

# The Impact of Medical and Nursing Home Expenses on Savings

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**Abstract:** We consider a life-cycle model with idiosyncratic risk in earnings, out-of-pocket medical and nursing home expenses, and survival. Partial insurance is available through welfare, Medicaid, and social security. Calibrating the model to the United States, we show that (1) savings for old-age, out-of-pocket expenses account for 13.5 percent of aggregate wealth, half of which is due to nursing home expenses; (2) cross-sectional out-of-pocket nursing home risk accounts for 3 percent of aggregate wealth and substantially slows down wealth decumulation at older ages; (3) the impact of medical and nursing home expenses on private savings varies significantly across the lifetime earnings distribution; and (4) all newborns would benefit if social insurance for nursing home stays was made more generous.

JEL classification: E1, E2, H3, I1, I3

Key words: out-of-pocket medical expenses, precautionary savings, nursing home expenses, welfare costs

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# 1 Introduction

The elderly in the United States face large, persistent and volatile out-of-pocket (OOP) health expenses that increase substantially with age. Over the period 1995–2008, average annual OOP health expenditures of individuals aged 65 and over were approximately \$3,500 with a standard deviation of over \$6,000. The distribution of these expenses was highly skewed with the top 5 percent of payers accounting for 45 percent of total expenses. Furthermore, individuals aged 85 years and over spent more than twice as much on health care as those aged 65 to 74.<sup>1</sup> An important driver of these expenses are long-term nursing home stays due to their high cost, persistent nature, and poor insurance coverage. Annual rates for nursing home care in 2005 averaged \$60,000 for a semi-private room and \$75,000 for a private room, and a significant fraction of the elderly face nursing home costs that persist for years. Of the 39 percent of 65-year-olds who will require nursing home care at some point in their lifetime, one in five will require more than 3 years of care, and one in ten will require more than 5 years.<sup>2</sup> These facts suggest that OOP health expenses, nursing home expenses in particular, may be important drivers of savings.

The main objective of this paper is to explicitly incorporate the key features of nursing home expenses into a full life-cycle, general equilibrium model. In particular, our goal is to develop a model in which retirees incur both nursing home expenses and other health-related expenses and to use our model to assess the impact of old-age OOP health expenses and old-age OOP health expense risk on savings. Note that health expenses are risky in part because individuals face uncertainty about what their OOP expenses will be at any given age and in part because individuals face uncertainty about the length of their lives. To distinguish between these two kinds of risk we refer to the former as cross-sectional OOP expense risk and the latter as longitudinal OOP expense risk. We are particularly interested in the importance of OOP nursing home expenses and cross-sectional OOP nursing home expense risk versus other OOP health expenses and other cross-sectional OOP health expense risk. Throughout the paper we use the term ‘medical expenses’ to refer to these other (non-nursing home) health expenses faced by the elderly and the term ‘health expenses’ to refer to the sum of medical expenses and nursing home expenses.

We find that the presence of old-age OOP health expenses accounts for 13.5 percent of aggregate private wealth and that over half of these savings are due to the presence of nursing home expenses. More than a quarter of these savings are accumulated to insure

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<sup>1</sup>Authors calculation based on data from the 1995–2008 Health and Retirement Study.

<sup>2</sup>Source for nursing home costs: Metlife Market Survey of Nursing Home and Assisted Living Costs. Source for nursing home usage statistics: Brown and Finkelstein (2008).

against cross-sectional OOP health expense risk, the importance of which is due almost entirely to nursing home expense risk. We also find that OOP nursing home expenses, cross-sectional OOP nursing home expense risk in particular, have a large impact on the savings of wealthier individuals, whereas poorer individuals save more for expected OOP medical expenses. Given these findings, our second objective is to analyze the welfare effects of extending the coverage of nursing home costs by social insurance programs. We find that all newborn individuals in our model would benefit from either increasing the generosity of Medicaid transfers to nursing home recipients, financed via an increase in income taxes, or taxing social security benefits to finance an extension of Medicare to cover nursing home costs.

Our study contributes to a growing literature on the importance of old-age OOP health expenses for savings.<sup>3</sup> It is the first study to develop and calibrate a full life-cycle, general equilibrium framework in which retirees face both risky medical expenses and risky nursing home expenses. Furthermore, it is the first to quantitatively evaluate the distinct effects of medical expenses and nursing home expenses on aggregate wealth accumulation and the welfare effects of extending social insurance coverage of nursing home care.

The work most closely related to ours is De Nardi et al. (2010). Health expenses in their analysis, like ours, are estimated using Health and Retirement Study (HRS) data. De Nardi et al. find that although old-age OOP health expenses are an important driver of the saving behavior of the elderly, cross-sectional OOP health expense risk has a very small effect.<sup>4</sup> Our results are, in part, consistent with theirs in that we also find that old-age OOP health expenses have a large impact on savings. However, we find a much larger impact than they do of cross-sectional OOP health expense risk. A key reason why we find a larger effect is because we separate nursing home expenses from other health expenses. By separately modeling nursing home expenses we are able to more fully capture the risk retirees face of incurring these large and persistent shocks, as well as their poor insurance coverage by the social insurance system. Another reason we find a larger effect is that De Nardi et al. only model the retirement period. Thus they do not capture the impact of health expenses on savings during the working period. We show that in a full-life-cycle model over half of the wealth generated by OOP health expenses is accumulated before retirement. Once these features are taken into account, we find that the effect of nursing home expense risk and thus total health expense risk on savings is substantial.<sup>5</sup>

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<sup>3</sup>Papers in this literature include Kotlikoff (1988), Hubbard et al. (1995), Palumbo (1999), Scholz et al. (2006), and De Nardi et al. (2010).

<sup>4</sup>Note that De Nardi et al. (2010) include nursing home expenses as part of medical expenses whereas we use the term ‘medical expenses’ to refer to non-nursing home expenses only.

<sup>5</sup>Additional reasons why our results differ from De Nardi et al.’s are provided in Section 6.4.

Our analysis also extends a large literature on precautionary savings and the welfare costs of idiosyncratic risk. Most of this research has focused on earnings and survival risk.<sup>6</sup> We demonstrate that nursing home risk is also important and one of the primary drivers of precautionary savings during retirement.

In what follows, we develop a general equilibrium, life-cycle model. The model features overlapping generations of individuals with four sources of uncertainty: earnings, survival, medical expenses, and nursing home expenses. Individuals are born at age 21 and assigned a permanent productivity type of either high or low; they work until age 65 and then retire. During the working stage of their lives, they face earnings uncertainty. Retired individuals face uncertainty with respect to their survival as well as medical and nursing home expenses. We assume that individuals cannot borrow and private insurance is unavailable. Partial insurance, however, is provided through three programs run by the government: a progressive pay-as-you-go social security program, a welfare program that guarantees a minimum level of consumption to workers, and a Medicaid-like social safety net that guarantees a minimum consumption level to retirees with impoverishing medical or nursing home expenses. We allow the insured consumption floor to be specific to the type of health shock (medical or nursing home).

Our calibration procedure is able to identify the level of consumption provided under public nursing home care. In particular, we find that the consumption floor guaranteed by Medicaid to a nursing home resident lies below the consumption floor guaranteed to a non-nursing home resident. In other words, Medicaid provides less insurance against nursing home expense risk than medical expense risk. We interpret this differential as reflecting a lower quality of life provided by public nursing home care relative to receiving public assistance while living at home.

We use our calibrated model to quantify the amount of wealth held due to risky old-age OOP health expenses by conducting a series of partial equilibrium experiments. In the first set of experiments we set either medical expenses, nursing home expenses, or both to zero. We find the following. First, removing all health expenses from the economy results in a decrease in aggregate private wealth of 13.5 percent. Interestingly, individuals in the middle of the permanent income distribution, quintiles 3 and 4, reduce wealth the most in percentage terms. In other words, middle income individuals save the most for OOP health expenses. This group faces higher expenses relative to their income than those in quintile 5 but are too well off to receive substantial Medicaid transfers like those in quintiles 1 and 2.

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<sup>6</sup>Examples include Aiyagari (1994), Attanasio and Davis (1996), Huggett (1996), Storesletten et al. (2004) Heathcote et al. (2008), and Fehr and Habermann (2008), to name a few. There are also a few studies that look at the welfare costs of medical expense risk during the working age. See for example Jeske and Kitao (2009) and Hsu (2012).

Second, even though they are only a third of OOP health expenses, the presence of nursing home expenses accounts for more than half of savings for all health expenses. Moreover, nursing home expenses have a much larger effect on the savings of wealthier individuals. In contrast, medical expenses have a larger impact on the savings of poorer individuals. Third, comparing the profiles of average savings for nursing home and medical expenses by high and low permanent types, we find that while savings for medical expenses decline throughout retirement, savings for nursing home expenses increase until individuals are well into their 80's. From this finding we conclude that nursing home expenses are a primary reason for slow rates of dissaving by older retirees.

In the second set of experiments we make either OOP medical expenses, OOP nursing home expenses, or both deterministic. These experiments allows us to isolate the effect of cross-sectional OOP expense risk. We find that 27 percent of savings for old-age OOP health expenses, 3.7 percent of private wealth, is savings for cross-sectional OOP expense risk and that more than 80 percent of these precautionary savings, 3 percent of private wealth, is accumulated to self-insure against cross-sectional OOP nursing home expense risk. This is a substantial amount: if savings for cross-sectional OOP nursing home expense risk were held in the form of vehicles, it is large enough to account for the entire stock of transportation equipment in the US.<sup>7</sup> That nursing home expenses generate large precautionary savings is explained by the fact that the nursing home expense shock is one of the largest shocks in the model economy, the most persistent, and the least insured by the government. Furthermore, nursing home expenses are most likely to hit an individual after age 85. Thus the risk of incurring nursing home costs late in life compels individuals to hold significant amounts of wealth at very old ages. This is especially true for wealthier individuals, who are the least insured by Medicaid. In contrast, savings for health expenses by poorer individuals, for whom private nursing home care is largely unaffordable, are driven by expected medical expenses.

Finally, we consider the welfare implications of extending social insurance to provide additional coverage of nursing home expenses. We consider two types of extensions that capture the essence of many proposed long-term care reforms. First we look at the impact of raising the consumption floor guaranteed to nursing home residents on Medicaid such that it is the same as the floor guaranteed to non-nursing home residents. Then we assess the welfare effects of extending Medicare such that it covers all nursing home expenses.<sup>8</sup> For

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<sup>7</sup> According to BEA 1996–2005 capital stock data, the value of transportation equipment (all trucks, buses, trailers, autos, aircraft, ships, boats, and railroad equipment) averages to 8.1 percent of GDP. In our model, private savings generated by cross-sectional OOP nursing home expense risk is also 8.1 percent of GDP.

<sup>8</sup> Specifically, we consider an extension of Medicare such that it covers all of the medical costs associated with nursing home care but not the cost of room and board.

comparison purposes we also conduct two additional experiments: one in which we extend Medicare to cover all medical expenses and another in which we extend Medicare to cover all health expenses. All of these experiments are conducted in general equilibrium with an open economy. We find that both high and low productivity newborns are better off if Medicaid's means-test for nursing home expenses is as generous as that for medical expenses. However, the welfare implications of extending Medicare to cover additional nursing home expenses depends on the tax used to finance it. If it is financed by increasing the Medicare payroll tax, all newborns are worse off as compared to the benchmark economy. If, on the other hand, it is financed by a tax on social security benefits all newborn are made better off, although the benefits accrue almost entirely to high productivity types. Comparing the various types of Medicare extensions, we find that low productivity types benefit much more from universal coverage of medical expenses instead. As a result, given a choice, high types would prefer universal coverage of nursing home care while low types would prefer universal coverage of medical expenses. This disagreement is consistent with the differences in savings for nursing home versus medical expenses by wealthier versus poorer individuals that we described above.

The paper proceeds as follows. Section 2 provides motivation for explicitly modeling nursing home expenses. The model is presented in Section 3. Section 4 describes how we calibrate the model to obtain the benchmark economy. In Section 5, we assess the benchmark economy by comparing model-generated moments not targeted by the calibration procedure with corresponding moments constructed using data. Section 6 assesses the impact of old-age OOP health expenses and OOP health expense risk on savings. In Section 7, we quantify the welfare implications of extending social insurance in the US to provide additional coverage of nursing home expenses. Finally, Section 8 concludes.

## 2 Why Nursing Home Expenses?

Retirees in the US face a significant risk of incurring large and persistent nursing home expenses. Brown and Finkelstein (2008) estimate that 39 percent of 65-year-olds will enter a nursing home at some point before the end of their life. Conditional on entering, the likelihood of staying for multiple years is significant. Forty percent of entrants will spend more than 1 year, 20 percent will spend more than 3 years, and 11 percent will spend more than 5 years. Nursing home care is expensive. In 2005, the cost of one year of nursing home care was approximately \$60,000 to \$75,000.<sup>9</sup>

In addition to being expensive and persistent, nursing home expenses are not well-insured

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<sup>9</sup>Source for nursing home costs: Metlife Market Survey of Nursing Home and Assisted Living Costs.

