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June 2023

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June 8, 2023

Abstract

A major challenge in the study of saving behavior is how to disentangle different motives for saving. We approach this question in the context of an entire life-cycle model. Specifically, we identify the importance of different saving motives by simultaneously accounting for wealth accumulation during working period, wealth decumulation during retirement, and labor supply behavior. We show that exploiting all of these data features can sharpen our identification, thus complementing previous studies that focus only on wealth accumulation or decumulation. We estimate our model using several micro datasets and use the estimated model to evaluate the contribution of life-cycle, bequest, and precautionary motives to total savings. We also emphasize the importance of accounting for state-contingent assets when analyzing the precautionary saving motive.

Keywords: savings, self-insurance, bequest motives, life-cycle models, medical spending
JEL Classification Codes: D52, D91, E21, H53, I13, I18

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1 Introduction

A major challenge in the study of saving behavior is how to disentangle various motives for saving. In the canonical life-cycle model going back to Modigliani and Brumberg (1954) agents save only to smooth their consumption against the decline in labor income at retirement (the life-cycle motive for saving). Adding uncertainty and altruism to this model results in two additional reasons to save: precautionary and bequest motives. However, the latter two motives are hard to separate because every dollar saved for the precautionary reason can be bequeathed if an agent does not survive.

This identification challenge was emphasized by Dynan et al. (2002) who proclaimed that these two motives "cannot generally be distinguished". However, recently substantial progress has been made in the context of retirement saving models. Several studies identify the relative strength of bequest and precautionary motives by looking at additional features of the data such as participation in public programs (De Nardi et al. 2016a), purchases of private insurance (Lockwood, 2018) or answers to strategic survey questions (Ameriks et al., 2020). These studies arrive, however, at different quantitative conclusions, leaving the issue of the relative importance of saving motives unresolved (see De Nardi et al., 2016b for an extensive review).

Our goal in this paper is to revisit the question of why do people save in the context of a rich structural model that features the entire life-cycle and thus can speak to the data on both wealth accumulation and decumulation, as well as on labor supply behavior. Our approach can offer several insights into the discussion of saving motives.

First, the entire life-cycle perspective can complement the aforementioned studies of wealth decumulation after retirement in the following way. A particular model's parametrization can well explain the decumulation pattern of a *given* amount of wealth but may not necessary account for why this particular amount of wealth was accumulated. In addition, various saving motives affect not only wealth holdings but also labor supply. For example, the response of work decisions to the precautionary saving motive is investigated theoretically by Floden (2006) and quantitatively by Low (2005) and Pijoan-Mas (2006). Thus, work decisions provide additional information that help to quantify the importance of different reasons to save.

Second, our approach can also complement the studies of wealth accumulation over the working stage of a life-cycle (Cagetti, 2003; Hubbard et al., 1994; Gourinchas and Parker, 2002). These studies usually focus on the relative importance of life-cycle versus precautionary motives and do not target wealth decumulation after retirement. However, the relative importance of different saving motives changes over the life-cycle, and wealth trajectory after retirement is informative about the underlying structural parameters. For example, when looking only at wealth accumulation during working years, it is hard to pin down the importance of the bequest motive given that the full strength of this motive only reveals itself when survival probability decreases in the later stage of life.

Third, saving behavior is typically studied in the expected utility framework where risk aversion is restricted to be equal to the inverse of the intertemporal elasticity of substitution (IES). This restriction implies that either both precautionary and life-cycle saving motives are weak or both are strong. For example, when risk aversion is high people save more for precautionary reasons. At the same time, because IES is low, they are less tolerant to consumption fluctuations over time, implying their saving behavior is strongly influenced by the life-cycle motive.[1] In contrast, we consider a more flexible framework with non-expected utility using the parametrization suggested by Epstein and Zin (1989). De-linking risk aversion from IES allows for the possibility that people have a strong precautionary motive (high risk aversion) and a weak life-cycle motive (high IES), or vice versa.

We thus can summarize the key mechanisms generating saving(dissaving) in our quantitative model as follows. First, the average disposable income changes over the life-cycle. In particular, average labor income first increases and then decreases, falling to zero after retirement, while average medical spending always increases. This generates the life-cycle motive for saving. The strength of the life-cycle motive is determined by the institutional environment (especially the pension system) and preferences, specifically the IES.

Second, people face three sources of uncertainty: idiosyncratic labor productivity, medical expenses (including the costs of nursing homes), and survival. Since none of these risks can be perfectly insured in private markets, individuals have to self-insure, which generates precautionary saving. The strength of the precautionary motive is determined by risk aversion and the availability of partial insurance. Two important government programs providing partial insurance are the means-tested programs that guarantee the minimum subsistance level, and Social Security that provides insurance against longevity risk since it pays its benefits in the form of a lifelong annuity.

Third, people care about leaving inheritance to their kins, i.e., they derive utility from bequeathing. In parametrizing utility over bequests, we follow De Nardi (2004) by allowing for the possibility that bequests are luxury goods.

We calibrate/estimate our model using the Medical Expenditure Panel Survey (MEPS), Health and Retirement Study (HRS) and Panel Study of Income Dynamics (PSID) datasets.

[1] Note, while the precautionary motive implies people want to save more, the effect of the life-cycle motive on saving can be positive or negative depending on expected income. In particular, absent precautionary and bequest motives, young people would borrow in order to smooth consumption in face of future increase in income.

The calibrated model can reproduce many empirical patterns related to work and saving decisions. For labor market outcomes, our model can match average employment and labor income profile among workers. Importantly, in our estimation of labor income, we control for the selection of people into the labor force. This is important to adequately represent how available resources change over the life-cycle and thus to capture the life-cycle motive. For saving outcomes, our model matches wealth profiles, which includes not only the median, but also 25th and 75th percentiles of the net worth distribution for each age. This is important because if bequests are luxury goods, the bequest motive affects saving decisions of people at the top and the bottom of the wealth distribution in a different way.

Our findings are as follows. First, we illustrate the importance of the entire life-cycle perspective for the identification of saving motives in the following way. We start by showing that if we fix wealth at age 65 as in the data, we can parametrize the model so that it equally well accounts for the observed wealth decumulation after retirement either with a strong bequest motive or with a strong precautionary motive. However, these parametrizations fail to account for the observed wealth accumulation over the working stage of a life-cycle.

We then show that to *simultaneously* account for wealth accumulation over working years, wealth decumulation after retirement, and labor supply behavior, we need bequest and precautionary motives that are both relatively strong. Our identification argument can be illustrated as follows. The model without a bequest motive has to feature a very strong precautionary motive. This model fails to match saving and labor supply behavior in the beginning of the life-cycle since individuals with too strong precautionary motive work and save too much when young. Conversely, the model with a weak precautionary motive and a strong bequest motive produces too slow wealth accumulation in the very beginning of the life-cycle because decisions of the young are less affected by bequest motives given their high survival probability.

Second, our calibration/estimation of the full model (i.e., with both working and retirement periods) implies that both precautionary and bequest motives are indeed important. Our estimated risk aversion is significantly above the inverse of the IES, implying that people are more concerned about risk than about intertemporal fluctuations. At the same time, we estimate a high marginal propensity to bequeath (around 0.97) and even though bequests are luxury goods, the bequest motive is operational even for people with modest wealth holdings. Our results are thus consistent with De Nardi et al. (2016a) and Lockwood (2018) who also estimate the bequest motive to be important. Both studies argue that even though a very strong precautionary motive can account for wealth dynamics after retirement, it will also produce a counterfactually low Medicaid recepiency rate (the former study) or too much purchasing of long-term care insurance (the latter study). To account for these additional data features, the precautionary motive should be somewhat tuned down leaving larger role for the bequest motive. We add to this line of research by pointing to another reason why a significant part of savings after retirement should be attributed to the bequest motive: otherwise the precautionary motive would be excessively strong to be consistent with wealth accumulation and labor supply before retirement.

Our third result is the evaluation of the relative quantitative importance of saving motives in a unified framework with both working and retirement periods. We find that around half of the median wealth holding at the age of 65 can be attributed to the life-cycle motive. The bequest motive increases in significance with age: it "kicks in" for a median wealth holder at around age 50 and by age 65 accounts for around 20% of wealth holdings. Precautionary savings against all types of uncertainty contribute around 40% to the median wealth at age 65.[2]

To put the latter result in perspective, our estimated contribution of the precautionary motive to preretirement wealth is lower than that found in Cagetti (2003), Gourinchas and Parker (2002), and Hubbard et al. (1994). The first and third studies report a number of around 50%, the second – a range from 60 to 80%.[3] The difference in our result is due to two factors. First, the first two studies abstract from medical spending, while the third one abstracts from nursing home expenses. Medical and nursing home expenses increase both life-cycle and precautionary motives for saving but their effect on the former motive is larger[4]. Moreover, the effect of nursing home expenses on saving is as important as the effect of regular medical expenses (as emphasized by Kopecky and Koreshkova, 2014). Second, all three studies abstract from bequest motives in their benchmark estimation, thus, the entire preretirement wealth is attributed to life-cycle and precautionary motives only. Our estimates show that the bequest motive starts playing a significant role before retirement and thus also contributes to preretirement wealth accumulation.

Our final result is to emphasize the importance of accounting for state-contingent assets when evaluating the importance of the precautionary saving. We show that idiosyncratic labor productivity shocks contribute the most to precautionary saving (accounting for 26% of median preretirement wealth) while medical expense shocks contribute the least (account-

[2]In our quantitative exercises, we remove each saving motive one at a time and measure the decline in wealth holdings. Because of the interaction between motives for saving, the resulting numbers sum up to over 100%.

