I set $\lambda_J = 0$, assuming that the marginal utility of leaving bequests is constant over the life-cycle (constant motive). Second, I set $\lambda_4 = \lambda_5 = \lambda_6 = 0$, assuming that the marginal utility of leaving bequests does not change across family structures (homogeneous motive). Last, I set $\kappa = 0$, assuming that bequests are normal goods (normal goods). Table A1 reports the calibrated parameters for alternative specifications. As shown in Figure A1(a), the constant motive assumption leads a model to under-predict insurance coverage at young ages and over-predict insurance coverage at older ages; the homogeneous motive assumption leads a model to under-predict insurance coverage for the entire life cycle; the normal goods assumption has little impact on the average coverage, but it overstates the participation in the life insurance market, for instance, it predicts that 96 percent of agents aged 40-48 have life insurance while the data number is 68 percent (see Table 6). The specification of the bequest motive also affects the life-cycle profile of risk-free assets (Figures A1(b)) and bequests (Figures A1(c)), for instance, the constant motive assumption leads retirees to continue increasing their holdings of risk-free assets.

[Insert Appendix Tables A1 and Appendix Figure A1]

Table A2 reports the results of correlation analysis for these alternative models. The comparison across columns makes it clear that the luxury nature of bequests is the key assumption that generates advantageous selection in the life insurance market. Assuming bequests are normal goods causes agents who renew existing contracts or purchase new insurance to have greater mortality rates than the uninsured. In addition, assuming a homogeneous bequest motive causes those who purchase new insurance to have greater mortality rates than those who have zero insurance, although those who renew insurance still have smaller mortality rates. Another thing of interest is the sensitivity of the welfare results. As reported in Table A3, in all specifications, reducing SBDC generates welfare losses, while reducing SBAS produces welfare gains.

[Insert Appendix Tables A2 and A3]

Alternative Measures of Insurance Coverage

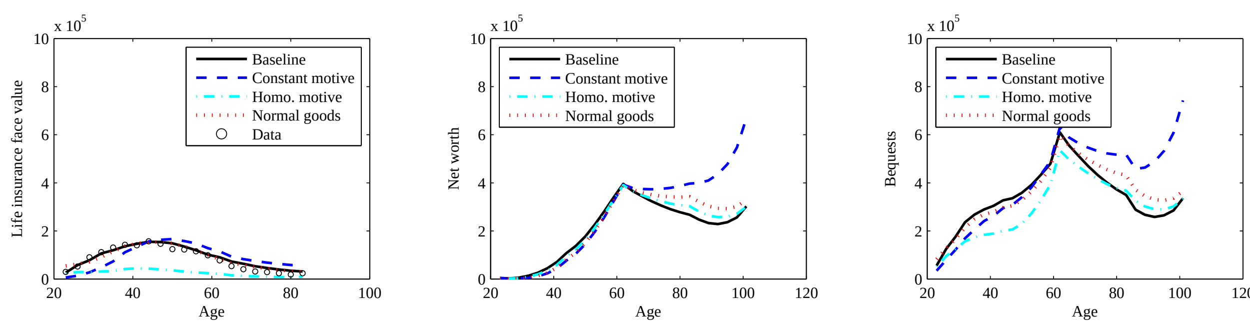
In the baseline model, I set the bequest motive to match the total insurance face value. One concern is that holdings of group life insurance may not be voluntary. Thus, for those with only group insurance, the observed positions may overstate what individuals would find optimal to purchase. To address this concern, I construct an alternative measure of insurance coverage by excluding the face value of individuals who have only group coverage, and re-calibrate the model to match these new measures. As shown in column 5 of Tables A1, A2 and A3, and Figure A2, characteristics of this alternative model are similar to the baseline model.