Table 1: Percent distribution of nursing home expenses and all health expenses in 2003 for individuals 65 and over by source of payment.

	Nursing Home	All
<b>Private</b>	<b>43</b>	<b>34</b>
Out-of-pocket	37	16
Private insurance	2	16
Other private	4	2
<b>Public</b>	<b>57</b>	<b>66</b>
Medicare	18	48
Medicaid	37	14
Other public	2	4

Source: Federal Interagency Forum on Aging-Related Statistics.

compared to other health care expenses. Medicare coverage is very limited, Medicaid coverage only becomes available once individuals have become impoverished, and the private market is small. First, consider Medicare, the largest health insurance program for the elderly. Medicare does not insure against the costs of long-term nursing home stays. The program only covers a limited period of nursing home care and only if that care is preceded by a qualifying hospital stay. Specifically, it will cover the first 30 days of care and partially subsidize the next 70 days for qualifying stays. This is why, as Table 1 shows, Medicare covers 48 percent of the US elderly’s aggregate health expenses but only covers 18 percent of their nursing home expenses.

Second, consider Medicaid, a means-tested government health care program available to the elderly. Medicaid is the largest insurer of nursing home expenses, covering 37 of aggregate costs. However, there are important differences between the rules governing Medicaid coverage of nursing home expenses and the rules governing Medicaid coverage of other health expenses that make Medicaid a poorer form of insurance against nursing home events. In particular, non-nursing home recipients of Medicaid are allowed to keep their income and assets whereas nursing home recipients of Medicaid are not. Nursing home recipients of Medicaid must contribute all their non-home, non-car assets in excess of \$2,000 and all of their monthly income, excluding a small (between \$30 and \$90) “personal needs allowance,” to their nursing home expenses. In a nursing home facility, Medicaid covers room and board in addition to medical and nursing care but it does not pay for a single room, personal television and cable, phone and service, radios, clothes, and other goods and services. The result is that the quality of life delivered to Medicaid-funded nursing home residents falls well below that of privately-financed residents. This view is supported by survey evidence

documented by Ameriks et al. (2011) who find that wealthy people tend to avoid using Medicaid to finance their nursing home care due to the low quality of life it entails.

Finally, consider private insurance. While private insurance covers 16 percent of all the elderly's health expenses, it only covers 2 percent of nursing home expenses. This is because the long-term care insurance (LTCI) market in the US is extremely small. Only approximately 8 percent of retirees hold a LTCI policy.<sup>10</sup> The small size of the market is most likely due to supply-side problems, market failures, and the possibility that Medicaid crowds out some demand for private LTCI.<sup>11</sup>

As a result of the lack of both public and private insurance options for nursing home expenses, 37 percent are paid for out of pocket. In comparison, as Table 1 shows, only 16 percent of all aggregate health expenses are paid for out of pocket.

With these facts in mind, in the next section we develop a model that explicitly captures the need for nursing home care. Short-term nursing home stays (stays of less than 1 year) are on average less than 5 months and heavily subsidized by Medicare. To focus on the risk of large and persistent nursing home expenses we model only long-term stays (stays of 1 year or more). To capture the differential treatment of retirees by Medicaid, we allow the minimum consumption floor it guarantees to vary by type of expense — medical or nursing home. We do not explicitly model the LTCI market given that this insurance only covers a tiny fraction of aggregate long-term care expenses.<sup>12</sup>

### 3 The Model

Time is discrete. The economy is populated by overlapping generations of individuals. Population grows at a constant rate  $n$ . Individuals work during the first  $R$  periods of their lives. At age  $R + 1$  they retire. The maximum length of life is  $J$  periods.

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<sup>10</sup>Authors' calculations. The fraction reported is the percentage of individuals 65 and over in our HRS sample, described in Section 4.5, who own a LTCI policy for at least half of the waves in which they are observed.

<sup>11</sup>Problems in the LTCI market include the following. First, declination rates of long-term care insurers are high. According to the American Association for LTCI, 20 percent of applicants are rejected during the second application round. A conservative estimate of the overall rejection rate using HRS data is 38 percent. Hendren (2013) shows that this can arise if applicants have private information about nursing home needs and finds that they do. Second, LTCI holders face significant rising premium risk and significant risk of coverage denial. See for examples the October 2010 Wall Street Journal "Long-Term-Care Premiums Soar", the 2008 Washington Post article "Long-Term-Care Insurance Rates Are Set to Increase," and the 2007 NY Times article "Aged, Frail and Denied Care by Their Insurers." The argument that Medicaid crowds out LTCI demand is put forth in Brown and Finkelstein (2008).

<sup>12</sup>We did consider a version of the model with LTCI. We found that its inclusion had a very small effect on our results. This is discussed in footnote 16.

Individuals derive utility from consumption. The momentary utility function is

$$U(c) = \frac{c^{1-\gamma}}{1-\gamma},$$

where  $\gamma > 0$  is the inverse of the intertemporal elasticity of substitution.

### 3.1 Sources of Uncertainty

Individuals face several sources of uncertainty and these sources vary depending on their age. During working ages, they only face uncertainty about their earnings. Upon retirement, they face uncertainty about survival, medical expenses, and nursing home needs. We now describe each of these risks in detail.

Each individual's labor productivity evolves over his working period according to a function  $\Omega(j, d, z)$  that maps his age  $j$ , permanent type  $d$  and current earnings shock  $z$  into efficiency units of labor. The earnings shock  $z$  follows an age-invariant Markov process with transition probabilities given by  $\Lambda_{zz'}$ . Newborn workers draw  $d$  and  $z$  from distributions  $\Gamma_d$  and  $\Gamma_z$ .

Similarly, medical expenses evolve stochastically during retirement according to a function  $M(j, h)$ . Thus, in each period a retiree's medical expenses depends on his current age  $j$  and current expense shock  $h$ .<sup>13</sup> The medical expense shock  $h$  follows an age-invariant Markov process with transition probabilities  $\Lambda_{hh'}$ . The initial distribution of medical expense shocks is given by  $\Gamma_h$  and is independent of the individual's state.

Retired individuals face the risk of needing long-term nursing home care. The probability that an age  $j$  retiree with average lifetime earnings  $\bar{e}$  must go to a nursing home next period is  $\theta(j, \bar{e})$ . In the data, low-income individuals have a higher probability of nursing home utilization. Allowing the nursing home entry probability to vary with  $\bar{e}$  allows us to capture this fact. Nursing home care is assumed to be an absorbing state in that once an agent enters a nursing home he only exits upon death.<sup>14</sup>

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<sup>13</sup>We do not make medical expenses a function of income. Although there is literature documenting a positive health-income gradient, there is little evidence on the relationship between total, as opposed to OOP, medical costs and income. One notable exception is Ozcan (2013). Using Medical Expenditure Panel Survey data for 1996–2007, he finds that, for people age 75 and above, average total medical expenses of the top and bottom income quintiles are very similar. Note that OOP expenses in our model will be positively related to income for two reasons. First, Medicaid will partially cover the medical expenses of some poorer individuals and second, we allow the probability of nursing home entry to decline with average lifetime earnings.

<sup>14</sup>The assumption that the nursing home state is absorbing is not unreasonable given that Dick et al. (1994) find that the majority of long-term nursing home spells end in death or exit to a hospital, Mehdizadeh et al. (2001) find that, in Ohio, discharges from nursing homes in which the nursing home spell lasted longer than nine months almost always are due to death, and Murtaugh et al. (1997) find that the majority of long-term nursing home users who do exit die within one year of discharge.

Retirees also face survival risk. Survival probabilities depend on both age and nursing home status. The probability that an individual of age  $j - 1$  survives to age  $j$  is  $s_j$  if he is not receiving nursing home care and  $s_j^n < s_j$  if he is receiving nursing home care. Working-age agents of age  $j \leq R$  have survival probabilities  $s_j = 1$ .

Let  $\bar{\theta}_j$  denote the unconditional (independent of average lifetime earnings) probability of entering a nursing home at age  $j$ . Let  $\lambda_j$  denote the fraction of cohort  $j$  residing in a nursing home. This fraction is zero for working-age cohorts. For a newly retired cohort, the fraction is the unconditional probability of entering a nursing home, i.e.,  $\lambda_{R+1} = \bar{\theta}_{R+1}$ . For a retired cohort of age  $R + 1 < j \leq J$ , the fraction  $\lambda_j$  evolves according to

$$\lambda_j = \frac{\bar{\theta}_j s_j (1 - \lambda_j) + s_j^n \lambda_j}{\bar{s}_j},$$

where the denominator,  $\bar{s}_j = s_j(1 - \lambda_j) + s_j^n \lambda_j$ , is the average survival rate from age  $j$  to  $j + 1$  and the numerator is a weighted sum of the survival rate of new entrants and the survival rate of current residents. It follows that if  $\eta_j$  is the size of cohort  $j$  then

$$\eta_{j+1} = \frac{\eta_j \bar{s}_j}{1 + n}, \text{ for } j = 1, 3, \dots, J - 1.$$

## 3.2 Nursing Home Care

Nursing home residents derive utility from the room and board (consumption) services that they receive and require a fixed and identical amount of medical and nursing (non-consumption) services. Expenditure of a private nursing home resident for one period of care is thus  $c^n + M^n$  where  $c^n$  is expenditure on consumption services and  $M^n$  is expenditure on non-consumption services. Private payers are allowed to choose the level of their consumption services,  $c^n$ . This assumption allows us to capture the fact that there is variation in the cost of private nursing home care. This variation is primarily due to differences in the quality of the room and board that individuals receive and not to differences in the quality of medical care. For example, a more expensive nursing home stay will tend to include a private room, nicer views, and additional amenities such as a personal television. Moreover, more expensive nursing home facilities tend to be in nicer locations and have fancier food and furniture.

## 3.3 Government Programs

The government runs two means-tested social insurance programs: a welfare program for workers and a welfare/Medicaid program for retirees (referred to as ‘the Medicaid program’).

These two programs provide agents with a guaranteed minimum level of consumption. The welfare program for workers captures, in a parsimonious way, US programs such as unemployment insurance and food stamps. The Medicaid program for retirees captures Medicaid and other means-tested social insurance programs that provide benefits to the elderly such as Supplemental Social Security Income (SSI), subsidized housing, food stamps and energy assistance programs.

We model these government programs as follows. The welfare program for workers provides transfers to workers whose after-tax income  $\tilde{y}$  plus assets  $a$  are below the minimum guaranteed level of consumption  $\underline{c}^w$ . The transfer amount is given by the difference between  $\underline{c}^w$  and the total resources the worker has available for consumption. Thus,

$$T^W(\tilde{y}, a) \equiv \max \{0, \underline{c}^w - (\tilde{y} + a)\}. \quad (1)$$

The Medicaid program for retirees treats nursing home residents differently from other retired individuals. For retired individuals not residing in a nursing home, the program provides transfers that ensure that individuals can afford both their medical expenses  $m$  and the minimum consumption level  $\underline{c}^m$ . Thus transfers are given by,

$$T^R(\tilde{y}, a, m) \equiv \max \{0, \underline{c}^m + m - (\tilde{y} + a)\}. \quad (2)$$

Notice that if an agent's after-tax income  $\tilde{y}$  plus assets  $a$  are larger than  $\underline{c}^m + m$  then they are not eligible for Medicaid and do not receive transfers. For retired individuals residing in a nursing home, the Medicaid program works as follows. First to qualify for the program, a nursing home resident must meet the following eligibility criteria:

$$\tilde{y} + a \leq \underline{c}^n + M^n. \quad (3)$$

If this criteria is met and the individual chooses public nursing home care, then the individual relinquishes all his income and assets to the government. In exchange the government pays for his non-consumption nursing home services and for  $\underline{c}^n$  amount of consumption nursing home services. We refer to individuals who are in a nursing home and receiving public nursing home care as public nursing home residents.

The two means-tested social insurance programs, along with non-valued government expenditures, are financed out of general tax revenues. These revenues are raised as follows. First, there is a progressive income tax. If  $y$  is the total income of a worker than his income tax is given by  $\tau^W(y)$ . For retirees, income taxes are a function of their capital income  $ra$ , social security income  $S(\bar{e})$  and medical expenses  $m$  and are given by  $\tau^R[ra, S(\bar{e}), m]$ . Fol-

lowing the US federal tax code, we allow for partial taxation of social security benefits. Also consistent with the code, we allow retirees to deduct medical and nursing home expenses that exceed a certain threshold from their taxable income. Second, there is a flat earnings tax. This tax represents the component of the US earnings tax that is used to finance Medicare.