[3]Hubbard et al. (1994) do not report the contribution of the precautionary motive to total savings directly, but it can be computed from Table 1 in their paper by comparing the wealth to income ratios in cases with and without uncertainty when risk aversion is equal to 3 and the rate of time preferences is equal to 3% (this parametrization produces results closest to the data). We can do this comparison because labor supply is exogenous in their model and average labor income across two experiments is the same.

[4]This effect was also shown in De Nardi et al. (2010) who find that savings after retirement are more affected by the mean of medical spending than its variance.

ing for 4%). One way to read this decomposition is that the contribution of a particular risk to wealth accumulation is high when the opportunities for state-contingent savings are limited. Specifically, no state-contingent savings are available to insure labor income risks, thus individuals accumulate a significant amount of wealth to self-insure against these risks. In contrast, medical shocks are partially insured by state-contingent savings in the form of health insurance.[5]

To illustrate this point, we consider an experiment where these state–contingent savings are removed. In this case, the contribution of the medical expense risk to the median wealth at retirement constitutes around 50%. In other words, the precautionary motive to insure against medical risk is strong but most of the resulting savings come in the form of state-contingent assets.

Better understanding of saving decisions has important implications for evaluation of public policies that affect saving incentives. Among such policies, two should be especially mentioned. First are reforms to social security and pension systems. As is well established in the literature starting from Auerbach and Kotlikoff (1987) these reforms can have important effects on savings. The quantitative assessment of these effects crucially depends on how important is the life-cycle saving motive (which strongly depends on the pension system) compared to other saving motives. For example, Fuster et al. (2003) show that the strength of bequest motive can have a significant effect on the welfare consequences of social security elimination.

The second group of related policies is the introduction of various tax-deferred saving accounts that are specifically designed to address a particular saving motive, i.e., the life-cycle motive (Individual Retirement Accounts, IRA) or the precautionary motive (Health Saving Accounts, HSA). Without knowing the quantitative importance of each saving motive, it is hard to assess welfare implications of these saving accounts.

Apart from its relevance for policy evaluations, understanding the relative importance of different saving motives has non-trivial implications for a number of long-standing questions in public economics, such as to what extent public pensions crowd out private savings (Blau, 2016) or what accounts for the annuity puzzle (Inkman et al, 2011, Pashchenko, 2013). The answer to the first question largely depends on how strong is the life-cycle motive for saving, while knowing the strength of the bequest motive is important for answering the second one.

The rest of the paper is organized as follows. Section 2 presents the baseline model, Section 3 discusses its estimation/calibration. Section 4 brings the model to the data. Section 5 presents the results and Section 6 concludes.

[5]De Nardi et al. (2022) show that most of the lifetime medical costs are covered by health insurance.

2 Baseline Model

2.1 Demographics and preferences

A model period is one year. Individuals enter the model at age $t = 25$. Until age R individuals make labor supply and consumption/saving decisions, after age R individuals retire and only make consumption/saving decisions.

Each period, an individual incurs a stochastic out-of-pocket medical expenditure shock x_t^h which depends on his age and health; we denote the probability distribution of medical shocks as $\mathcal{G}_t(x_t^h)$. Individuals after a certain age are also exposed to the risk of needing long-term care; these shocks arrive with age- and health-dependent probability pn_t^h. An agent who needs to move to a nursing home has to pay xn_t out-of-pocket.

Health status of an age-t agent (h_t) evolves according to an age-dependent Markov process, $\mathcal{H}_t(h_t|h_{t-1})$, and can be either good ($h_t = 1$) or bad ($h_t = 0$). Apart from medical expenses, health also affects productivity and survival probability. We denote the probability to survive from period t to $t+1$ as ζ_t^h.

An individual's total time endowment is normalized to one. It can be used for either leisure or work, where work brings disutility modeled as a fixed costs of leisure ϕ_w. Labor supply (l_t) is indivisible: $l_t \in \left\{0, \bar{l}\right\}$. The leisure of an individual can be represented as $\widetilde{l}_t$ where:

$$\widetilde{l}_t = 1 - l_t - \phi_w \mathbf{1}_{\{l_t>0\}}.$$

Here $\mathbf{1}_{\{.\}}$ is an indicator function equal to one if its argument is true.

Individuals enjoy utility from consumption, leisure and from leaving bequests. To be able to separately parametrize agents' attitude towards risk and intertemporal fluctuations, we use non-expected utility (Epstein and Zin, 1989; Weil, 1990). Specifically, we use the parametrization that is commonly referred to in the literature as Epstein-Zin preferences:

$$U_t = \left[\left(c_t^{\chi} (\widetilde{l}_t)^{1-\chi} \right)^{1-\gamma} + \beta \left\{ \zeta_t^h E_t U_{t+1}^{1-\psi} + (1-\zeta_t^h) \eta \left(k + \phi\right)^{1-\psi} \right\}^{\frac{1-\gamma}{1-\psi}} \right]^{\frac{1}{1-\gamma}}$$

where χ is a parameter determining the relative weight of consumption in the consumption-leisure composite, ψ is risk-aversion, $1/\gamma$ is the intertemporal elasticity of substitution (IES), β is the discount factor, η is the strength of the bequest motive and ϕ is a shift parameter that controls to what extent bequests are luxury goods. In this formulation of bequest motive we follow De Nardi (2004).

2.1.1 Labor income, taxation, transfers and Social Security

The earnings of an individual are equal to $wz_t^h l_t$, where w is wage and z_t^h is the idiosyncratic productivity that depends on age (t) and health (h_t). All individuals pay an income tax $\mathcal{T}(y_t)$, where taxable income y_t is based on both labor and capital income. Working households also pay Medicare (τ_{MCR}) payroll tax.

Individuals who experience low earnings or high medical expenses shock can receive means-tested transfers T_t^{SI} that guarantee each household a minimum consumption level $\underline{c}$. This safety net is a stylized representation of public transfer programs such as SNAP (food stamps), Supplemental Security Income, disability insurance, and uncompensated care.

Working individuals pay Social Security payroll tax, τ_{ss}. The Social Security tax rate for earnings above $\overline{y}_{ss}$ is zero. Social Security benefits $ss(AE)$ is a concave function of the average lifetime earnings (AE). Average earnings evolve as follows:

$$AE_{t+1} = \begin{cases} AE_t + \dfrac{y_t}{35} & ;\ \text{if } t < 60 \\ AE_t + \dfrac{1}{35}\max\{0, y_t - AE_t\} & ;\ \text{otherwise} \end{cases}$$

where

$$y_t = \min\left\{wz_t^h l_t, \overline{y}_{ss}\right\}$$

Note that over the 35-year period from age 25 to 60, AE_t is updated every period, while after age 60, it is updated only if the current earnings exceed the average of previous earnings.[6]

The level of Social Security benefits is calculated as follows:

$$ss(AE_t) = \begin{cases} 0.9AE_t & ;\ \text{if } AE_t < B_1 \\ 0.9B_1 + 0.32(AE_t - B_1) & ;\ \text{if } B_1 \leq AE_t < B_2 \\ 0.9B_1 + 0.32(B_2 - B_1) + 0.15(AE_t - B_2) & ;\ \text{if } AE_t \geq B_2, \end{cases} \tag{1}$$

where B_1 and B_2 are the bend points, i.e., the levels of AE_t when the replacement rate changes first from 0.9 to 0.32, then from 0.32 to 0.15. Social Security rules regarding benefits calculations change for each cohort; we use individuals born in 1936-1938 as our base cohort. We set the bend points B_1 to \$6,372 and B_2 to \$38,424 based on the Social Security benefits formula for 2000.[7]

[6] Social Security benefits are a function of the average earnings of the 35 years with the highest earnings. We use a simplified version of this rule because otherwise we have to keep track over the entire previous earnings history as additional state variables which makes our computation infeasible.

[7] These numbers correspond to the annual benefits, they are derived by multiplying the bend points

2.1.2 Timing in the model

The timing in the model is as follows. In the beginning of each period, individuals learn their productivity and health status. Based on this information, an individual decides his labor supply (l_t). After that, the out-of-pocket medical shock (x_t^h) is realized; for individuals older than age R^N the nursing home shock (xn_t) is realized. In the very end of the period, consumption/saving decisions are made. Individuals after age R only make consumption/saving decisions.

2.1.3 Optimization problem

Individuals of a working age ($t < R$)**.** The state variables for individuals younger than age R at the beginning of each period are capital ($k_t \in \mathbb{K} = R^+ \cup \{0\}$), health ($h_t \in \mathbb{H} = \{0, 1\}$), idiosyncratic labor productivity $\left(z_t^h \in \mathbb{Z} = R^+\right)$, average lifetime earnings ($AE_t \in \mathbb{A} = R^+$), and age ($t \in \mathbb{T} = \{1, 2, ..., R-1\}$). We denote the vector of state variables of an individual of age t as $\mathbb{S}_t$: $\mathbb{S}_t = (k_t, h_t, z_t^h, AE_t)$.