[Insert Appendix Figure A2]

Difference across Cohorts

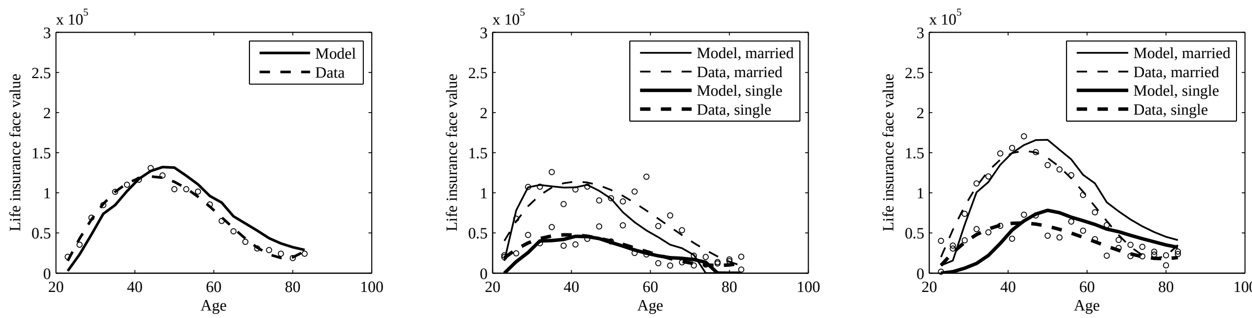
This paper uses cross-sectional data on life insurance coverage to pin down the bequest motive. If the motive to support wives and children responds to the change in labor market opportunities for females, cross-sectional data are not closely representative of life-cycle variation. To address this concern, Figure A3 plots the average life insurance face values for households with a male head of different ages in the Survey of Consumer Finances (SCF) in various years. The SCF collects information on insurance face value for a longer period of time than the SIPP, but the reported coverage is for the entire household. As shown in Figure A3, the amount of insurance coverage for households with a male head of age 30s and 40s is quite stable after 2000, while the coverage for other age groups is still changing over time. This is one of the reasons why I choose insurance coverage of males in their 30s and 40s as model targets.

[Insert Appendix Figure A3]



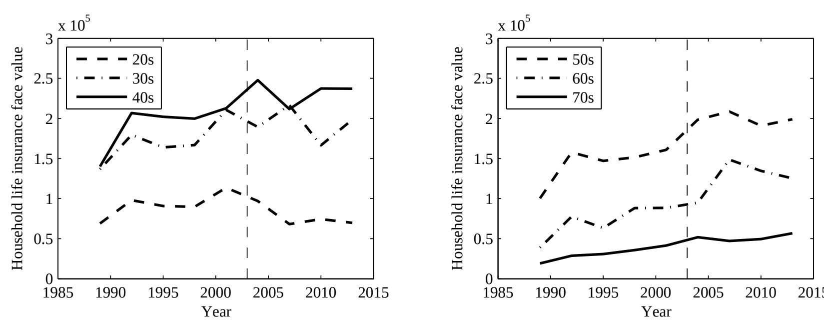
(a) Insurance coverage (b) Rish-free assets (c) (Potential) bequests

Figure A1: Insurance coverage, risk-free assets, and bequests by age group under alternative models



(a) All (b) Non-fathers (c) Fathers

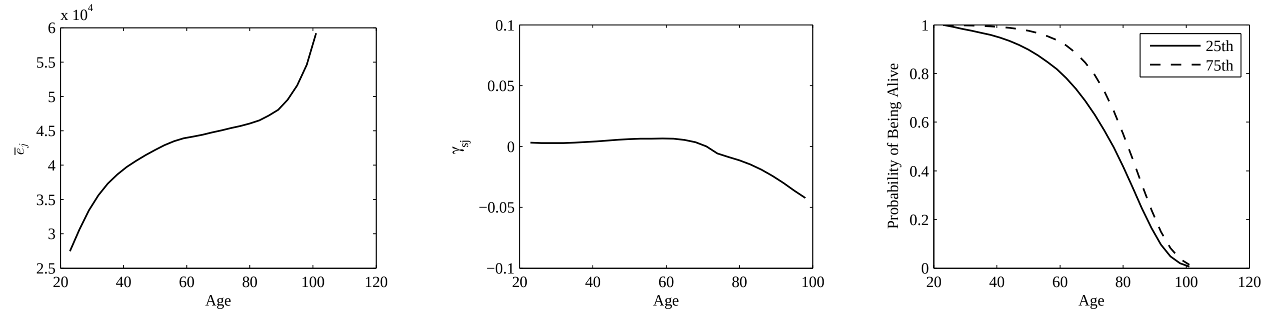
Figure A2: Insurance face values in a model that matches an alternative measure of insurance coverage