In addition to the two welfare programs described above, the government also runs a pay-as-you-go social security program. Under this program, all retired individuals receive a Social Security benefit,  $S(\bar{e})$ , which is an increasing and concave function of their average lifetime earnings  $\bar{e}$ . Social Security is financed out of a capped payroll tax following the US system. Both the Social Security and Medicare taxes on earnings  $e$  are summarized by a single payroll tax function  $\tau_e(e)$ .

Finally, the government manages the collection and redistribution of unintended bequests. We assume that these bequests are redistributed to individuals at the beginning of their first period in retirement. Hendricks (2001) finds using both Survey of Consumer Finances (SCF) and Panel Study of Income Dynamics (PSID) data that the distribution of bequests is highly unequal with wealthier households receiving larger bequests on average than poorer households. To broadly capture this feature of the data in a simple way we assume that each individuals' bequest transfer  $\chi(\bar{e})$  is proportional to his average lifetime earnings  $\bar{e}$ .<sup>15</sup>

### 3.4 Market Structure

Markets are competitive but incomplete. Agents receive a wage rate  $w$  per efficiency unit of labor which they supply inelastically. They can save by holding a risk-free asset that pays interest at rate  $r$ . Borrowing is not allowed, and there are no private insurance markets to hedge either earnings, medical expense, nursing home, or mortality risks.<sup>16</sup>

### 3.5 Individuals' Problems

We are now ready to describe individuals' budget constraints and decision problems. Workers and retirees without nursing home needs only make savings decisions. Retirees with nursing home needs, in addition, choose whether to receive care in a private or public nursing home.

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<sup>15</sup>By making bequest transfers proportional to lifetime earnings we reduce the extent to which resources are unrealistically redistributed from wealthier agents to poorer ones without imposing additional computational costs.

<sup>16</sup> We also considered a version of the model in which agents could choose to buy a LTCI contract. However, we found that the inclusion of LTCI had very small effects on the results because take-up rates are only 8 percent. For transparency, we decided to abstract from LTCI in our benchmark model. The LTCI version of the model, the calibration details, and the results are available in the online appendix.

### 3.5.1 Working Individuals

A working individual's state includes his age  $j \leq R$ , assets  $a$ , average lifetime earnings  $\bar{e}$ , permanent productivity type  $d$ , and current productivity shock  $z$ . The individual chooses consumption  $c$  and savings  $a'$  so as to satisfy his budget constraint,

$$c + a' = a + y - \tau^W(y) + T^W[y - \tau^W(y), a]. \quad (4)$$

The variable  $y$  is the individual's income which is given by

$$y = ra + e - \tau_e(e), \quad (5)$$

where  $ra$  is asset income,  $e \equiv w\Omega(j, d, z)$  is labor earnings. The functions  $\tau_e(e)$ ,  $\tau^W(y)$  and  $T^W[y - \tau^W(y), a]$  are the worker's payroll tax, income tax and means-tested transfer functions described in Section 3.3.

Let  $V^W(j, a, \bar{e}, d, z)$  denote the value function of a worker of age  $j < R$ . Making expectations about his future productivity shock  $z'$ , the worker solves the following problem:

$$V^W(j, a, \bar{e}, d, z) = \max_{c, a' \geq 0} \left\{ U(c) + \beta \mathbf{E}[V^W(j+1, a', \bar{e}', d, z')|z] \right\} \quad (6)$$

subject to the initial distribution and law of motion for  $z$ ; equations (1), (4) and (5); the law of motion for average lifetime earnings,

$$\bar{e}' = (e + j\bar{e})/(j+1); \quad (7)$$

and the initial condition  $a = 0$  at  $j = 1$ .

### 3.5.2 Retired Individuals

Now consider a retired individual of age  $j > R$  who is not currently residing in a nursing home. This individual's state consists of his permanent earnings  $\bar{e}$ , assets  $a$ , and health shock  $h$ . The individual chooses consumption  $c$  and savings  $a'$  to satisfy his budget constraint,

$$c + a' + M(j, h) = a + \tilde{y} + T^R[\tilde{y}, a, M(j, h)], \quad (8)$$

where  $M(j, h)$  are his current medical expenses. The variable  $\tilde{y}$  denotes the retiree's after-tax income and is given by

$$\tilde{y} = ra + S(\bar{e}) - \tau^R[ra, S(\bar{e}), M(j, h)] + \mathbb{1}\{j = R+1\}\chi(\bar{e}), \quad (9)$$

where  $\mathbb{1}\{j = R + 1\}$  is the indicator function and  $\chi(\bar{e})$  is the bequest transfer the individual receives in the first period of retirement. The functions  $S(\bar{e})$ ,  $\tau^R [ra, S(\bar{e}), M(j, h)]$  and  $T^R[\tilde{y}, a, M(j, h)]$  are the retiree's social security benefit, income tax, and means-tested transfer functions described in Section 3.3.<sup>17</sup>

Similarly, a retired individual who is currently residing in a nursing home and paying for private care faces the budget constraint

$$c^n + a' + M^n = (1 + r)a + S(\bar{e}) - \tau^R [ra, S(\bar{e}), \underline{c}^n + M^n] + \mathbb{1}\{j = R + 1\}\chi(\bar{e}), \quad (10)$$

where  $M^n$  is the non-consumption cost of his care. Under US tax code, goods and services purchased from a nursing home are considered qualifying expenses when calculating medical expense tax deductions. For simplicity, we assume that all private residents report qualifying expenses of  $\underline{c}^n + M^n$  to the tax authority. In other words, solely for the purpose of calculating the income tax deduction, we assume  $c^n = \underline{c}^n$ .

We are now ready to describe the problem of a retired agent who is currently not residing in a nursing home. Let  $V^R(j, a, \bar{e}, h)$  denote the agents value function. Conditional on surviving, this individual will enter a nursing home next period with probability  $\theta(j, \bar{e})$ . Recall that the nursing home shock is both an expense shock and a bad health shock that reduces the individual's survival probability. If the individual draws this shock and equation (3) is satisfied, meaning that he is eligible for public care, he will have to choose whether he wants to take it or pay for private care. Under public care the individual is provided with the minimum consumption level  $\underline{c}^n$ . Notice from equations (3) and (10) that this consumption level is always higher than the level individuals eligible for public care could achieve if they chose private care. Hence it is always optimal for an agent who is eligible for public care to take it. Moreover, since agents' social security income during retirement is deterministic and constant, as is  $r$ , an agent receiving public care would never choose to switch to private care in the future. Given these facts, we assume that upon obtaining public nursing home care, retirees surrender all of their assets as well as current and future pension income to the government and make no further decisions. This means that the value of receiving public care at age  $j$ ,  $V^G(j)$ , is just the present discounted value of utility from consuming  $\underline{c}^n$  from

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<sup>17</sup>Note that the budget constraint (8) implicitly incorporates Medicare expenses: we could have included them as both a cost on the left-hand side of (8) and a transfer on the right-hand side of (8). However these costs and transfers cancel out because, unlike Medicaid, Medicare transfers are not means-tested. Hence, in our model, Medicare shows up only as a tax burden. That is, consistently with the US system, the payroll taxes in the model finance both Medicare and Social Security.

the current period forward, or

$$V^G(j) = \sum_{i=j}^J \left[ \beta^{i-j} \prod_{k=j}^{i-1} s_{k+1}^n u(\underline{c}^n) \right]. \quad (11)$$

Let  $V^P(j, a, \bar{e})$  represent the value of receiving private care at age  $j$ . Then the problem of a retiree with current state  $(j, a, \bar{e}, h)$  who is not in a nursing home can be written as

$$V^R(j, a, \bar{e}, h) = \max_{c, a' \geq 0} \left\{ U(c) + \beta s_j (1 - \theta(j, \bar{e})) \mathbf{E}[V^R(j+1, a', \bar{e}, h') | h] + \beta s_j \theta(j, \bar{e}) \max [V^P(j+1, a', \bar{e}), V^G(j+1)] \right\} \quad (12)$$

subject to the initial distribution and law of motion for  $h$  and equations (2), (8), and (9). The expectation operator  $\mathbf{E}$  is taken over next period's medical shock  $h'$ .

Note that even though all eligible nursing home residents choose public care, the timing of the rollover onto Medicaid is still endogenous. This is because individuals control the allocation of their resources over their lifetime. Since Medicaid transfers are means-tested they create an incentive for poorer individuals to accumulate less wealth for retirement and to spend down their wealth faster than they would in the absence of the program.

Next we describe the problem of a retired agent who is currently receiving private nursing home care. This agent faces the lower survival probability  $s_j^n$  and will choose to switch to public nursing home care if he becomes eligible. He solves the following maximization problem:

$$V^P(j, a, \bar{e}) = \max_{c^n, a' \geq 0} \left\{ u(c) + \beta s_j^n \max [V^P(j+1, a', \bar{e}), V^G(j+1)] \right\} \quad (13)$$

subject to equation (10).

Finally, we describe the problem of a worker with state  $(R, a, \bar{e}, d, z)$  who will be retiring next period. Conditional on surviving, he will enter a nursing home upon retirement with probability  $\bar{\theta}_R$ . The problem of this individual is

$$V^W(R, a, \bar{e}, d, z) = \max_{c, a' \geq 0} \left\{ U(c) + \beta s_R (1 - \bar{\theta}_R) \mathbf{E}[V^R(R+1, a', \bar{e}, h')] + \beta s_R \bar{\theta}_R \max [V^P(R+1, a', \bar{e}), V^G(R+1)] \right\} \quad (14)$$

subject to the initial distribution for  $h'$  and equations (1), (4), (5) and (7).

Let the optimal nursing home type (public or private) of an individual of age  $j$  with current assets  $a$  and average lifetime earnings  $\bar{e}$  be given by  $g(j, a, \bar{e})$ . Specifically, this

function takes the value 1 if the individual is in a public nursing home and 0 otherwise.

### 3.6 Nursing Home Budget

There is a representative nursing home in the economy that houses both public and private residents and operates at zero profits. The nursing home provides  $\underline{M}^n$  units of non-consumption services to each resident. In addition, public residents receive  $\underline{c}^n$  units of consumption while private residents receive as many units as they choose. Hence, the total cost of nursing home care per public resident is  $\underline{M}^n + \underline{c}^n$ . In the US, the price in which Medicaid pays per resident for nursing home care is set by the government and is, on average, lower than the price for the same services that private payers pay. We thus assume that the government only pays the fraction  $p^G < 1$  of the cost of nursing home care for public residents. To maintain a balanced budget, the nursing home charges private residents fees in excess of the care provided. As a result in equilibrium  $M^n > \underline{M}^n$ . Denoting by  $n^G$  the number of public nursing home residents per private resident, the nursing home budget constraint determines  $M^n$ :

$$M^n = (1 - p^G) (\underline{M}^n + \underline{c}^n) n^G + \underline{M}^n.$$

### 3.7 Government Budget

The government must balance a single budget each period. For the budget to balance, revenues raised from income and payroll taxes have to cover means-tested transfers, social security benefits and a fixed level of government consumption  $G$ . To be able to set both payroll tax rates and benefits to the levels in the data, we do not specify a separate budget constraint for social security.

### 3.8 Goods Production

Firms produce goods by combining capital  $K$  and labor  $L$  according to a constant-returns-to-scale production technology:

$$F(K, L) = AK^\alpha L^{1-\alpha},$$

and rent  $K$  and  $L$  in perfectly competitive factor markets. Goods can be consumed by individuals, used in health care, used for government expenditures and invested in physical capital. The aggregate resource constraint is

$$C + (1 + n)\bar{K}' - (1 - \delta)\bar{K} + \tilde{M} + G = F(K, L) + (r + \delta)(\bar{K} - K), \quad (15)$$

where  $\delta$  is the depreciation rate of capital,  $\bar{K}$  is per capita private wealth,  $C$  is per capita consumption,  $\tilde{M}$  is per capita medical expenses and  $G$  is government expenditures.

### 3.9 Definition of Equilibrium

We consider a stationary competitive equilibrium for a small open economy. The definition of equilibrium includes a standard set of conditions which ensure that individuals and firms optimize; goods and labor markets clear; the distribution of agents is consistent with individual behavior; and government and nursing home budgets balance. The full definition of the equilibrium is available in the online appendix.

## 4 Calibration

The model is calibrated to match a set of aggregate and distributional moments for the US economy, including demographics, earnings, medical and nursing home expenses, as well as features of the US social welfare, Medicaid, social security and income tax systems. Most of the data statistics used are averages over or around 1995–2008. Some parameters can be set using direct estimates from the data or without computing the equilibrium of the model. Others are determined in the following minimization procedure. First, we make initial guesses on the relevant parameters. Then we compute the equilibrium of the model and relevant model moments and compare them to their counterparts in the data.<sup>18</sup> We continue updating the values of the parameters until the difference between model moments and data counterparts can no longer be improved. Note that, for expositional purposes only, in what follows we will divide the parameters into groups to discuss empirical targets. We report corresponding parameter values in the same section where we discuss these targets even if the parameters were obtained by the minimization procedure.