The value function of an individual in this age range can be written as follows:

$$V_t(\mathbb{S}_t) = \max_{l_t} \left\{ \sum_{x_t^h} \mathcal{G}_t\left(x_t^h\right) W_t(\mathbb{S}_t; l_t, x_t^h)^{1-\psi} \right\}^{\frac{1}{1-\psi}} \tag{2}$$

where

$$W_t(\mathbb{S}_t; l_t, x_t^h) = \max_{c_t, k_{t+1}} \left\{ \begin{array}{c} \left(c_t^{\chi}(\widetilde{l}_t)^{1-\chi}\right)^{1-\gamma} + \\ \beta \left[\zeta_t^h E_t\left(V_{t+1}(\mathbb{S}_{t+1})\right)^{1-\psi} + (1-\zeta_t^h)\eta\left(k_{t+1}+\phi\right)^{1-\psi}\right]^{\frac{1-\gamma}{1-\psi}} \end{array} \right\}^{\frac{1}{1-\gamma}} \tag{3}$$

subject to

$$k_t(1+r) + wz_t^h l_t + T^{SI} = k_{t+1} + c_t + x_t^h + Tax \tag{4}$$

$$T_t^{SI} = \max\left(0, \underline{c} + x_t + Tax - k_t(1+r) - wz_t^h l_t\right) \tag{5}$$

$$Tax = \mathcal{T}\left(y_t^{tax}\right) + \tau_{ss}\min\left(wz_t^h l_t, \overline{y}_{ss}\right) + \tau_{MCR} w z_t^h l_t \tag{6}$$

corresponding to monthly benefits by 12.

$$y_t^{tax} = k_t r + w z_t^h l_t \tag{7}$$

The conditional expectation on the right-hand side of Eq (3) is over z_{t+1}^h and h_{t+1}. Eq (4) is the budget constraint. Eq (5) describes the means-tested transfers that provide the minimum consumption guarantee $\underline{c}$. In Eq (6), the first term is the income tax and the last two terms are payroll taxes. Eq (7) describes taxable income.

Retired individuals Individuals after age R make only consumption-saving decisions and their state variables are capital (k_t), health (h_t), average lifetime earnings ($AE \in \mathbb{A} = R^+$), and age (t). Denote the vector of the state variables as $\mathbb{S}_t^R = (k_t, h_t, AE)$. The value function of these individuals is:

$$V_t^R(\mathbb{S}_t^R) = \left\{ \sum_{x_t} \sum_{xn_t} \mathcal{G}_t \left(x_t^h\right) pn_t^h W_t^R(\mathbb{S}_t^R; x_t^h, xn_t)^{1-\psi} \right\}^{\frac{1}{1-\psi}}$$

where

$$W_t^R(\mathbb{S}_t^R; x_t^h, xn_t) = \max_{c_t, k_{t+1}} \left\{ \begin{array}{c} \left(c_t^{\chi} (\widetilde{l}_t)^{1-\chi}\right)^{1-\gamma} + \\ \beta \left[\zeta_t^h E_t \left(V_{t+1}^R(\mathbb{S}_{t+1}^R)\right)^{1-\psi} + (1-\zeta_t^h)\eta \left(k_{t+1} + \phi\right)^{1-\psi}\right]^{\frac{1-\gamma}{1-\psi}} \end{array} \right\}^{\frac{1}{1-\gamma}} \tag{8}$$

subject to:

$$k_t (1+r) + ss(AE) + T^{SI} = k_{t+1} + c_t + \mathcal{T}\left(y_t^{tax}\right) + x_t^h + xn_t$$

$$T_t^{SI} = \max\left(0, \underline{c} + \mathcal{T}\left(y_t^{tax}\right) + x_t^h - k_t(1+r) - ss(AE)\right) \tag{9}$$

$$y_t^{tax} = k_t r + ss(AE)$$

Here, $xn_t = 0$ if $t < R^N$. Note that the interim value function W_t^R is conditional on the realization of the out-of-pocket medical spending shock x_t^h and the nursing home shock xn_t. Eq (9) describes the means-tested transfers that individuals with large medical shocks receive.

3 Data and calibration

3.1 Data and sample selection

We combine information from the three datasets for our calibration: the Medical Expenditure Panel Survey (MEPS), the Health and Retirement Study (HRS) and the Panel Study of Income Dynamics (PSID). In all three datasets, we select a sample of male individuals.

MEPS is a nationally representative survey of households that focuses on medical usage and health insurance variables. It contains individuals of all ages but age is top-coded at 85. Medical spending reported in MEPS are cross-checked with insurers and providers which improves their accuracy.[8] We use MEPS to construct data moments related to medical spending (except for nursing home spending), health, labor income, and employment.[9] We use fourteen waves of MEPS from 1999 to 2012.

The HRS is a nationally representative sample of individuals over the age of 50. We use the RAND Version P of this dataset to construct moments related to nursing home costs and to adjust survival probabilities for the difference in health. To construct moments related to nursing home costs, we pool together waves 2002-2012 of HRS. We use a sample of individuals older than 70 that do not have missing information on nursing home use, health or age.

The PSID is a national representative panel survey of individuals and their families. It started in 1968 on an annual basis and from 1997 it is administered bi-annually. We use PSID to construct data moments related to wealth profiles.

We estimate/calibrate our model in two steps. In the first step, we set parameters related to demographics, Social Security benefits, taxes, medical expense and labor productivity shocks and estimate the health transition probabilities directly from the data. In the second step, we calibrate the remaining parameters using our model to match the targeted moments from the data. We convert nominal values to constant 2002 dollars using the CPI as a deflator.

3.2 Parameters set/estimated outside the model

3.2.1 Demographics and preferences

Agents enter the model at age 25 and can live to a maximum age of 99. For survival probabilities, we use the cohort life table for men born in 1940 provided by the Social Security

[8] Pashchenko and Porapakkarm (2016a) provide more details on the MEPS dataset.

[9] MEPS does not contain information on nursing home spending because it only contains non-institutionalized population and thus excludes nursing home residents.

Administration. To adjust conditional survival probabilities ζ_t^h for the difference in health, we follow Attanasio et al. (2011). In particular, we use the HRS to estimate the difference in survival probabilities for people in different health categories. Specifically, we use the HRS data to estimate the survival probability as a function of a cubic polynomial of age, using a probit model for each health status. Then, we compute the *survival premium* - the difference between the estimated survival probabilities of healthy and unhealthy males for each age. From the Social Security Administration cohort life table, we know the average survival probability of males. From the MEPS, we can construct the fraction of people in each health category for each age. Using this information, we can recover the survival probabilities of healthy and unhealthy people for each age.

We set the consumption share in the utility function χ to 0.5 to facilitate matching the employment profile. This number is in the range estimated by French (2005).[10] We set the labor supply of those who choose to work ($\bar{l}$) to 0.4. We define a person as employed if he earns at least \$2,678 per year in base year dollars (this corresponds to working at least 10 hours per week and earning a minimum wage of \$5.15 per hour).

A common approach in macroeconomic and structural studies is to identify the discount factor β from aggregate/average wealth holdings (e.g., Guvenen, 2007, Krueger and Perri, 2005, Storesletten et al., 2004) or from the evolution of median wealth or consumption over the life-cycle (e.g., Cagetti, 2003, Gourinchas and Parker, 2002). These studies, however, use standard expected utility preferences, i.e., they restrict risk aversion to be equal to the inverse of the IES. In our model, we relax this restriction, meaning we have one extra parameter that affects saving behavior. Because of this, as we show in Section 5.1.3 below, the discount factor is not identified in our model.[11] We set this parameter to 0.99, which is a common value in structural models with survival uncertainty.[12]

3.2.2 Labor productivity process

The productivity of individuals takes the following form:

$$z_t^h = \lambda_t^h \Upsilon_t = \lambda_t^h \exp(v_t) \exp(\xi) \tag{10}$$

[10] Given that we have an indivisible labor supply, we cannot pin down this parameter using a moment in the data.

[11] Pashchenko and Porapakkarm (2023) use Social Security claiming behavior to identify the discount factor in a model with non-expected utility preferences.

[12] The effective discount factor in models with survival uncertainty is β multiplied by survival probability, because of this the actual discount factor is usually set to a larger number compared to models without survival uncertainty.

where λ_t^h is the deterministic component that depends on age and health, and the stochastic component of productivity Υ_t consists of the persistent shock v_t and a fixed productivity type ξ:

$$v_t = \rho v_{t-1} + \varepsilon_t, \quad \varepsilon_t \sim N(0, \sigma_\varepsilon^2) \tag{11}$$

$$\xi \sim N(0, \sigma_\xi^2)$$

For the persistent shock v_t, we set ρ to 0.98 and σ_ε^2 to 0.02 following the incomplete market literature (Storesletten et al., 2004; Hubbard et al., 1994; French, 2005). We set the variance of the fixed productivity type (σ_ξ^2) to 0.242 as in Storesletten et al. (2004). In our computation, we discretize the shock processes using 9 gridpoints for v_t and 2 gridpoints for ξ. To construct the distribution of individuals just entering the model, we draw v_1 in Eq (11) from the $N(0, 0.352^2)$ distribution following Heathcote et al. (2010). We estimate the deterministic part of productivity λ_t^h inside the model and we explain how we do it in Section 3.3.2 below.

3.2.3 Health, medical expense and nursing home shocks

We use self-reported health status reported in MEPS to construct our measure of health. A person's self-reported health status in MEPS is coded as 1 for excellent, 2 for very good, 3 for good, 4 for fair and 5 for poor. Individuals in MEPS are interviewed five times over two-year period and the question about health is asked in every interview round. We classify a person as being in bad health if his average health score over that year is greater than 3.

To construct the age-dependent health transition matrix, we start by computing the transition matrices for ages 30, 40,...70. In each case, we use a sample in a 10-year age bracket. For example, to construct the transition matrix for age 40, we pool individuals between ages 35 and 44. Then we construct the health transition matrix for all the remaining ages by using polynomial degree two approximation.