(a) 20s-40s (b) 50s-70s

Figure A3: Household life insurance coverage by year and by age group

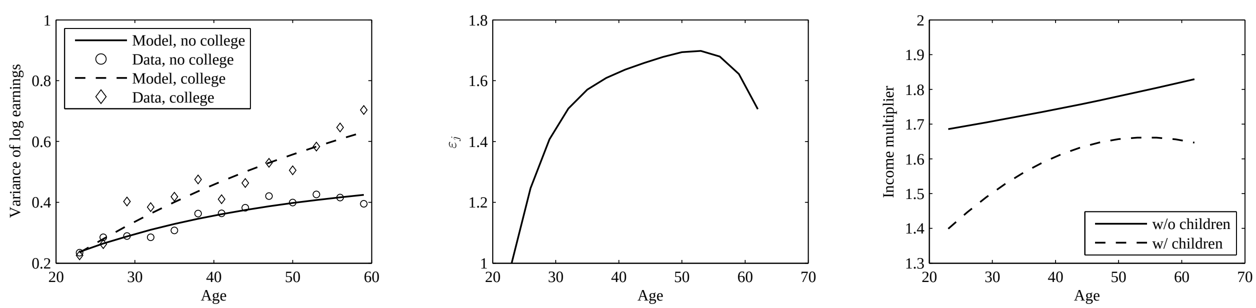
Note: 2003 is indicated by the vertical dashed line. Households are grouped into different age categories according to the age of the male head. Households with more than \$2 million life insurance coverage, twice the maximum individual coverage observed in the SIPP, are dropped to exclude insurance coverage against business losses.



(a) $\overline{e}_j$ (b) γ_{sj} (c) Cumulative survival rates

Figure A4: Characteristics of the survival function

Note: Figures A4(a) and A4(b), respectively, present $\overline{e}_j$ and γ_{sj} for equation (12). Figure A4(c) displays the cumulative survival rates for two agents: one has earnings at the 25 percentile of the earnings distribution of each age group (solid line) and the other has earnings at the 75 percentile (dashed line).



(a) Variance of log earnings (b) Age-efficiency profile (c) Household/husband's earnings

Figure A5: Characteristics of earning profiles

Note: Figure A5(a) compares the data variance of log personal earnings to the model variance. Figure A5(b) presents the age-efficiency productivity profile. Figure A5(c) shows the ratio of household earnings to the husband's earnings among married households.

Table A1: Calibrated parameters for alternative models

Para.	Meaning	Baseline (1)	Constant motive (2)	Homogeneous motive (3)	Normal goods (4)	Voluntary insurance (5)
λ_3	Basic motive	126.87	55.30	26.99	5.04	190.83
λ_J	Age effect	-7.70	0.00	-0.25	0.10	-10.63
λ_4	Child effect	34.31	32.80	0.00	12.25	34.05
λ_5	Spouse effect	7.10	5.45	0.00	12.52	-8.03
λ_6	Mother effect	7.50	5.25	0.00	8.46	20.01
κ (000's)	Luxury shifter	449.66	370.00	130.14	0.00	719.64
β	Discount factor	0.85	0.81	0.84	0.81	0.86