Agents in our model are a combination of a household and an individual. This is a compromise between model simplicity and data availability that we are not the first to make.<sup>19</sup> The main tradeoff is the following. On the one hand, the distributions of earnings and wealth are two crucial dimensions of heterogeneity for the questions we address. These distributions are the result of joint decision-making within households, and as such, the household is an appropriate unit of analysis. On the other hand, nursing home entry and survival risk is individual and data on nursing home residents is observed for individuals. Our solution is to view our agents as households when working and as individuals when

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<sup>18</sup>The algorithm used to compute the equilibrium is discussed in the appendix.

<sup>19</sup>Hubbard et al. (1995) is the closest example to us.

retired. This assumption is consistent with the fact that while the majority of households with heads aged 25 to 64 consist of married couples, over 60 percent of households with heads 65 and over are single individuals.

## 4.1 Demographics, Preferences and Technology

**Age structure** In the model, agents are born at age 21 and can live to a maximum age of 100. We set the model period to one year. The maximum life span is  $J = 80$  periods. For the first  $R = 44$  years of life, the agents work, and at the beginning of period  $R + 1 = 45$ , they retire.

The population growth rate  $n$  targets the ratio of population 65 years old and over to that 21 years old and over. According to the US Census Bureau, this ratio was 0.176 in 1990, 0.178 in 2000, and 0.182 in 2010.<sup>20</sup> Our steady-state analysis abstracts from population aging, hence we target the average ratio of 0.18. We target this ratio rather than directly set the population growth rate because the weight of the retired in the population determines the tax burden on workers, which is important to our analysis. The resulting value of  $n$  is 2 percent per year.

**Preferences** We set the coefficient of risk aversion,  $\gamma$ , to 2. This is a value commonly used in the literature.<sup>21</sup> Following Hong and Rios-Rull (2012), the subjective discount factor,  $\beta$ , is chosen such that model generates a wealth-to-earnings ratio of 3.2.<sup>22</sup> The resulting value of  $\beta$  is 0.96.

**Technology** The parameters  $\alpha$  and  $\delta$  are set using their direct counterparts in the US data. Thus the capital income share,  $\alpha$  is set to 0.3 and the annual depreciation rate,  $\delta$  is set to 7 percent (Gomme and Rupert, 2007). The rate of return on capital,  $r$ , is set to 4.1 percent (McGrattan and Prescott, 2000) and  $A$  is set to 0.95 so that the wage per an efficiency unit of labor,  $w$ , is 1.

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<sup>20</sup>For 1990, the share of 65+ is given for the population aged 20 years old and over.

<sup>21</sup>See for example Castaneda et al. (2003), Heathcote et al. (2010) and Storesletten et al. (2004).

<sup>22</sup>This ratio is computed using data from the 1992 SCF for the bottom 95 percent of the population — the relevant data counterpart for a model which does not generate enough wealth concentration at the top 5 percent of the wealth distribution.

Table 2: Cross-sectional moments targeted in calibration of labor productivity process.

	Quintiles					Top Percentiles			Gini
	Q2	Q3	Q4	Q5	10	5	1		
<b>Earnings of the Young (30 and under)<sup>a</sup></b>									
<i>fraction young, %</i>									
Data	35.7	29.7	19.2	7.3	3.7	1.2	.04	.44	
Model	33.9	33.1	20.9	6.3	3.1	0.9	.00	.45	
<b>Earnings Distribution<sup>b</sup></b>									
<i>share of total, %</i>									
Data	4.0	13.0	22.9	60.2	42.9	31.1	15.3	.61	
Model	5.2	13.0	21.4	60.3	45.0	31.5	16.2	.60	
<b>Lifetime earnings Distribution<sup>c</sup></b>									
<i>share of total, %</i>									
Data	9.8	15.5	23.5	46.9	30.2	19.5	7.5	.42	
Model	9.4	16.7	22.6	47.0	29.8	17.8	4.8	.42	

*a.* The share of households age 30 and under in each cell of the earnings distribution in *b* and the Gini of the earnings distribution for 26–30 year-olds. *b.* The share of total earnings paid to households in each cell and the corresponding Gini. *c.* The share of lifetime earnings upon retirement held by households in each cell and the corresponding Gini. Data sources: *a* and *b*. Rodriguez et al. (2002), Tables 5 and 8. Data: 1998 SCF, retired households included. *c.* Authors' computations. Data: 1995–2008 HRS/AHEAD retired household heads aged 65–69. Additional details in the appendix.

## 4.2 Productivity Process

The productivity process  $\Omega(j, d, z)$  consists of a deterministic, age-dependent component and a stochastic component as follows:

$$\log \Omega(j, d, z) = \alpha_d + \beta_1 j + \beta_2 j^2 + \beta_3 j^3 + z,$$

where permanent productivity type  $d$  and productivity shock  $z$  are independent,  $\alpha_d \in \{\alpha_L, \alpha_H\}$  and  $z \in \{z_1, \dots, z_5\}$  follows a finite-valued Markov process with probability transition matrix  $\Lambda_{zz'}$ . Initial productivity levels  $(d, z)$  are drawn from distributions  $\Gamma_d$  and  $\Gamma_z$ .

The coefficients for the age profile are set to estimates from Heathcote et al. (2010):  $\beta_1 = 4.80 \times 10^{-2}$ ,  $\beta_2 = -8.06 \times 10^{-4}$ , and  $\beta_3 = -6.46 \times 10^{-7}$ . The estimates are based on 1967–2003 PSID data for 25–59 year-old, non-self-employed, married males whose work hours and wages exceed some minimum values. Married males constitute the majority of household heads in the data and, given our treatment of workers as households, are the relevant counterpart of working individuals in our model.

Table 3: Mobility moments targeted in calibration of labor productivity process.

		5-year transition probabilities, %				
		Q1 to Q1	Q2 to Q2	Q3 to Q3	Q4 to Q4	Q5 to Q5
<b>Stayers</b>						
Data		58	44	43	46	65
Model		57	46	42	45	62
<b>Extreme Movers</b>		Q1 to Q4	Q1 to Q5	Q2 to Q5	Q5 to Q1	Q5 to Q2
Data		3	2	3	6	2
Model		3	4	3	4	3

The percent of households in earnings quintile  $Q_i$  who are in earnings quintile  $Q_j$  5 years later. Data source: Rodriguez et al. (2002), Table 16. Data: 1989 and 1994 waves of the PSID, households with positive earnings.

We require  $z$  to be mean zero and average productivity to be one. Given these restrictions, we are left with 30 independent parameters.<sup>23</sup> We calibrate them by targeting 34 cross-sectional and mobility moments characterizing the life-cycle distribution of earnings. Both the empirical moments and their model counterparts are listed in Tables 2 and 3. All the empirical moments, except those for lifetime earnings, are taken from Rodriguez et al. (2002). We choose these moments and data sources for the following reasons. First, the cross-sectional moments are obtained using SCF data which represents earnings inequality in the US better than the PSID.<sup>24</sup> Second, using mobility moments allows us to target the persistence of earnings over the life-cycle without restricting productivity to follow an AR(1) process. According to Castaneda et al. (2003), under such a restriction it is more difficult to generate the degree of earnings inequality observed in the data.

The last two rows of Table 2 show the percentile shares and the Gini of the lifetime earnings distribution that we targeted in the data and the values are minimization procedure delivers from the model. Targeting the lifetime earnings distribution is important because, in the model, health expenses occur after retirement. Thus correct assignment of the means-tested Medicaid transfers relies on an adequate distribution of lifetime earnings. The moments characterizing the lifetime earnings distribution are calculated using our HRS sample described in the appendix. Since the other earnings distribution targets are constructed from household level data, we restrict the sample to retired household heads aged 65–69 years.

The initial distributions of productivity shocks and permanent types are identified by targeting the Gini of earnings for young households and the fraction of young (age 30 and

<sup>23</sup>Specifically, we still need to calibrate 20 independent values in the probability transition matrix for  $z$ , the ratio  $\alpha_L/\alpha_H$ , 4 independent parameters in  $\Gamma_d$ , 1 in  $\Gamma_z$ , and 4 in the grid for  $z$ .

<sup>24</sup>For more details on the data sets see Heathcote et al. (2010) and Rodriguez et al. (2002).

under) households in each quintile and the top 10, 5 and 1 percentiles of the earnings distribution. The productivity grid, the relative productivity of high permanent types, and the transitional probabilities are determined by targeting the distribution of earnings for all ages, the distribution of lifetime earnings, and mobility across the earnings quintiles. Targeted moments of the distributions are the shares of total earnings paid to each quintile and the top 10, 5 and 1 percentiles; and the Ginis. Targeted mobility moments consist of both the high probabilities of staying in the same quintile as well as the low probabilities of moving from bottom quintiles to top quintiles and vice versa, all computed over a 5-year period.<sup>25</sup> As a result of the calibration the ratio of  $\alpha_H$  to  $\alpha_L$  is 3.8,  $\Gamma_d = \{0.41, 0.59\}$ ,  $z \in \{-3.5, -0.33, 0, 0.68, 2.4\}$  and  $\Gamma_z = \{0.17, 0.59, 0.23, 0.02, 0\}$ . The resulting values for  $\Lambda_{zz'}$  are reported in the appendix.

### 4.3 Survival Probabilities

We assume that for nursing home residents the probability of surviving to age  $j$  conditional on having survived to age  $j - 1$ ,  $s_j^n$ , is the fraction  $\phi^n$  of  $s_j$ , the corresponding probability for non-institutionalized individuals. Thus we set

$$s_j^n = \phi^n s_j, \quad \text{for } j = R + 1, \dots, J.$$

The advantage of this specification is that it reduces the calibration of the survival probabilities of nursing home residents to a single parameter,  $\phi^n$ . We choose this parameter such that the average nursing home stay duration in the model matches the average *long-term* nursing home stay duration in the data.<sup>26</sup> Given that most long-term nursing home stays end in death, see footnote 14, the average duration of long-term nursing home stays is a good proxy for the average time until death for nursing home entrants. Dick et al. (1994) and Brown and Finkelstein (2008) estimate that an average nursing home spell is 21.6 months (1.8 years) and that 60 percent of all nursing home stays are short-term. Using estimates of the distribution of nursing home spells from Dick et al. (1994), we back out an average length of stay for short-term stayers of 4.4 months and an average length for long-term stayers of

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<sup>25</sup>Model moments are computed similarly to data moments: by identifying an individual's location within the earnings distribution 5 years later.

<sup>26</sup>There are two reasons against using HRS data to estimate directly survival rates conditional on nursing home status. First, the number of observations with nursing home stays in the data is small, especially long-term stays, giving a lot of noise to our estimates. Second since we model nursing home care as an absorbing state, it is difficult to directly estimate necessary parameters using micro data with nursing home exit and re-entry. Once again, small sample intensifies this issue.

47.4 months (4.0 years).<sup>27</sup> We use the latter as the target value to pin down  $\phi^n$ .

Survival probabilities  $s_j$  for  $j = R + 1, \dots, J$ , are set such that the unconditional age-specific survival probabilities are consistent with those observed in the data.<sup>28</sup> The calibration procedure delivers a value for  $\phi^n$  of 0.86.

## 4.4 Government

### 4.4.1 Social Security and Taxes

The social security benefit function in the model captures the progressivity of the US social security system. Specifically, the payment function is

$$S(\bar{e}) = \begin{cases} s_1\bar{e}, & \text{for } \bar{e} \leq \tau_1, \\ s_1\tau_1 + s_2(\bar{e} - \tau_1), & \text{for } \tau_1 \leq \bar{e} \leq \tau_2, \\ s_1\tau_1 + s_2(\tau_2 - \tau_1) + s_3(\bar{e} - \tau_2), & \text{for } \tau_2 \leq \bar{e} \leq \tau_3, \\ s_1\tau_1 + s_2(\tau_2 - \tau_1) + s_3(\tau_3 - \tau_2), & \text{for } \bar{e} \geq \tau_3, \end{cases}$$

where the marginal replacement rates,  $s_1$ ,  $s_2$ , and  $s_3$ , are set to 0.90, 0.33, and 0.15. The threshold levels,  $\tau_1$ ,  $\tau_2$ , and  $\tau_3$ , are set to 20 percent, 125 percent and 246 percent of average earnings.

The payroll tax function is

$$\tau_e(e) = \hat{\tau}_e \min\{e, e_{\max}\} + \tau_{mc}e.$$

The social security tax rate,  $\hat{\tau}_e$ , is set to 12.4 percent and the Medicare tax rate,  $\tau_{mc}$ , is set to a 2.9 percent. These are the rates in the year 2000. The parameter  $e_{\max}$  is set such that it corresponds to \$76,200 which is the maximum taxable earnings in 2000.