Medical costs in our model correspond to the out-of-pocket medical expenditures in the MEPS dataset. In our calibration, medical expense shock is approximated by a 3-state discrete health- and age-dependent stochastic process. For each age and health status, these three states correspond to the average out-of-pocket medical expenses of the three groups: those with out-of-pocket medical spending below the 50th, 50th to 95th, and above the 95th percentiles, respectively.[13] To construct the transition matrix, we measure the fraction of

[13]The MEPS tends to underestimate aggregate medical expenditures (Pashchenko and Porapakkarm, 2016a). The ratio of aggregate medical spending in the National Health Expenditure Account (NHEA) divided by aggregate medical spending in MEPS for people younger and older than 65 years old constitute 1.6 and 1.9, respectively. These numbers were computed by averaging over the years 2002, 2004, 2006, 2008, and 2010 (the years when NHEA provides the aggregate statistics by age). The larger discrepancy

people who move from one group to another between two consecutive years separately for those between ages 25 and 64 and for those who are 65 and older.

We estimate the risk of incurring a nursing home shock (pn_t^h) from HRS as follows. First, we compute the probabilities to enter a nursing home for selected ages: 67, 72, 77, 82, 87, and 95. In each case, we use a sample in a 5-year age bracket. To do this, we compute the percentage of individuals reporting staying in a nursing home in each interview round for the following age groups: 65-69, 70-74, 75-79, 80-84, 85-89, and older than 90. Since HRS is a bi-annual survey, we convert these numbers into annual probabilities under the assumption that the probability of staying in a nursing home over the two-year interval is equal to the product of the annual probabilities. We then extrapolate the probability to stay in a nursing home for other ages using polynomial degree three approximation. We do this separately for healthy and unhealthy males. HRS also reports the number of nights over all nursing home stays. To compute the average nursing home costs, we multiply the number of nights by the average daily rate for a semiprivate room in a nursing home, which was $158.26 in 2003 Metlife.[14]

3.2.4 Taxes and government transfers

In specifying the tax function $\mathcal{T}(y)$ we use a nonlinear functional form formulated by Gouveia and Strauss (1994):

$$\mathcal{T}(y) = a_0 \left[y - (y^{-a_1} + a_2)^{-1/a_1} \right]$$

Following Gouveia and Strauss (1994), we set a_0 and a_1 to 0.258 and 0.768, respectively. We set the parameter a_2 to 0.616 following Pashchenko and Porapakkarm (2016b).

The Medicare and Social Security tax rates are set to 2.9 percent and 12.4 percent, respectively. The maximum taxable income for Social Security ($\overline{y}_{ss}$) is set to $76,200 (corresponding to year 2000).

for the older group is due to the fact that MEPS does not include nursing home expenditures. To bring aggregate medical expenses computed from the MEPS in line with the corresponding statistics in the NHEA, we multiply our estimated medical expenses by 1.60. We use this number because we explicitly account for nursing home spending in our model.

[14] The MetLife Market Survey of Nursing Home and Home Care Costs, August 2003.

3.3 Parameters used to match data moments

3.3.1 Preferences and consumption floor

We use four parameters to match the wealth profiles over the life-cycle: the intertemporal elasticity of substitution (IES, $\frac{1}{\gamma}$), risk aversion (ψ), the strength of the bequest motive (η) and the degree to which bequest is a luxury good (ϕ).

We jointly adjust risk aversion and the IES to capture wealth accumulation over the beginning of the life-cycle. Saving behavior of the young is strongly affected by these two parameters because bequest motive plays a relatively small role due to their high survival probability. The resulting parameters' values are 5 for risk aversion and 1.7 for the inverse of IES (1/IES). Note that to match the wealth accumulation profile we need to set risk aversion to a relatively high number and make it significantly different from 1/IES. We discuss this in more detail in Section 5.1.2 below.

After middle age, bequest motives start having a stronger impact on wealth dynamics since survival probability starts declining. The bequest function that we use implies that bequests are a luxury good, i.e., the bequest motive becomes operational only when individuals' assets are above a certain threshold, in which case the amount of assets they allocate to bequests is controlled by the marginal propensity to bequeath (MPB). The threshold and the MPB can be expressed as functions of the parameters η and ϕ in a simple two-period consumption-savings model (more on this see De Nardi et al. (2010) and Pashchenko (2013)). We adjust the threshold to match the wealth profiles of individuals in the bottom 25th percentile of the wealth distribution and we adjust the MPB to match the profiles for the median and the 75th percentile. The resulting numbers are \$3,605 for the threshold and 0.969 for the MPB.[15]

When calibrating the consumption minimum floor $\underline{c}$, we use the fact that this safety net has a significant effect on labor supply of individuals with low assets, such as the young. We set the minimum consumption floor to \$3,500 to match the employment rate among individuals 25-29 years old. Our estimate of the consumption floor is in line with with other models with medical expense shocks that consider the entire life-cycle (e.g. Capatina, 2015).

3.3.2 Labor productivity and disutility from work

We estimate the deterministic part of productivity λ_t^h together with fixed leisure costs of work ϕ_w. In this estimation, we need to take into account the fact that in the data, we only observe labor income of workers and we do not know the potential labor income

[15]The corresponding values of η and ϕ are 2.4^{11} and $115,000$, respectively.

of non-workers, which are not necessarily the same because there can be a selection into employment. To avoid selection bias, we use the method developed by French (2005) and adapted for an environment similar to ours by Pashchenko and Porapakkarm (2013).

We start by estimating the labor income profiles from the MEPS dataset for all workers. Then, given other parameters of the model, we guess λ_t^h in Eq. (10) and fixed cost of work ϕ_w. Next, we feed the resulting productivity into our model. After solving and simulating the model, we compute the average labor income profile of workers and employment in our model and compare them with the data. Then, we update our guess and reiterate until the life-cycle profiles for labor income and employment in the model are the same as in the data.

We set the wage rate w so that the level of the average earnings in our model is the same as in the data. The model parametrization is summarized in Table 2 in Appendix A.

4 Baseline model performance

The top panel of Figure (1) compares the employment profile (left panel) and the average labor income of workers (right panel) in the data and in the model. The model closely tracks the data. The average labor income profiles and employment profiles were targeted in our calibration by adjusting the exogenous productivity, the disutility from work parameter, and the consumption floor.

The bottom panel of Figure (1) shows that our calibration strategy of adjusting risk aversion, IES, and the bequest function parameters allows us to capture the wealth profiles for the bottom 25th percentile, median and 75th percentile constructed from the data. In the next section, we examine the role of different parameters in achieving this result.

5 Results

This section is organized as follows. We start by illustrating how our quantitative model works and our identification strategy. Then we provide a decomposition exercise showing the importance of different saving motives. Finally, we show how the availability of state-contingent assets changes the contribution of medical expenses risks to life-cycle savings.

5.1 How does the model work?

The goal of this section is to illustrate the mechanics of the model and the identification of the key parameters. We first discuss the relationship between the accumulation and decumulation phases of the life-cycle. We then show the distinct role of risk aversion and

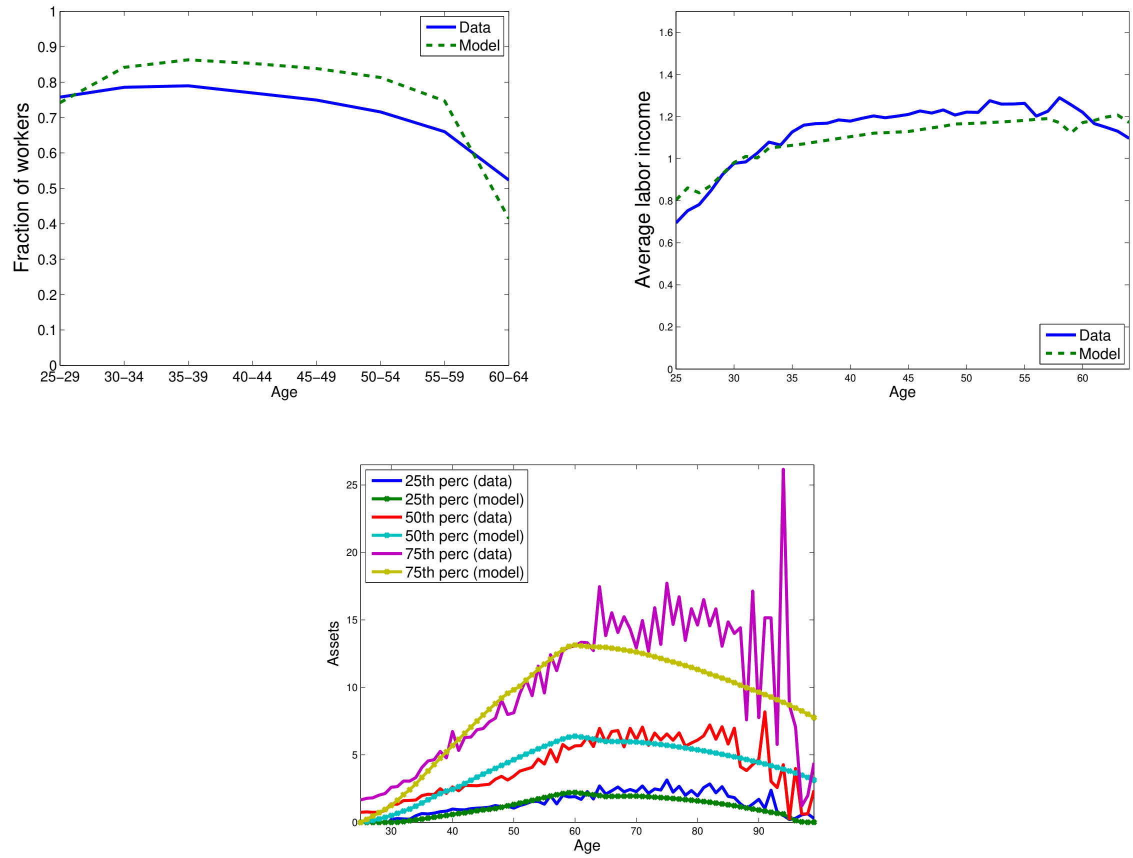

Figure 1: Left top panel: fraction of workers by age. Right top panel: average income among workers by age. Bottom panel: wealth profiles by age. Nominal variables are normalized by average income.

the intertemporal elasticity of substitution (IES) in affecting saving behavior. Finally, we illustrate the role of the discount factor.