Table A2: Coverage-mortality correlation analysis under alternative models

	Baseline (1)	Constant motive (2)	Homogeneous motive (3)	Normal goods (4)	Voluntary insurance (5)
Renew coverage	-0.00231	-0.00209	-0.00070	0.00113	-0.00219
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00001)
Purchase new coverage	-0.00067	-0.00032	0.00064	0.00129	-0.00063
	(0.00001)	(0.00001)	(0.00001)	(0.00001)	(0.00002)

Note: Table presents estimates of β_x (renew coverage) and β_q (purchase new coverage) from equation (15) using all agents who are eligible to purchase life insurance ($j < J^I$). Standard errors in parentheses.

Table A3: CEV (%) for a new generation under alternative models

	Baseline (1)	Constant motive (2)	Homogeneous motive (3)	Normal goods (4)	Voluntary insurance (5)
Reduce SBDC	-0.28	-0.23	-0.18	-0.38	-0.21
Reduce SBAS	0.40	0.39	0.42	0.30	0.37

Note: Line 1 reports the CEV for reducing SBDC by 23 percent and line 2 reports the CEV for reducing SBAS by 23 percent.

Table A4: Coverage-mortality correlation analysis by subgroup

		Age		Risk	
	All	Workers	Retirees	High	Low
	(1)	(2)	(3)	(4)	(5)
Panel A: Agents facing actuarially favorable prices					
% of sample	8.6%	10.8%	2.0%	9.9%	7.1%
Renew coverage	-0.000018	-0.000018	-0.000020	-0.000231	-0.000009
	(0.000002)	(0.000002)	(0.000042)	(0.000005)	(0.000002)
Purchase new coverage	0.000005	0.000004	0.000046	-0.000023	0.000016
	(0.000002)	(0.000002)	(0.000042)	(0.000005)	(0.000002)
Panel B: Agents facing actuarially adverse prices					
% of sample	91.4%	89.2%	98.0%	90.1%	92.9%
Renew coverage	-0.002143	-0.002347	-0.001462	-0.004359	-0.000005
	(0.000013)	(0.000009)	(0.000141)	(0.000017)	(0.000020)
Purchase new coverage	-0.000540	-0.000632	0.002231	-0.000384	0.000062
	(0.000013)	(0.000009)	(0.000141)	(0.000017)	(0.000020)

Note: Table presents estimates of β_x (renew coverage) and β_q (purchase new coverage) from equation (15) separately for agents who face actuarially favorable price (Panel A) and for agents who face actuarially adverse price (Panel B) based on individual mortality rates. Column (1) reports the estimates using all agents who are eligible to purchase life insurance ($j < J^I$). Columns (2)-(4) report estimates for different subgroups: (2) for workers ($j < Jr$), (3) for retirees ($j \geq Jr$), (4) for agents in the high-risk pool ($e_j \leq \bar{e}_j$), and (5) for agents in the low-risk pool ($e_j > \bar{e}_j$). Standard errors in parentheses.

Table A5: CEV (%) of reducing SBDC and reducing SBAS under alternative assumptions about life insurance firms

	All	Low	High	No college	College
	(1)	(2)	(3)	(4)	(5)
Panel A: Assuming community rated premiums					
Reduce SBDC	-0.26	-0.34	-0.12	-0.28	-0.17
Reduce SBAS	0.39	0.39	0.40	0.38	0.43
Panel B: Assuming a zero loading factor					
Reduce SBDC	-0.26	-0.36	-0.09	-0.29	-0.16
Reduce SBAS	0.43	0.40	0.47	0.40	0.50

Note: Panel A assumes insurance premiums are community rated. Panel B assumes the loading factor is zero, i.e., there is no underwriting or other operating expenses. In each panel, line 1 reports the CEV for reducing SBDC by 23 percent and line 2 reports the CEV for reducing SBAS by 23 percent.

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