Income taxes are determined by the effective progressive income tax formula estimated by Gouveia and Strauss (1994) using data on 1989 individual income tax returns. Specifically, given taxable income  $\hat{y}$ , income taxes are given by

$$\tau_y(\hat{y}) = \tau_0 \left[ \hat{y} - (\hat{y}^{-\tau_1} + \tau_2)^{\frac{1}{\tau_1}} \right], \quad (16)$$

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<sup>27</sup>To compute these numbers we use the percentiles of the distribution provided in Table 10.11 of their paper and the fact that the bottom 60 percent of the distribution are the short-term stayers. The row of the Table we use is “Nursing home utilization for those with at least one admission”.

<sup>28</sup>The data on survival probabilities is taken from Table 7 of *Life Tables for the United States Social Security Area 1900-2100*, Actuarial Study No. 116 and are weighted averages of the probabilities for both men and women born in 1950. In both the data and the model expected years of life remaining at age 65 is 18.

where  $\tau_0 = 0.258$  and  $\tau_1 = 0.768$ . The parameter  $\tau_2$  is normalized so that, in equilibrium, the marginal tax rate, evaluated at average individual income, is the same in the model and the data. For workers,  $\hat{y} = y$  and  $\tau^W(y) = \tau_y(y)$ .

Income taxation of retirees is more complicated because we take into account both the exemption of SS benefits, its phasing out as income rises and medical expense tax deductions. A retiree's taxable income  $\hat{y}$  is determined as follows. First we calculate his provisional income which is given by

$$\bar{y} = ra + 0.5S(\bar{e}).$$

Then we calculate his pre-deduction, taxable income  $\underline{y}$ . According to US Federal tax code, the exemption of SS benefits is phased out in two stages. Specifically  $\underline{y}$  is given by

$$\underline{y} = \begin{cases} ra, & \text{if } \bar{y} < T^1, \\ ra + 0.5 \min [S(\bar{e}), \bar{y} - T^1], & \text{if } T_s^1 < \bar{y} < T^2, \\ ra + \min \left\{ 0.85S(\bar{e}), 0.85[\bar{y} - T^2 + \min (\bar{Y}, 0.5S(\bar{e}))] \right\}, & \text{otherwise,} \end{cases}$$

where the first threshold,  $T^1$ , is \$25,000, the second threshold,  $T^2$ , is \$34,000 and minimum income,  $\bar{Y}$ , is \$4,500.<sup>29</sup> Finally taxable income is given by

$$\hat{y} = \max \{0, \underline{y} - \max[0, m - \kappa \underline{y}]\},$$

where  $\kappa$  is set to 0.075 to allow for a deduction for medical expenses that exceed 7.5 percent of income. Given the retiree's taxable income  $\hat{y}$  his income taxes  $\tau^R[ra, S(\bar{e}), m] = \tau_y(\hat{y})$ .

Finally, government spending,  $G$  is set such that, the government budget constraint holds in equilibrium.

#### 4.4.2 Welfare Program

The welfare program in the model economy represents a variety of public assistance programs in the US, such as food stamps, Aid to Families with Dependent Children, Supplemental Social Security Income, and Medicaid. Hubbard et al. (1994) estimate that the government-guaranteed consumption levels for single retirees and retired couples in 1984 were approximately \$7,117 and \$10,596, respectively.<sup>30</sup> Estimates of the government-guaranteed consumption level for a household consisting of 1 adult and 2 children range over the period

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<sup>29</sup>The expression for  $\underline{y}$ , threshold dollar amounts and minimum income amount are taken from Scott, C. and J. Mulvey (2010). "Social Security: Calculation and History of Taxing Benefits," *Congressional Research Service*.

<sup>30</sup>All dollar amounts are 2000 dollars.

1968 to 2000 from \$7,354 to \$12,135 (Moffitt, 2002; Hubbard et al., 1994; Scholz et al., 2006). The estimates suggest that the minimum consumption floor is very similar for workers and non-institutionalized retirees and, for an individual, is somewhere in the range of 10 to 20 percent of average earnings of full-time workers.<sup>31</sup> Thus we set  $\underline{c}^w = \underline{c}^m$ . Since  $\underline{c}^m$  has a direct effect on Medicaid take-up rates, this parameter is determined in the minimization procedure such that the model reproduces the Medicaid take-up rate of retirees in our HRS sample. This sample is described in detail in the appendix. The take-up rate is 14 percent. The calibration results in a consumption floor of 16.5 percent of average earnings which is well within the estimates cited above. The calibration of  $\underline{c}^n$  is described in Section 4.5.2.

## 4.5 Health Expenses

### 4.5.1 Medical Expense Process

We assume that, similarly to productivity, medical expenses can be decomposed into a deterministic age component and a stochastic component:

$$\ln M(j, h) = \beta_{m,0} + \beta_{m,1}j + \beta_{m,2}j^2 + \beta_{m,3}j^3 + \beta_{m,4}j^4 + h,$$

where  $h \in \{h_1, \dots, h_4\}$  follows a finite state Markov chain with probability transition matrix  $\Lambda_{hh'}$  and initial distribution  $\Gamma_h$ . The medical expense process is calibrated by targeting both moments constructed using HRS data and aggregate moments taken from the US Department of Health and Human Services. Note that the calibration is complicated by the fact that the expense process in the model is for pre-Medicaid medical expenses, whereas, the HRS only contains information on OOP (post-Medicaid) expenses.

Both the shape of the deterministic profile and the cross-sectional and mobility moments we target in the calibration of the stochastic component are computed using 1995–2008 HRS/AHEAD data. Our sample consists of retired individuals, both married and single, 65 years of age and older and, if married, with retired spouses. All the moments are adjusted for cohort effects. Our measure of OOP health expenses includes insurance premia and expenses in the last year of life. We use the average of social security, defined-benefit pension, and

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<sup>31</sup>Average earnings of full-time workers aged 21–59 in 2000 is \$38,221. This estimate is based on IPUMS data. Note that the consumption floor is difficult to measure due to the large variation and complexity in welfare programs and their coverage. In addition, families with 2 adults and adults under 65 without children would receive less in benefits than found above. By estimating their model, De Nardi et al. (2010), find a much lower minimum consumption level: \$2,813. This is similar to a value of \$3,200 used by Palumbo (1999). However, not only is DeNardi et al.’s estimate model specific, but health expenses in their model include nursing home costs, and hence their estimate is not directly comparable to the non-nursing home minimum consumption level in our model.

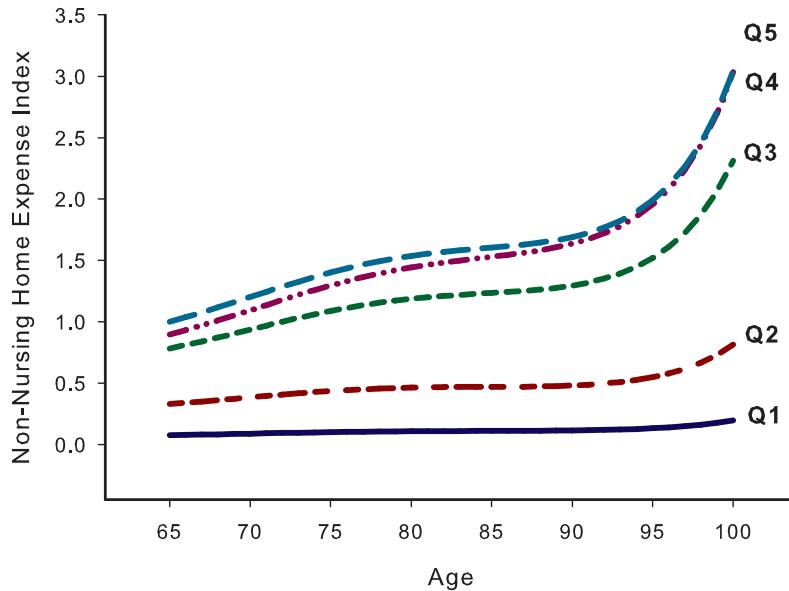


Figure 1: Average OOP medical (non-nursing home) expenses by age and lifetime earnings quintile for retired individuals, 65 and older. Estimated using HRS data and a fixed effects estimator. The average expense of 65 year-olds in quintile 5 is normalized to 1.

annuity income in retirement during all observable periods as a proxy for lifetime earnings. More details about our sample and variables is available in the appendix.

**Deterministic Profile** We use our HRS sample, excluding observations with nursing home stays, and a fixed-effects estimator to determine the shape of the medical expense profile.<sup>32</sup> Since we wish to obtain an estimate of the pre-Medicaid profile, we exploit the fact that individuals with high lifetime earnings (or who have/had spouses with high lifetime earnings) are unlikely to be eligible for means-tested Medicaid transfers and should, therefore, have similarly-shaped pre- and post-Medicaid profiles. We, thus, include lifetime earnings quintile dummies and their age-interaction terms (to account for the fact that Medicaid transfers increase with age) in the age-profile regression. Household heads are assigned a lifetime earnings quintile based on where their lifetime earnings lies within the lifetime earnings distribution in Table 2. Non-household heads are assigned to the quintile of their spouse.

Figure 1 plots the estimated medical expense profiles for each lifetime earnings quintile. As expected, the shapes of the top 3 quintiles' expense profiles (those least likely to be eligible for Medicaid transfers) are very similar. Hence we take the shape of the fifth quintile's

<sup>32</sup>As pointed out by De Nardi et al. (2010), the fixed effects estimator overcomes the problem of variation in the sample composition due to differential mortality as well as accounts for cohort effects.

age-profile to be the shape of the pre-Medicaid age-profile faced by individuals and set  $\beta_{m,1} = -5.08$ ,  $\beta_{m,2} = 0.103$ ,  $\beta_{m,3} = -9.16 \times 10^{-4}$ , and  $\beta_{m,4} = 3.01 \times 10^{-6}$ . We use an aggregate moment, OOP health expenses as a fraction of GDP, to pin down the level parameter in the health expense profile specification,  $\beta_{m,0}$ .

**Stochastic Process** OOP health expenses are highly concentrated and fairly persistent. Table 4 reports that the top 1 percent of the elderly account for nearly a quarter of all expenses and the top 10 percent account for more than half. The Gini coefficient of the OOP health expense distribution is 0.69. Approximately half of the individuals in the top OOP medical expense quintile are still in the top two years later. Although not reported in the Table, the mobility numbers look very similar for the OOP health expense distribution. In particular, for the top quintile the number doesn't change: 52 percent of individuals who were in the top quintile are still there two years later. We wish to capture these features of OOP health expenses in as parsimonious a way as possible. To this end, we follow a similar calibration approach for stochastic medical expenses as to that for productivity. That is, we specify a Markov chain for the stochastic component of the pre-Medicaid medical expense process and calibrate its parameters by directly targeting the cross-sectional and mobility moments of OOP expenses we want the model to reproduce. Note that, in contrast to productivity, the parameters of the stochastic component for medical expenses must be calibrated in the minimization procedure. This is because, while productivity and pre-Medicaid medical expenses are exogenous, OOP expenses and their distribution are endogenous. Thus we must guess on the parameters of the pre-Medicaid process and then compute the model equilibrium to obtain model moments that can be compared to moments constructed using HRS data.

Our approach is a departure from the standard approach in the literature of estimating and discretizing an AR(1) process. We make this departure because the OOP medical expense distribution, while slightly less skewed than the OOP health expense distribution, is still highly skewed. The Gini is 0.65, the top 1 percent account for 15 percent of expenses and the top 10 percent account for 51 percent. Notice that the extent of skewness of the OOP medical expense distribution and the persistence of medical expense shocks are akin to those of earnings. Thus, as is the case with earnings, neither the OOP medical nor health expense distributions will be well captured if medical expense shocks are assumed to be generated solely by an AR(1) process. One way to deal with this issue that has been used in the literature is to assume that medical expenses also depend on additional variables such as a stochastic health state and a transitory expense shock.<sup>33</sup> In contrast to this approach,

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<sup>33</sup>See for example French and Jones (2004) and De Nardi et al. (2010).

Table 4: Cross-sectional and mobility moments targeted in calibration of medical expense process.

	Quintiles					Top Percentiles			Gini
	Q1	Q2	Q3	Q4	Q5	10	5	1	
<b>OOP Health Expense Distribution of 65-69 Year-Olds<sup>a</sup></b>									
<i>shares of expenses, %</i>									
Data	4.1	11.0	21.5	62.9	45.1	32.3	15.7	.62	
Model	4.0	10.4	23.9	61.1	48.3	41.7	18.4	.63	
<b>OOP Health Expense Distribution of All Retirees<sup>b</sup></b>									
<i>shares of expenses, %</i>									
Data	3.7	9.0	16.8	70.0	56.1	45.2	24.3	.69	
Model	2.9	6.2	19.7	70.7	56.6	48.2	18.4	.70	
<b>Mobility over OOP Medical Expense Distribution<sup>c</sup></b>									
<i>2-year stayers, %</i>									
Data	59	36	33	37	52				
Model	52	39	34	45	48				

*a* and *b*. The share of OOP health (nursing home and medical) expenses paid by retirees in each cell of the distribution and the corresponding Gini. *c*. The share of retirees, among those who did not receive nursing home care, who remained in the same quintile of the expense distribution over a period of 2 years. Data source: Authors' computations using 1995–2008 HRS/AHEAD data. Data was adjusted for cohort-effects.

the advantage of our procedure is that, as Table 4 shows, it allows us to match well both the skewness of the OOP health distribution and persistence of medical expenses without the introduction of additional state variables.