5.1.1 Wealth accumulation versus decumulation

The purpose of this section is to show how combining information on wealth accumulation and decumulation can help with the identification of bequest and precautionary motives. We start by providing a simple illustration of this identification problem. To do this, we first consider a model that only includes the retirement stage of a life-cycle. In such a model, initial wealth is exogenously fixed, and we set it to be equal to the median wealth at age 65 in the data. Next, we adjust parameters of the model to match the decumulation of this given amount of wealth. We do this in two versions of the model. In the first version, we remove the bequest motive and adjust the strength of the precautionary motive. The strength of the precautionary motive is controlled by two parameters: risk aversion and the minimum consumption floor. These parameters are usually jointly estimated in structural models of wealth decumulation after retirement (e.g., De Nardi et al., 2010 and 2016a, Lockwood, 2018).[16] In the second version of the model, we assume a weak precautionary motive by setting low risk aversion and a high consumption floor, and then adjust the strength of the bequest motive to match the wealth decumulation. It is worth noting that the purpose of this exercise is not to provide any formal parameter estimation but to illustrate, in the simplest possible setting, how two different mechanisms can produce similar outcomes.

Figure 2 plots the median wealth evolution after the age of 65 in the data (solid lines) and in the two versions of the model just described (dashed lines). In the first version of the model featuring no bequest motive and strong precautionary motive (left panel), risk aversion is set to 9 (compared to the baseline value of 5) and the consumption floor to \$500 (compared to the baseline value of \$3,500). In the second version of the model featuring a strong bequest motive alongside a weak precautionary motive (right panel), risk aversion is set to 2 and the consumption floor is set to \$6,000. The shift parameter in the bequest function is the same as in the baseline; the multiplier in the bequest function, which determines the strength of the bequest motive, is adjusted to match the wealth profile.

The two alternative versions of the model reproduce the median wealth profile after retirement equally well even though in the first case saving decisions are driven only by the precautionary motive while in the second - mostly by the bequest motive. This simple illustration re-affirms the problem pointed out by Dynan et al. (2002), i.e., bequest and precautionary motives are hard to tell apart by looking at savings alone. In the recent literature studying wealth decumulation after retirement in a structural framework, this problem is addressed by looking at additional features of the data, such as participation in public programs (De Nardi et al., 2016a), the purchase of long-term care insurance (Lockwood, 2018), or answers to strategic survey questions (Ameriks et al., 2020). We argue that another possible source of identifying information can come from wealth accumulation over the working stage of the life-cycle and labor supply decisions.

To illustrate this, Figure 3 simulates saving and labor supply decisions starting from the age of 25 for the same combination of parameters used in the two partial life-cycle versions of the model in Figure 2. As before, the left panel corresponds to the situation without the bequest motive and the right panel corresponds to the situation with a weak precautionary motive.

Note that because the model without the bequest motive (left panel) features a very

[16] Note that in models with non-discretionary medical shocks and a consumption floor, the latter parameter is important in determining the strength of the precautionary motive. This happens because it determines consumption in the worst possible state of the world: when medical shocks exceed available resources. For example, it is possible to have a situation when the precautionary motive is weak despite high risk aversion because the consumption floor is high.

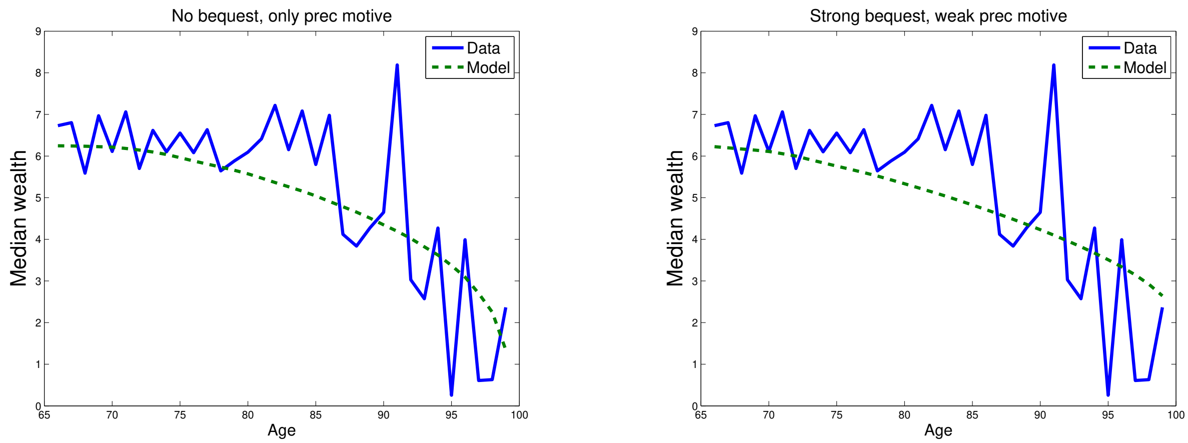

Figure 2: Left panel: wealth decumulation when there is no bequest motive. Right panel: wealth decumulation with a strong bequest motive and weak precautionary motive. Initial wealth level is fixed as in the data. Wealth is normalized by average income.

strong precautionary motive, it produces wealth accumulation and employment profiles that are not in line with the data. Specifically, people work too much and save too much in the beginning of their life-cycle.[17]

The model with a strong bequest motive (right panel) also cannot match the behavior over the beginning of the life-cycle but for a different reason. Young individuals have survival probability close to one, which decreases the weight of the bequest motive in their decisions. In addition, the luxury bequest motive becomes operational only when individuals have wealth above a certain threshold. This condition does not hold for young individuals who have little wealth. Since this version of the model features a weak precautionary motive, in the absence of an operational bequest motive it produces wealth accumulation and labor supply that are too low compared to the data.

Overall, this illustration suggests that a particular model parametrization can well explain the decumulation of exogenously fixed amount of wealth after retirement but, at the same time, fail to match the accumulation of this amount of wealth endogenously. The model with a strong precautionary motive overpredicts the level of accumulated wealth, and the model with a strong bequest motive underpredicts it. Thus, saving and labor supply decisions over the beginning of a life-cycle are important for understanding the quantitative importance of bequest and precautionary motives. This suggests that examining saving behavior within an entire life-cycle framework offers additional insights about the importance of different motives for saving.

[17]Floden (2006), Low (2005), and Pijoan-Mas (2006) also point out that in models with endogenous labor supply, individuals respond to the precautionary motive not only with their savings but also with their decisions to work.

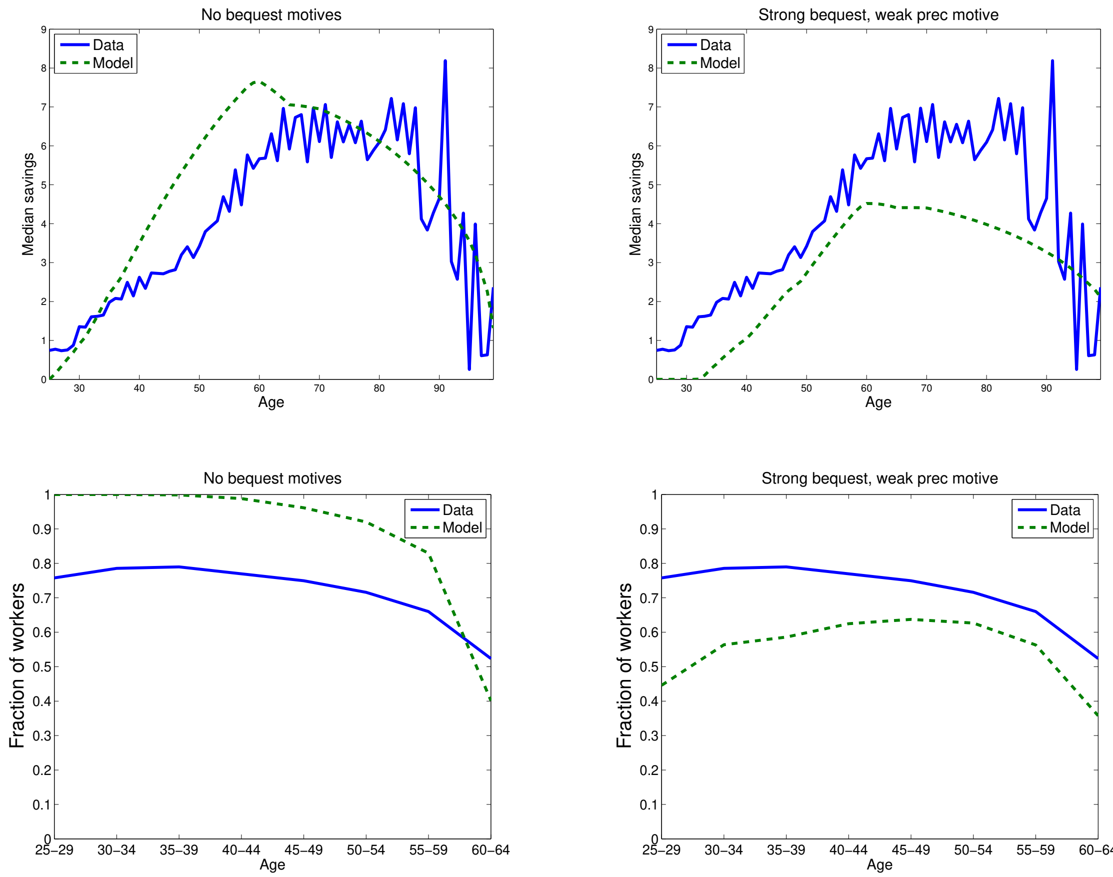

Figure 3: Left panel: wealth and employment profiles when there is no bequest motive. Right panel: wealth and employment profiles with a strong bequest motive and a weak precautionary motive. Nominal variables are normalized by average income.

5.1.2 Risk aversion versus Intertemporal Elasticity of Substitution

A common approach in many macroeconomic and structural studies is to use the expected utility framework, i.e., to assume that risk aversion is equal to the inverse of IES. Because of this, it is difficult to identify risk aversion (and hence IES) from wealth profiles.[18] This happens because an increase in risk aversion produces two effects. First, people become less tolerant to consumption fluctuations over states of the world. Second, the simultaneous decrease in IES makes people less tolerant to consumption fluctuations over time. The first effect induces people to have a steeper wealth profile, while the second one induces them to have flatter wealth profile over the life-cycle. Since it is not clear which effect dominates, it is difficult to capture the empirical wealth profile when these parameters are tied together.

To illustrate this issue, Figure 4 plots the change in the wealth profile over the life-cycle

[18]The difficulty of identifying risk aversion from saving behavior in the standard utility framework is illustrated in Lockwood (2018) (see Table 3 in his paper and the following discussion).

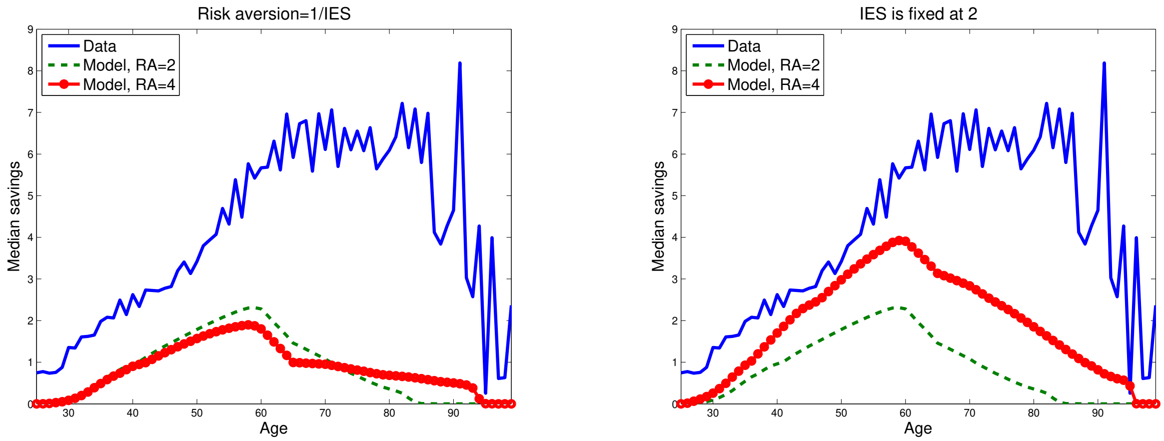

Figure 4: The effect of increase in risk aversion from 2 to 4 on wealth profiles. Left panel: IES is equal to the inverse of risk aversion. Right panel: IES is fixed at 0.5. Bequest motives are set to zero.

for two values of risk aversion: 2 and 4. We consider two cases depending on whether or not IES is tied to risk aversion. In the first case, IES is equal to one over risk aversion and thus is equal to 0.5 (0.25) when risk aversion is equal to 2 (4). In the second case, IES is fixed at 0.5. In both experiments, the bequest motives is set to zero to make comparison cleaner.[19] Because of this, wealth profiles in this version of the model are below that in the data.

In the first case (left panel of the figure), the increase in risk aversion from 2 to 4 decreases wealth accumulation before retirement and slows down wealth decumulation after retirement. This happens because the effect of the decrease in IES dominates and people flatten their wealth profile. In the second case (right panel), the increase in risk aversion increases wealth levels at each age because there is no counter effect of the decrease in IES. This shows that the non-expected utility framework allows for a sharper identification of risk aversion.

5.1.3 The role of the discount factor

In this section, we argue that once the assumption of expected utility is relaxed, wealth profiles do not provide sufficient information to identify the discount factor.

We illustrate this point in Figure 5. The left panel of the figure shows the effect of decreasing β. Specifically, the graph plots median wealth profiles from the two versions of the model. The first version, which we refer to as "baseline no bequest" has the same parameters as the baseline model but bequest motive is set to zero for the ease of illustration. The second model differs from the first only in that it has lower discount factor set to 0.98 (compared to 0.99 in the baseline). As can be seen, wealth holdings go down at all ages as

[19]Changing risk aversion changes the bequest threshold and the MPB, and thus makes the comparison difficult.

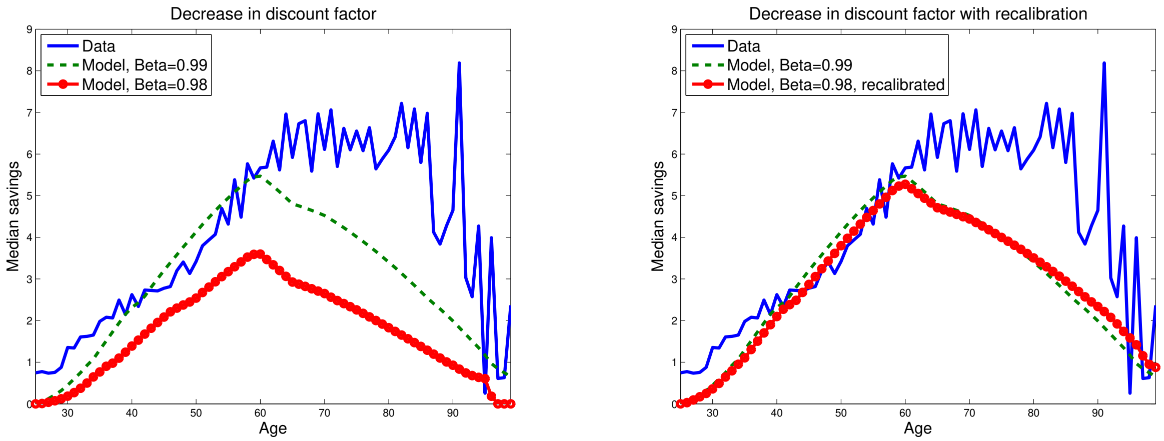

Figure 5: The effect of the decrease in the discount factor from 0.99 to 0.98 on wealth profiles. Left panel: only β decreases, other parameters are unchanged. Right panel: risk aversion and IES are recalibrated.

people become less patient.

The right panel of Figure 5 still has the wealth profile from the model "baseline no bequest" and adds the wealth profile from a third version of the model. This version has the discount factor of 0.98 but risk aversion and IES are recalibrated to produce the same wealth profile as the model "baseline no bequest". As can be seen, even though the two models have different discount factors, risk aversion and IES can be adjusted until they produce almost identical wealth profiles.

5.2 Decomposition of saving motives

In this section, we examine the quantitative importance of different saving motives. To do this, we consider three counterfactual experiments where each of the three saving motives is shut down, one at a time.

5.2.1 Life-cycle motive

The life-cycle saving motive arises because average income net of medical expenses changes with age. People receive labor income only over the first half of their life-cycle, after retirement earnings are zero but partially replaced with pension income. Over the working stage of the life-cycle, average labor income displays a hump-shaped profile: first increasing and then decreasing. People accumulate assets to smooth these fluctuations of income over the life-cycle and to substitute for falling income in retirement.[20] In addition,

[20]Because of this, the life-cycle savings motive is sometime referred to as the retirement motive, see, for example, Gourinchas and Parker (2002).

average out-of-pocket medical spending increases with age which creates an additional incentive to accumulate assets.

To strip down the model from the life-cycle motive and thus to evaluate its importance, we consider the following environment. First, we average medical spending and labor income of individuals over the life cycle (assigning zeros to earnings after retirement). Specifically, we compute avx and avz as follows:

$$avx = \frac{1}{75} \sum_{t=25}^{99} \overline{x}_t^h \tag{12}$$

$$avz = \frac{1}{75} \sum_{t=25}^{64} w\overline{z}_t^h, \tag{13}$$

where $\overline{x}_t^h$ and $\overline{z}_t^h$ are average medical spending and average labor productivity for age t, respectively.

We then consider a model that has two key modifications compared to our baseline economy. First, there is no distinct working and retirement periods. Instead, individuals can decide whether to work or not at any age from 25 to 99. Those who chose to work receive earnings $wavz\bar{l}$ where avz is defined in Eq (13). People can still claim Social Security at age 65 and the Social Security benefit formula is unchanged. We do not introduce changes into the Social Security program as these changes by itself can have a large effect on savings thus confounding the results of our experiment.