There are 18 independent parameters governing the stochastic component of the medical expense process that need to be determined: 3 grid points for medical expense shocks, 3 elements of the initial distribution  $\Gamma_h$ , and 12 probabilities in  $\Omega_{hh'}$ . The grid points and initial distribution are chosen by targeting 8 moments characterizing the OOP health expense distribution of 65–69 year-olds: shares of 4 quintiles, top 10, 5 and 1 percent, and the Gini. As a result  $h \in \{0, 2.0, 3.5, 6.0\}$  and  $\Gamma_h = \{0.20, 0.16, 0.61, 0.03\}$ . The transition probabilities, which are provided in the appendix, are calibrated to match the percent of stayers in each OOP medical expense quintile over a two-year period (5 moments) and quintile and top percentile shares for the overall distribution of OOP health expenses (8 moments).<sup>34</sup> To make sure the model economy is consistent with aggregate health expenditures in the data,

<sup>34</sup>We target OOP health expense distribution moments instead of OOP medical expense distribution moments because it is important that the model matches well the overall distribution of OOP health expenses. Note that by targeting these moments in the minimization procedure we are also putting restrictions on the OOP nursing home expense distribution generated by the model.

we also target Medicaid expenses as a share of GDP.

The targeted empirical moments and model counterparts are listed in Tables 4 and 5. The model is able to match the medical expense moments remarkably well. However, it fails to reproduce the top 1 percent's share of medical expenses. While this share is 24.3 percent in the data it is only 18.4 percent in the model.

#### 4.5.2 Nursing Home Expenses and Medicaid

The consumption level provided by Medicaid to nursing home residents,  $\underline{c}^n$ , is a crucial parameter for our analysis. However, obtaining a direct estimate of this parameter is problematic because it requires estimating the value of the rooms and amenities that nursing homes provide to Medicaid recipients. Instead, our approach is to infer the value of  $\underline{c}^n$  indirectly using aggregate moments.<sup>35</sup> Specifically,  $\underline{c}^n$  is chosen by targeting Medicaid's share of the elderly's nursing home expenses net of Medicare. We want this share only for nursing home expenses associated with long-term nursing home stays. The Centers for Medicare & Medicaid report aggregate statistics on nursing home expenses by type of stay: short-term or long-term. The statistics are based on data from the Medicare Current Beneficiary Survey (MCBS). Their definition of a long-term stay, while not equivalent to ours, is very comparable. Thus our target number for Medicaid's share of nursing home expenses, 45 percent, is based on 2002 MCBS data on long-term stays only.<sup>36</sup> The medical cost of nursing home care for a public resident,  $M^n$ , is then chosen by targeting nursing home expenses as a fraction of GDP. Just like Medicaid's share, we only include the nursing home expenses of MCBS long-term stays and expenses are net of those paid by Medicare. According to statistics drawn from the 2002 MCBS, these expenses are 0.68 percent of GDP.

Note that even though both aggregate nursing home expenditures and Medicaid's share of these expenditures increase with  $M^n + \underline{c}^n$ , we are able to separately identify these 2 parameters using these 2 moments. This is because aggregate nursing home expenditures depend on the *population share* of nursing home residents, while Medicaid's share of these expenses, in addition, depends on their *income distribution*. In fact, Medicaid's share of nursing home expenses exceeds that of medical expenses to a large extent because nursing home residents are disproportionately poor and are less educated than the rest of the population. To allow

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<sup>35</sup>For the same reasons as in footnote 28, we cannot use HRS data to calibrate nursing home expenses. However, given that we are interested in the aggregate effects of nursing home expenses, we focus on the ability of the model to reproduce aggregate moments related to nursing home costs.

<sup>36</sup>Medicaid's share of long-term care expenses is taken from Table 4.7 of "2002 Health and Health Care of the Medicare Population," published by Centers for Medicare & Medicaid as a part of the MCBS. The exact definition of a short-term stay in the MCBS is a stay of less than one year in a skilled nursing facility by Medicare-eligible individuals who at the time of the survey are living in the community as opposed to an institution. Long-term stays are all other types of nursing home events.

Table 5: Additional moments targeted in the calibration.

	Data	Model
OOP Expenses/GDP, %	1.5	1.5
Medicaid Expenses/GDP, %	0.60	0.60
Nursing Home Expenses/GDP, %	0.68	0.69
Medicaid's Share of Nursing Home Expenses, %	45	45
Fraction in Nursing Home by Age, %		
65–74	1.1	1.1
75–84	4.7	4.7
85+	18.2	18.2
Fraction of Low Income Individuals in a Nursing Home <sup>a</sup>		
65–74	2.1	2.2
75–84	7.1	7.1
85+	20.8	21.2

*a.* Low income individuals are defined as having an annual income below \$20,000. Data sources: Total expenses: US Department of Health and Human Services. Nursing home expenses and low income residents: MCBS, 2000 and 2003. Nursing home population: US Census special tabulation for 2000.

the model to be consistent with this fact, we assume that nursing-home entry probabilities are a function of both an individual's age and lifetime earnings. In particular, we assume that, at each age  $j$ , the probability of entering a nursing home decreases with individual lifetime earnings at a constant rate:

$$\ln \theta(j, e) = \beta_{n,1}^j - \beta_{n,2}^j \ln e, \quad j = R, \dots, J-1.$$

Then, to correctly identify the 2 parameters,  $\underline{c}^n$  and  $\underline{M}^n$ , we choose the nursing home entry probability parameters  $\beta_{n,1}^j$  and  $\beta_{n,2}^j$  for  $j = R, \dots, J-1$  such that we match both the fraction of individuals residing in nursing homes by age and the fraction of low-income individuals residing in nursing homes by age. To this end, we assume that the unconditional probabilities of entering a nursing home and the elasticities  $\beta_{n,2}^j$  for  $j = R, \dots, J-1$  are the same across agents within the following age groups: 65–74, 75–84, and 85 and over.

The moments obtained from both the model and the data are in Table 5. Since we only model the risk of a long-term stay in a nursing home, we target the fraction of individuals residing in a nursing home for at least one year. The model matches well the large increase in long-term nursing home usage after age 85 as well as the relatively higher, and decreasing with age, rates of utilization by low income individuals. As a result of the calibration we set  $\beta_{n,2}^{65-74} = 0.53$ ,  $\beta_{n,2}^{75-84} = 0.23$  and  $\beta_{n,2}^{85+} = -0.18$ . The unconditional nursing home entry

probabilities are 0.31, 1.1, and 4.6 percent for each age group, respectively.

The government price of nursing home services,  $P^g$ , targets the Medicaid reimbursement rate relative to the private pay rate for nursing home services in the data. Using National Nursing Home Survey data, Meyer (2001) reports that, in 1997, the median Medicaid per diem rate was \$91 while the private per diem rate for the same services and amenities was \$102. Thus  $P^g$  is pinned down by requiring that

$$\frac{P^g(\underline{M}^n + \underline{c}^n)}{M^n + \underline{c}^n} = 0.89.$$

The cost of the non-consumption component of private nursing home care,  $M^n$ , is determined in equilibrium by the nursing home's budget constraint.

The calibration procedure results in values for  $\underline{c}^n$ ,  $\underline{M}^n$ , and  $M^n$  of 12, 88, and 94 percent of average earnings, respectively, and a value for  $P^g$  of 0.97. Note that the total cost for a private nursing home resident is  $M^n + c^n$ , while the total cost for a public resident is  $P^g(\underline{M}^n + \underline{c}^n)$ . Calculating the average total expenditure on nursing homes of private payers in the model and converting to year 2000 dollars yields \$66,618, while the same calculation for public residents yields \$37,074. These numbers are comparable to an average annual rate of \$65,331 for a private room in 2005, \$56,642 for a semi-private room and, using Meyer's Medicaid per diem rate, a median annual public rate in 1997 of \$35,636. (All dollar amounts are in constant year 2000 dollars.)

The value for  $\underline{c}^n$  lies below the non-nursing home consumption floor,  $\underline{c}^m$ . We view this differential as reflecting a lower quality of life enjoyed by nursing home residents receiving Medicaid relative to those receiving public assistance while living at home. As we show later in our quantitative analysis, the low quality of life under public nursing care plays an important role in individual saving decisions.

## 5 Benchmark Economy

The calibration procedure did not target the distribution of OOP and Medicaid expenses by age and nursing home status, the OOP expense/income relationship, or the wealth distribution. Instead, we use these moments as a test of the model.

### 5.1 Distribution of Health Expenses by Age and Income

The model does an excellent job matching the distribution of OOP and Medicaid expenditures by age, nursing home status and income. Table 6 shows OOP and Medicaid expendi-

Table 6: OOP and Medicaid expenses as a share of GDP and nursing home's share by age in the data and the model.

	OOP Expenses				Medicaid Expenses			
	share of GDP, %		NH's share, %		share of GDP, %		NH's share, %	
	Data	Model	Data	Model	Data	Model	Data	Model
65–74	0.61	0.69	8	8	0.16	0.13	33	26
75–84	0.55	0.51	25	24	0.21	0.22	43	45
85+	0.34	0.35	54	59	0.23	0.25	67	69

These moments are not targeted in the calibration procedure. Data source: US Department of Health and Human Services.

tures of different age groups as a share of GDP and the share due to nursing home expenses in both the model and the data. The model slightly underestimates the fraction of Medicaid expenses due to nursing home expenses for individuals ages 65–74. It also understates Medicaid expenses as a fraction of GDP and overstates OOP expenses as a fraction of GDP for this age group. This is, in part, due to our assumption that all transfers of accidental bequests are given to 65 year-olds. The transfers reduce the reliance of younger retirees on the Medicaid program. The effect of these transfers on Medicaid take-up rates for this age group is likely larger in our model than in the data because in the data the distribution of bequests is much more skewed with the majority of bequest going to wealthy individuals.<sup>37</sup> Also in the data inheritances do not all occur at age 65.

In the model, pre-Medicaid expenses of the first lifetime earnings quintile, those with the highest nursing home entry risk, exceed those of the fifth by 20 percent. However, OOP expenses are positively related to income due to the presence of means-tested social insurance. Figure 2, top left panel, shows the distribution of OOP expenses by lifetime earnings quintile in the model and the data. The OOP expenses are shown relative to their mean. Overall, the model slightly over-predicts OOP expenses of the rich and slightly under-predicts OOP expenses of the poor. OOP expenses of the bottom lifetime earnings quintile are about a third of those faced by the top quintile while they are about half in the data. This discrepancy is more substantial when the samples are restricted to specific age groups (see the remaining three panels on the same figure).

The fact that our model overpredicts inequality in OOP expenses by lifetime income may be due to our rudimentary modeling of Medicaid. First, in the US economy, the eligibility criteria for Medicaid are complicated and vary by state. Second, some participants are required to pay a small portion of their medical costs. Hence, the Medicaid program in

<sup>37</sup>See Hendricks (2001, 2002) for discussions of the distribution of bequests in the US.

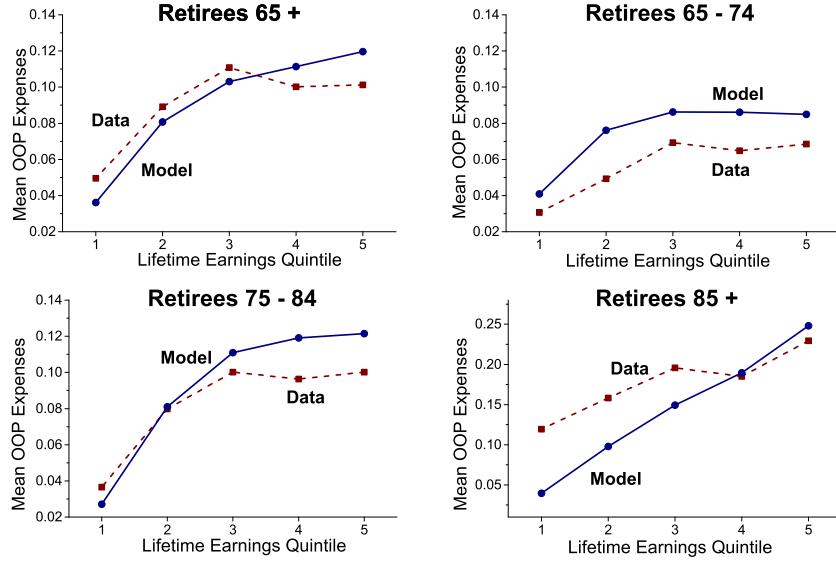


Figure 2: Mean OOP health expenses by lifetime earnings quintile for all retirees (top left), retirees 65–74 (top right), retirees 75–84 (bottom left) and retirees 85+ (bottom right) in the model and the data (our HRS sample). Expenses are relative to average earnings of full-time workers in 2000 which were \$38,221.

the model is relatively more generous to the poor. Since our calibration targets aggregate Medicaid and OOP health expenses over GDP, the lower OOP expenses of the poor are achieved at the cost of slightly higher OOP expenses of the rich.