Second, each period people still have to pay stochastic out-of-pocket medical expenses but the average of these expenses do not change with age and is always equal to avx as computed in Eq (12).

Note that in both counterfactual experiments, people still face the same variance of shocks as in the baseline case and it is only the averages that change. Thus, people still have precautionary as well as bequest motives for savings. However, they do not have to save to smooth their consumption in the face of changing average disposable resources as these are now constant throughout the life-cycle.

The top left panel of Figure 6 plots the wealth profiles (median, the bottom and the top 25th percentiles) in this counterfactual economy alongside the profiles from the baseline economy. Two important changes in wealth profiles can be observed in the figure. First, the amount of wealth accumulated at each percentile of wealth distribution noticeably decreases. The first row of Table 1 shows that the median wealth at age 65 drops by 51%, i.e., around half of the wealth accumulated over the working stage of the life-cycle is in preparation for changing disposable resources in retirement.

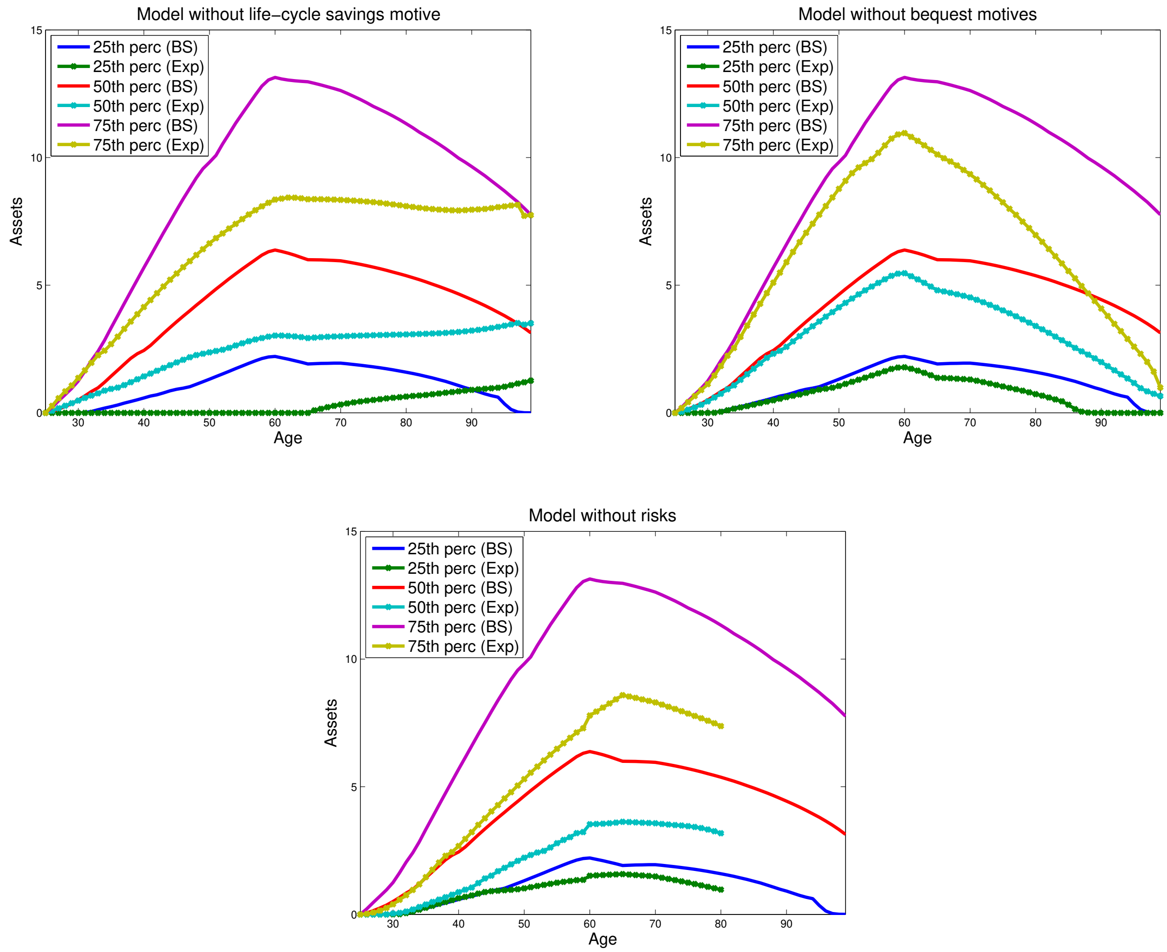

Figure 6: Dynamics of wealth moments over life-cycle: baseline versus an experiment. Top left panel: no life-cycle saving motive. Top right panel: no bequest motive. Bottom panel: no precautionary motive.

Second, the shape of wealth profiles undergoes a noticeable change. The hump-shape profile observed in the data (and replicated in the baseline economy) is replaced with monotonically increasing profiles. This is not surprising as individuals do not have to accumulate a pile of wealth by the beginning of retirement. At the same time, the amount of wealth accumulated by age 65 is not considered "enough" as potentially bequeathable wealth and individuals keep accumulating wealth at a steady rate after retirement.

Overall, these results illustrate that the life-cycle saving motive is sizable and can account for a large portion of wealth accumulation before retirement.

5.2.2 Bequest and precautionary motives

The top right panel of Figure 6 compares wealth profiles in the baseline economy to an economy without bequest motives, i.e., when the parameter η is set to zero. Note that the effect of this motive on savings is increasing with age and with wealth level. When the bequest motive is eliminated, the most significant change in wealth is observed among older people. For example, among those 85 years old, the median wealth almost halves. Among individuals younger than 50, the effect of bequest motives on savings is very modest. Overall, as the second column of Table 1 shows, 20% of median wealth accumulated by the age of 65 can be attributed to bequest motives.

The bottom panel of Figure 6 presents the results of an experiment when uncertainty in medical spending, productivity and survival is removed. Specifically, we assume that every period individuals pool together their risks, i.e., their medical expenses and labor productivity correspond to the cross-sectional average for that age. As for survival uncertainty, we assume that individuals live with certainty until the age which corresponds to the average life expectancy and die with probability one after that. Note that because no one survives into advanced ages, wealth profiles are plotted over a shorter lifespan compared to the baseline.

Overall, the removal of uncertainty substantially reduces savings at every age. Note that while the removal of bequest motives mostly affected individuals after the age of 50 the removal of the precautionary motive substantially reduces savings even at the youngest age. Because of this, as the third row of Table 1 shows, the contribution of the precautionary motive to median wealth accumulation by the age of 65 is 40%, which is twice that of the bequest motive.[21]

5.2.3 Effects of different sources of uncertainty

As was shown in the previous subsection, a sizable share of total saving is due to the precautionary motive. We next turn to the question of quantifying the relative importance of three sources of uncertainty in generating these precautionary savings. First, we consider an economy without uncertainty in out-of-pocket medical expenses, keeping other stochastic variables as in the baseline. The top left panel of Figure 7 shows that the removal of medical spending risk has relatively small effect on wealth profiles; overall, the decline in median wealth at age 65 constitutes only 4% (the fourth row of Table 1).[22]

Next, we consider an environment without survival uncertainty but with uncertainty in productivity and medical expenses. The top right panel of Figure 7 shows that people facing deterministic lifespans save noticeably less: the decline in median wealth at age 65 constitutes 17% (the fifth row of Table 1).

[21] Note that in our decomposition exercise, we shut down saving motives one at a time and the resulting numbers do not sum up to 100%. This happens because of the interaction between different saving motives.

[22] This result if very close to Kopecky and Koreshkova (2014) who also find that medical expense uncertainty contribute around 4% to aggregate saving.

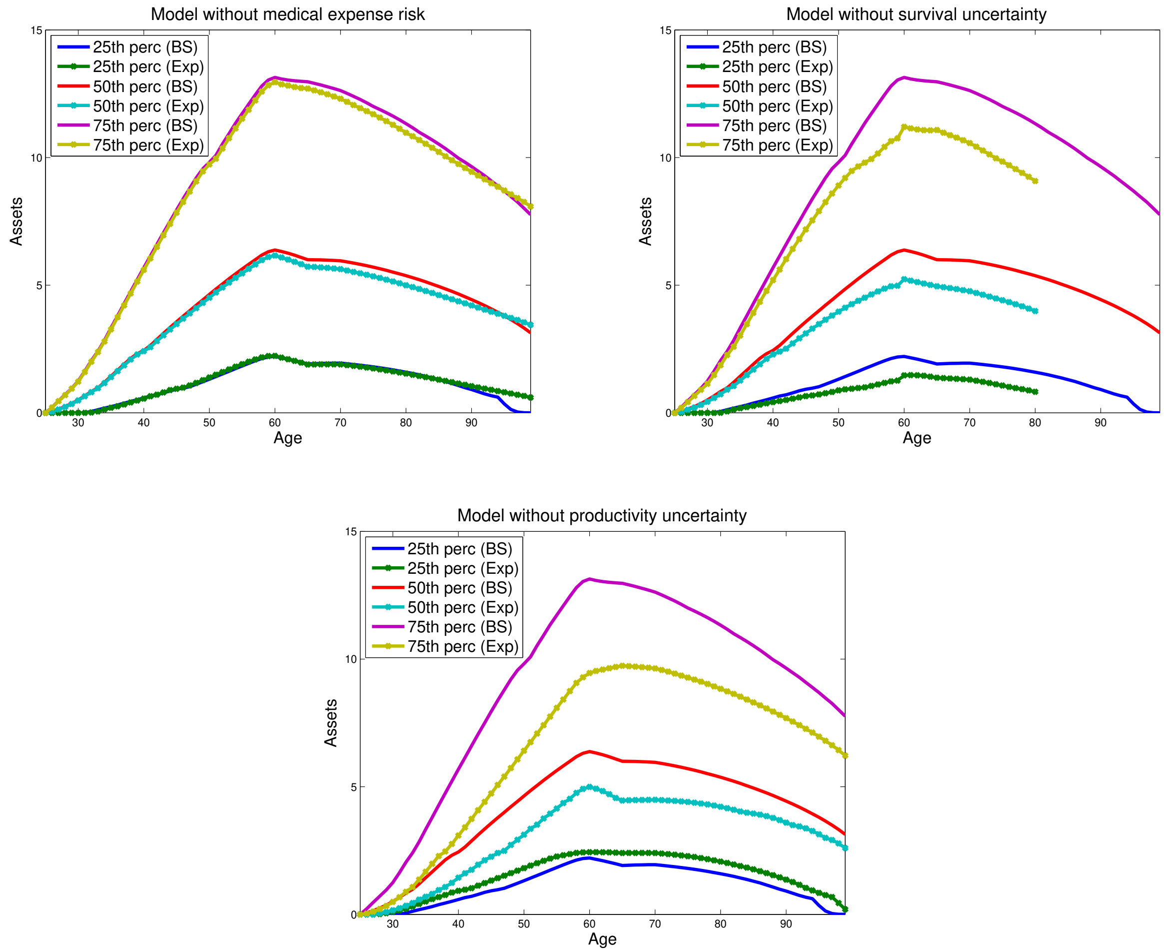

Figure 7: The effects of uncertainty. Dynamics of wealth moments over the life-cycle: baseline versus an experiment. Top left panel: no medical expenses risk. Top right panel: no survival uncertainty. Bottom panel: no uncertainty in labor productivity.

Finally, we remove the uncertainty in idiosyncratic labor productivity while keeping uncertainty in medical spending and lifespans. The bottom panel of Figure 7 shows that among all three types of risk we consider, stochastic productivity contributes the most to the accumulation of wealth: 26% of median wealth at age 65 can be accounted for by precautionary saving against this risk (the sixth column of Table 1).

Note that the effect of uncertain productivity on saving decisions differ for the wealth-rich and the wealth-poor. The decline in wealth holdings among people at the top 25th percentile of wealth distribution when uncertainty in productivity is removed is large and also exceeds the decline for those with median wealth. In contrast, people at the bottom 25th percentile of wealth distribution increase their savings when productivity becomes deterministic. This happens because disincentives to save created by the government means-tested programs (the minimum consumption guarantee) is the highest among this group.[23] When fluctuations in productivity are removed, the probability for them to end up on the consumption floor decreases, which increases their savings.

5.2.4 How to account for state-contingent savings?

On the surface, our decomposition results from the previous subsection show that precautionary savings are mostly driven by uncertainty in productivity and to a somewhat lesser degree in lifespans, while the contribution of medical expense risk is relatively small. However, precautionary savings are not limited to accumulation of net worth. Some of these savings can be done in state-contingent assets such as insurance.

To illustrate the relationship between precautionary savings done in regular versus state-contingent assets, we use a simple example. Consider an individual who lives for two periods; in the second period with probability π he experiences a shock to his budget constraint equal to x. Suppose an individual wants to insure a fraction μ of this shock. Assuming zero interest rate ($r = 0$) this requires savings in the amount μx. This represents precautionary savings in regular assets.

Assume next that an actuarially fair insurance is available against this shock x. To insure the shock to the same extent, an individual needs to buy an insurance that covers a fraction μ of the shock. Given the assumption of actuarial fairness and zero interest rate, the cost of this insurance is $\pi\mu x$. This represents precautionary savings in state-contingent assets.

Two observations are in order. First, there are no precautionary savings in regular assets in the second case. In other words, if we are to measure by how much an individual's savings change when we remove the shock x, the answer will be zero.

Second, even if we include state-contingent assets in our measure of precautionary savings, we find that total precautionary savings are smaller in the second case compared with the first: μx in the former versus $\pi\mu x$ in the latter. Moreover, the difference will increase as π decreases. For example, if the probability of incuring the shock x is 10%, the precautionary savings in state-contingent assets are ten time less than savings in regular assets.

This example illustrates that the size of precautionary savings, commonly measured as the amount of wealth accumulated to insure a particular risk, crucially depends on the availability of state-contingent assets that provide additional insurance against this risk.

To illustrate this point further, we turn back to our model and provide an additional investigation of the importance of uncertainty in medical expenses on precautionary savings. To gauge the full extent of precautionary behavior generated by this risk, we need to remove

[23]Hubbard et al. (1994) discuss in details the dicencentives to save for low-income people created by means-tested programs.

all available additional insurance. To do this, we introduce the following modification to our baseline model.

We substitute out-of-pocket medical shocks x_t^h with total medical shocks X_t^h computed from the MEPS dataset. We compensate each age-t individual for the absence of health insurance by increasing his resources by a lump-sum transfer $comp_t$ computed as the difference between average total and average out-of-pocket medical spending for people at age t, $comp_t = \overline{X}_t^h - \overline{x}_t^h$. In addition, we also remove public health insurance by eliminating the government means-tested support and setting the consumption floor to be equal to \$10.[24] Note that this experiment corresponds to the situation when the entire insurance market is removed (both public and private), individuals receive back their premiums but are now fully responsible for covering their total medical bills themselves.

We then ask how much the removal of the uncertainty in total medical spending decreases wealth accumulation? The last row of Table 1 shows that in sharp contrast with removing out-of-pocket medical risk, removing uncertainty in total medical spending reduces the median wealth by almost half. Thus, the small contribution of medical shocks to savings in the baseline economy happens because the major part of savings against this risk is done in state-contingent assets.

	% decline in median wealth at 65
Baseline	0
No life-cycle motive	51
No bequest motive	20
No uncertainty	40
- No medical shocks	4
- No survival uncertainty	17
- No productivity shocks	26
Environment with no health insurance	
- No medical shocks	48

Table 1: Decomposition of saving accumulated by the age of 65. Each saving motive is removed one at a time.

[24]Note that if we do not remove the consumption floor, the model demonstrates a very sizable moral hazard: given very large total medical shocks, it is easy for individuals to qualify for this assistance and a large fraction of people use this strategy.

6 Conclusion

In this paper, we revisit the question of why do people save using a unified framework that allows for the three major determinants of savings: life-cycle, precautionary and bequest motives. We construct a model that contains both working and retirement stages of the life-cycle, and where individuals face three types of uncertainty: in labor productivity, medical and nursing home expenses, and lifespans. We calibrate the model using the PSID, HRS and MEPS datasets.

We show that analyzing saving behavior from the perspective of the entire life-cycle provides additional identification information for distinguishing between bequest and precautionary motives. Specifically, a particular model parametrization can well explain the decumulation of a given amount of wealth after retirement. However, this parametrization can fail to account for the accumulation of this amount of wealth once the model is extended to include the full life-cycle. Previous studies of wealth decumulation after retirement have arrived at different conclusions regarding the relative importance of bequest versus precautionary motives. While Ameriks et al.(2020) emphasize the precautionary motive as a main driver of savings after retirement, De Nardi et al. (2016a) and Lockwood (2018) find bequest motive to be very important as well. Our findings also emphasize the importance of bequest motives. The intuition for this conclusion comes from the fact that a model where the primary driver of saving behavior is the precautionary motive overpredicts how much people save and work when they are young.

We use our model to provide a decomposition exercise to quantify the contribution of different motives to wealth accumulated by the time individuals retire. We show that around half of the median preretirement wealth is accumulated because of the life-cycle motive (generated by the change in average labor income and average medical spending over the life-cycle). The bequest motive accounts for around 20% and the precautionary motive for 40% of median preretirement wealth. The main driver of the precautionary saving motive is labor productivity shocks while medical spending shocks contribute the least. We also emphasize the importance of accounting for state-contingent assets when evaluating precautionary savings. We show that the small contribution of medical shocks can be explained by the fact that most of savings against this risk is done in state-contingent savings, i.e., health insurance. If these state-contingent savings are removed, the contribution of medical shocks to overall savings increases substantially.

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Appendix

A Summary of the parametrization of the baseline model

Parameter name	Notation	Value	Source
Parameters set outside the model			
Consumption share	$\varkappa$	0.5	French (2005)
Labor supply	$\bar{l}$	0.4	
Tax function parameters	a_0	0.258	Gouveia and Strauss (1994)
	a_1	0.768	"
	a_2	0.616	Pashchenko and Porapakkarm (2016b)
Labor productivity			
- Persistence parameter	ρ	0.98	Storesletten, et al (2000)
- Variance of innovations	σ_ε^2	0.02	"
- Fixed effect	σ_ξ^2	0.24	"
Parameters used to match some targets			
Discount factor	β	0.99	-
Risk aversion	ψ	5	Wealth accumulation before 60
1/IES	γ	1.7	- " -
Bequest parameters			
- MPB	-	0.969	Wealth profile before 60 for p50 and p75
- Bequest threshold	-	\$3,605	Wealth profile before 60 for p25
Consumption floor	$\underline{c}$	\$3,500	% employment among 25-29
Wage rate	w	1.55	average earnings
Fixed costs of work	ϕ_w	0.255	employment profiles (healthy)

Table 2: Parameters of the model