## 5.2 Wealth Distribution

The degree of wealth inequality in the benchmark economy is similar to that in the US. Table 7 provides wealth distribution moments and the Gini in both the model and the data. Notice that the wealth Gini in the model economy is 0.82 compared to 0.80 in the data. The primary drivers of wealth inequality in the benchmark economy are the earnings process and the Medicaid program. When we remove earnings risk from the benchmark, the wealth Gini falls to 0.67. When we essentially remove Medicaid from the benchmark by setting the minimum consumption floors guaranteed to retirees to very low values, the wealth Gini falls to 0.68.

Note that these two features of the benchmark economy impact the distribution of wealth in different ways. High and persistent earnings shocks promote higher wealth inequality by concentrating wealth at the top of the distribution. In other words, earnings risk especially

Table 7: Wealth distribution in the data and the model.

	Quintiles					Top Percentiles			<i>Gini</i>
	Q1	Q2	Q3	Q4	Q5	10	5	1	
<i>share of total, %</i>									
Data	-0.3	1.3	5.0	12.2	81.7	69.1	57.8	34.7	.80
Model	0.0	0.4	3.0	11.4	85.2	70.4	51.4	18.0	.82

The wealth distribution is not targeted in the calibration procedure. Data source: Rodriguez et al. (2002).

helps us match the upper tail. When we remove this risk from the benchmark, the share of wealth held by the top 1 percent of the population declines from 18 to 5 percent. Our findings on the large impact of earnings risk on overall inequality and the upper tail of the distribution are not new and are very similar to those found by Huggett (1996).<sup>38</sup>

In contrast to earning risk, when we remove Medicaid from the benchmark the share of wealth held by the top 1 percent is almost unaffected. However, removing Medicaid increases the fractions of wealth held by quintiles 1 and 2 from 0 and 0.4 percent to 0.8 and 3.2 percent, respectively. As is explained in detail in Section 6.1, while risky, old-age health expenses increase the savings of wealthier individuals, these expenses together with the availability of Medicaid discourages savings of the poor. This fact was also documented by Hubbard et al. (1995). However, they do not look at the impact of means-tested programs on the aggregate wealth distribution.

As a final assessment of the benchmark model, we compare its prediction for the share of wealth held by individuals 65 and older to the data. In our model, this share is 0.33. Wolff (2010) estimates age-wealth profiles for the US using SCF data. Using these profiles and population shares from the US census we find that, over the period 1992–2007, the share of wealth held by individuals 65 and older fluctuated from 0.25 to 0.33. Thus the share of wealth held by the elderly in the benchmark model, while on the high end, is consistent with this share in the data.

## 6 Savings for Health Expenses and Their Risks

In this section we quantify the amount of wealth held in the anticipation of stochastic OOP health expenses during retirement. We first focus on the role that each type of health

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<sup>38</sup>The inability of our model to match exactly the share of wealth held by the top 1 percent is not surprising. As has been pointed out in the literature, see Cagetti and De Nardi (2008) and Castaneda et al. (2003) for surveys, models in which wealth accumulation is driven by precautionary motives have difficulty matching the high savings rate of individuals in the upper tail of the permanent income distribution.

expense, nursing home and medical, play in individual saving decisions. We then assess the contribution of OOP nursing home and medical expense risk.

Our analysis consists of a series of partial equilibrium experiments. First, to assess the effect of OOP expenses on savings, we consider a set of experiments in which we set either medical expenses, nursing home expenses or both to 0. Next, to isolate the contribution of cross-sectional OOP nursing home and medical expense risk we consider experiments in which either OOP nursing home expenses, OOP medical expenses or both are deterministic. Note that cross-sectional OOP expense risk is not the only form of health expense uncertainty that individuals face. Even when OOP expenses are deterministic, individuals still face uncertainty about lifetime health expenses due to survival risk. We refer to this form of risk as longitudinal OOP expense risk. To assess the contribution of longitudinal OOP expense risk, we include a final experiment in which we make individual life spans known and equal to life expectancy in the benchmark economy.<sup>39</sup>

In each experiment we alter the health expense process or survival probabilities faced by retirees, recompute individual decision rules, aggregate individual wealth holdings and compute the percentage change in aggregate private wealth from the benchmark. We interpret this percentage change in wealth as the fraction of private wealth that is accumulated due to either old-age OOP expenses, cross-sectional OOP expense risk, or longitudinal OOP expense risk. Results of all these experiments are presented in Table 8 and Figure 3. The saving patterns by lifetime earnings are obtained by dividing individuals into lifetime earnings quintiles and computing the share of each quintile's wealth allocated to OOP expenses. Savings for OOP expenses and cross-sectional OOP expense risk by permanent type and age are obtained similarly.

## 6.1 Savings for OOP Expenses

To assess the impact of OOP health expenses on private savings, we compute the change in wealth when either nursing home expenses, medical expenses or all health expenses are set to 0 in all ages and states. Note that, when expenses are 0, both the effect of expected expenses and expense risk are shutdown. Recall that the cost of nursing home care in our model consists of both a consumption and non-consumption (medical) component. When we remove nursing home expenses, only the non-consumption cost of nursing home care,  $M^n$ , is eliminated. As a result, individuals receiving nursing home care must still finance their consumption. In each experiment government transfers are still provided to agents that meet the means-test.

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<sup>39</sup>Hubbard et al. (1994) also shut down survival risk in this way.

Table 8: Percentage shares of wealth held due to the presence of health expenses and their risks.

	Nursing	Medical	Nursing Medical
<b>Savings for OOP Expenses</b>			
Aggregate	6.84	6.26	13.54
Low type	4.01	6.48	10.73
High type	7.22	6.23	13.91
<i>By Lifetime Earnings</i>			
Quintile 1	-0.35	-7.18	-9.12
Quintile 2	3.76	10.97	14.32
Quintile 3	9.40	17.86	25.95
Quintile 4	11.44	11.44	23.28
Quintile 5	5.94	3.54	10.24
<b>Savings for Cross-Sectional OOP Expense Risk</b>			
Aggregate	3.03	0.74	3.69
Low type	2.45	1.49	3.79
High type	3.10	0.64	3.68
<b>Savings for Longitudinal OOP Expense Risk</b>			2.09

The numbers are the percentage decline in the benchmark wealth levels when a particular expense or risk is removed. The first column shows the decline in wealth when nursing home expenses or risk are removed. The second column shows the decline when medical expenses or risk are removed and the third column shows the decline when both nursing home and medical expenses or risks are removed. ‘Low (high) type’ refers to agents with the low (high) permanent productivity type.

As Table 8 shows, on aggregate, savings for OOP health expenses account for 13.5 percent of wealth. Although the share of wealth held is sizable on aggregate, it varies dramatically across the permanent earnings distribution. Individuals in quintiles 3 and 4 hold 26 and 23 percent of their wealth for such expenses. Individuals in the top quintile only hold 10 percent. The presence of health expenses actually reduces the savings of the bottom quintile. Overall, the presence of OOP health expenses slightly *reduces* cross-sectional wealth inequality. The Gini coefficient of the wealth distribution increases from 0.830 to 0.843 when health expenses are removed.

Why do individuals respond so differently to the presence of old-age health expenses? Middle-income individuals save more for OOP health expenses than those at the top of the permanent earnings distribution because they face higher expenses relative to their income than this other group. Poorer individuals save less because the presence of risky health

expenses in old age raises the probability that an individual will receive Medicaid transfers. These transfers are reduced one-for-one with each additional unit of wealth an individual holds. In other words, for individuals that meet the means-test, Medicaid imposes a 100 percent tax on their savings. In the presence of old-age health expenses, poorer individuals are more likely to meet the means-test than wealthier ones. Faced with a relatively lower expected rate of return on savings they choose to save less.<sup>40</sup>

What share of savings is generated by OOP nursing home expenses? On aggregate, they account for 6.8 percent of wealth. OOP medical expenses account for a slightly smaller amount: 6.3 percent. Recall that aggregate OOP nursing home expenses are approximately a third of OOP medical expenses. Hence, per unit of expense, aggregate life-cycle savings for nursing home expenses are 3 times as large as for medical expenses. Why do nursing home expenses have such a large impact on savings? As we show in the next section, this result is due to the fact that nursing home expenses are riskier than medical expenses and thus generate larger *precautionary savings*.

Comparing the contributions of nursing home expenses and medical expenses to savings across the permanent earnings distribution reveals that nursing home expenses are more important for the savings of wealthier individuals, whereas medical expenses are more important for the savings of poorer individuals. Nearly two thirds of the top quintile's savings for OOP health expenses are for nursing home expenses. Half of quintile 4's savings are for nursing home expenses. Notice that, in percentage terms, nursing home expenses have the largest impact on this quintile's wealth, accounting for 11.4 percent of it. In contrast, two thirds of quintile 3's savings and three quarters of quintile 2's are for medical expenses.

These savings patterns emerge because long-stays in nursing homes are more likely to be unaffordable to individuals in the second and third quintiles. As a result, these individuals save mostly for medical expenses and rely heavily on Medicaid to pay for nursing home care. Figure 4 shows that, among nursing home residents in the model, the main beneficiaries of Medicaid are individuals of all ages from the bottom 2 quintiles and older individuals from quintiles 3 through 4. Notice that the Medicaid take-up rate is much higher among nursing home residents. This is not surprising given the size of the nursing home shock, its persistence and end-of-life timing. Nursing home residents quickly deplete their assets and qualify for Medicaid sooner than the general population. Furthermore, the probability of entering a nursing home decreases with lifetime earnings. Hence nursing home residents are on average poorer than the rest of the population.

A similar savings pattern can be seen if we compare individuals by permanent produc-

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<sup>40</sup>Hubbard et al. (1995) are the first to demonstrate that means-testing programs can discourage savings by individuals with low lifetime earnings.

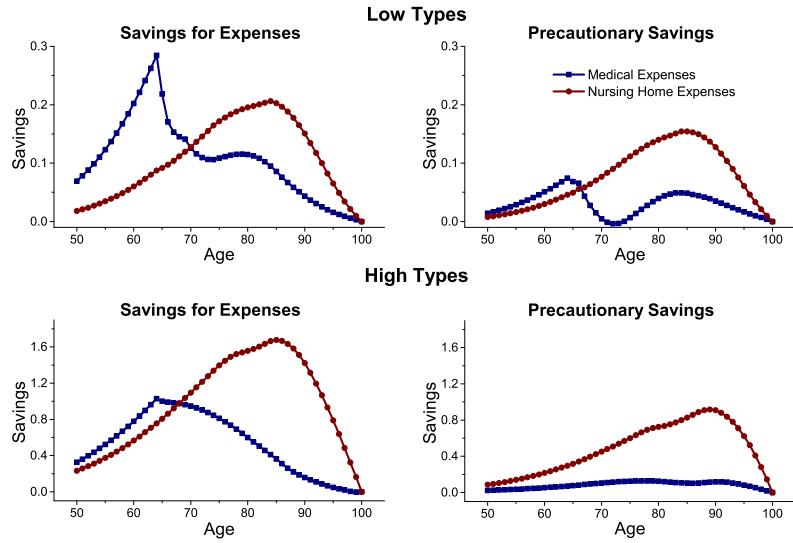


Figure 3: Savings for OOP medical and nursing home expenses (left panels) and cross-sectional OOP medical and nursing home expense risk (right panels) by low permanent types (top) and high permanent types (bottom) in the model. Calculated by subtracting each types wealth profile in the economy without the particular type of expense (risk) from the corresponding profile in the benchmark economy. One unit of savings equals average (annual) earnings.

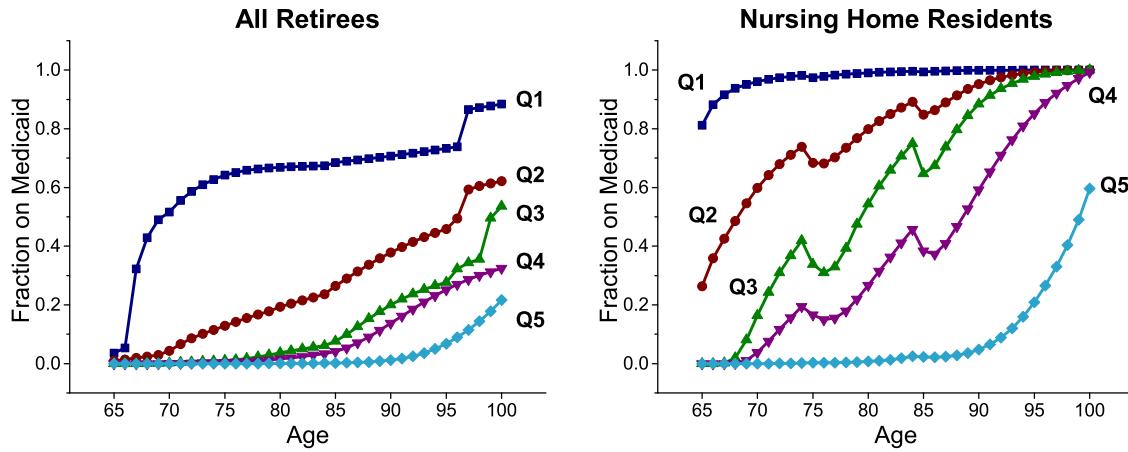


Figure 4: Fraction of retirees receiving Medicaid transfers (left) and fraction of nursing home residents receiving Medicaid transfers (right) in the benchmark economy by age and lifetime earnings quintile.

tivity type. Poorer low types save more for medical expenses while wealthier high types save primarily for nursing home expenses. The left panels of Figure 3 plot age profiles of average savings for nursing home and medical expenses by each type. The figure shows that nursing home expenses have a large effect on wealth accumulation at older ages especially for high types. Savings for medical expenses peak at retirement and decline thereafter. In contrast, savings for nursing home expenses continue to grow until individuals are well into their 80's or early 90's. This pattern occurs because nursing home expenses are more concentrated at very old ages than medical expenses. The combination of the size and persistence of nursing home expenses, and the fact that they tend to occur very late in life, induces individuals to hold large amounts of wealth late into their retirement period. While many low types choose instead to rely on Medicaid in the event of needing nursing home care, ending up on Medicaid is more painful for high types. These individuals are used to a much higher level of consumption than is provided by Medicaid to nursing home residents.

Consistent with these saving patterns, we find that the anticipation of nursing home expenses is the primary reason for slow dissaving at old ages. As savings for consumption decline with age, retirees' portfolios more and more heavily target nursing home expenses. At age 83, retirees are holding a third of their wealth to finance possible nursing home expenses. By age 92, the fraction has risen to two thirds.

Finally, we find that health expenses affect wealth accumulation over the entire life cycle. Savings of workers account for more than a third of aggregate savings for OOP nursing home expenses and over a half of savings for OOP medical expenses. As Figure 3 shows, both high and low types start to accumulate savings for health expenses well before retirement.

## 6.2 Savings due to Cross-sectional OOP Expense Risk

We now assess the contribution of cross-sectional OOP nursing home and medical expense risk to savings for OOP expenses. To this end, we consider experiments in which we shut down either all OOP health expense uncertainty, only nursing home uncertainty or only medical uncertainty. In each experiment, we shut down uncertainty conditional on an individual's age. We also condition on individuals' permanent type so that we only remove insurable cross-sectional risk. Cross-sectional OOP medical expense risk is shut down by replacing each agent's medical expenses with a single deterministic profile equal to mean *OOP* medical expenses by age and permanent type. Similarly, to shut down cross-sectional OOP nursing home expense risk, first, we set the non-consumption component of OOP nursing home expenses to zero for all agents. Then we require each agent, regardless of nursing home status, to pay an amount equal to mean OOP nursing home expenses conditional on

age and permanent type (but unconditional on nursing home status).<sup>41</sup> When removing nursing home risk, survival probabilities are kept at their benchmark levels conditional on the nursing home state.

On aggregate, precautionary savings due to cross-sectional OOP health expense risk account for 3.7 percent of wealth. As Table 8 shows, these savings are almost entirely due to nursing home expense risk which alone accounts for 3.0 percent of aggregate wealth. Savings for cross-sectional nursing home expense risk is substantial. If this savings was held in the form of vehicles it would be large enough to account for the entire stock of transportation equipment in the US.<sup>42</sup> As a fraction of savings for OOP expenses, nearly half of savings for nursing home care is precautionary while only one eighth of savings for medical expenses is precautionary.

The large effect of cross-sectional OOP nursing home expense risk on savings is explained by the fact that the nursing home expense shock is one of the largest shocks in the model economy, the most persistent, and the least insured by the government. To assess the role of the third factor, we now evaluate the importance of the differential consumption floor for the effect of nursing home expense risk on wealth accumulation. In the benchmark economy, the minimum floor guaranteed to nursing home residents is only 73 percent of that guaranteed to the rest of the population. To evaluate this differential's effect, we remove cross-sectional OOP nursing home expense risk from an economy equivalent to the benchmark but with  $\underline{c}^n = \underline{c}^m$ . When the degree of public insurance for nursing home care is equal to that for medical expenses, nursing home expense risk only accounts for 1.5 percent of aggregate wealth. This is half of the wealth accounted for by the nursing home risk in the benchmark economy. From this experiment, we conclude that the differential insurance provided by Medicaid is an important driver of savings for cross-sectional OOP nursing home expense risk.

Table 8 shows that cross-sectional OOP nursing home expense risk accounts for a larger fraction of the savings of high permanent types than low ones. This is not surprising given that low types are better insured against this risk by Medicaid. Notice that high types also save much more for nursing home expense risk than for medical expense risk, consistent with the pattern of savings for expenses by this type discussed in Section 6.1. Interestingly, low

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<sup>41</sup>We shut down *OOP* health expense risk as opposed to *pre-Medicaid* (total) health expense risk for the following reasons. The strategy used in the literature to assess OOP risk effects is to shut down shocks to pre-Medicaid health expenses. See for example De Nardi et al. (2010) and Hubbard et al. (1994). This strategy produces a biased effect on savings because it induces changes in Medicaid transfers and, as a result, levels of OOP health expenses. Note that our strategy removes uncertainty about OOP health expenses induced by earnings risk and Medicaid but does not remove *lifetime* OOP expense risk since agents still face survival uncertainty.

<sup>42</sup>Source: BEA, average value over the period 1996–2005.

types save more for nursing home expense risk than medical expense risk as well. This is opposite to the overall effect that these expenses have on low types' savings documented in Section 6.1. Putting all these patterns together, the findings demonstrate that both nursing home expense risk and expected medical expenses are important drivers of savings in old age. Figure 3 also supports these findings. The right panels of the figure plot age profiles of average precautionary savings for cross-sectional OOP nursing home expense and medical expense risk by each type. Notice that nursing home expense risk accounts for most of the wealth maintained for nursing home expenses especially for high types. In contrast, medical expense risk accounts for only a small fraction of savings for medical expenses.

Finally, Figure 3 highlights the differences between precautionary savings for nursing home expenses and precautionary savings for medical expenses. Notice that, in contrast to savings for medical expense risk, savings for nursing home expense risk rise throughout retirement, peaking at age 86 for low types and age 90 for high types. In fact, after age 85, when nursing home risk is the greatest, the share of wealth held to insure against it exceeds one half. From this we conclude that it is cross-sectional OOP nursing home expense risk in particular that drives individuals to hold significant wealth in the presence of risky OOP health expenses. In other words, nursing home expense risk substantially slows down wealth decumulation at older ages.

### 6.3 Savings due to Longitudinal OOP Expense Risk

Uncertainty about lifetime health expenses is generated not only by uncertainty about health expenses at any particular age but also by uncertainty about survival. The fact that OOP health expenses, nursing home expenses in particular, increase substantially with age suggests that this source of uncertainty, which we refer to as longitudinal OOP health expense risk, may play an important role in saving decisions. To assess the impact of longitudinal OOP health expense risk on savings we consider one final experiment. The experiment consists of shutting down the uncertainty agents face about their survival. Survival uncertainty is shut down by making each agent's life span certain and equal to their life expectancy conditional on their permanent type in the benchmark economy. In this version of the economy all agents know from birth exactly how long they will live.

The results from this final experiment are in the last row of Table 8. Savings due to the presence of longitudinal OOP health expense risk account for 2.1 percent of aggregate wealth. The large effect of survival uncertainty on savings is due to the presence of risky health expenses. If we repeat the experiment in an economy with no health expenses, savings only decrease by half a percent when life spans are made certain. Thus longitudinal OOP

health expense risk is an important driver of savings for OOP health expenses although it has a smaller effect than cross-sectional OOP nursing home expense risk.

## 6.4 Relation to the Literature

Our results are, at least in part, consistent with those of De Nardi et al. (2010) in that we both find that the presence of risky, old-age health expenses has a large impact on saving behavior and that this impact is primarily due to the expectations individuals have about lifetime OOP health expenses as opposed to cross-sectional OOP expense risk. However, while De Nardi et al. find that the impact of cross-sectional OOP expense risk on old-age savings is very small, we find a large impact of this risk. In our model, savings for cross-sectional OOP health expense risk account for 27 percent of savings for OOP health expenses. In their model, shutting down this risk has very little effect on old-age asset profiles.

We see four reasons why we get different results from them. First, as De Nardi et al. acknowledge, OOP medical expense risk may be understated in their analysis because the pre-Medicaid medical expense process they feed into their model is estimated using OOP expenses only.<sup>43</sup> This understatement is especially significant for lower income individuals and large nursing home expenses since both are more likely to be subsidized by Medicaid. In contrast, we calibrate the parameters of our pre-Medicaid process such that moments of the OOP expense distribution generated by our model match corresponding moments from the data. Second, we explicitly model nursing home expenses. De Nardi et al. lump medical and nursing home expenses in the data together and do not model separately nursing home events.<sup>44</sup> As a result, they do not directly capture the greater persistence of nursing home expenses nor their differential treatment by the Medicaid program. We find that these features, put together with the high cost of nursing home stays, makes cross-sectional OOP nursing home risk an important driver of wealth accumulation especially late in life. Third, in their setup, health expenses are a function of health status. When they remove cross-sectional OOP expense risk they do not remove the risk that is due to uncertainty about future health. In our model, this risk is incorporated into the stochastic component of our medical expense process and is removed when cross-sectional risk is shut-down. Fourth, individuals in their model are born at age 70. Thus, unlike us, they do not capture the effect of cross-sectional OOP expense risk on individuals' savings before they retire. Our model predicts that over half of the effect on savings is generated before retirement.

Finally, our findings on the importance of longitudinal OOP expense risk are consistent

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<sup>43</sup>See Section VI of De Nardi et al. (2010).

<sup>44</sup>Note that while we use the term 'health expenses' to refer to both medical and nursing home expenses, De Nardi et al. refer to both non-nursing home and nursing home expenses as medical expenses.

with those in De Nardi et al. (2009). They show that different expectations about life expectancy generate significant differences in wealth holdings by retirees especially at very old ages.<sup>45</sup>

## 7 Extending Social Insurance for Nursing Home Care

Proposals to extend social insurance for long-term care have been put forth by a number of policymakers. The proposals include both increasing Medicaid subsidies and expanding Medicare such that it provides coverage of nursing home expenses and other long-term care costs.<sup>46</sup> What are the welfare implications of extending social insurance to provide additional coverage of nursing home expenses? Without getting into the complicated details of each proposal, we consider two types of policies that capture the essence of many proposed reforms. First, we assess the value of higher means-tested insurance provided to nursing home residents through Medicaid. We then replace means-tested benefits with a universal coverage of nursing home expenses akin to an entitlement program such as Medicare.<sup>47</sup>

All experiments are performed in general equilibrium with an open economy and are revenue neutral. Welfare effects are measured using an equivalent consumption variation — a percentage change in consumption at all ages and states that makes a newborn individual indifferent between being born in the benchmark economy and in an alternative economy. Since the point of these experiments is to assess the value of providing additional insurance against health expenses rather than to analyze a particular policy reform, we omit transitions from our welfare calculations and focus instead on steady-state comparisons. We report two welfare metrics. The first metric, EVC, is the average equivalent consumption variation of newborn agents. The second and our preferred metric, ECV\*, takes into account the change in the equilibrium distribution of bequest. Specifically, it is computed using an alternative economy in which bequest transfers are kept at their benchmark level. It is important to control for changes in bequests because agents in our economy like receiving bequests and,

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<sup>45</sup>Our results cannot be directly compared to those obtained in De Nardi et al. (2009) because the nature of the experiments is different. De Nardi et al. do not consider experiments that impose a certain life span. Instead they consider experiments in which agents face different survival probability profiles.

<sup>46</sup>For examples of a few of these proposals see Burman and Johnson (2007). Also see Burwell et al. (1993), *An Analysis of Long-term Care Reform Proposals*, which is an analysis of long-term care proposals prepared for the US Department of Health and Human Services. And see *A National Long-term Care Program for the United States; A Caring Vision*, a proposal drafted by a 17-member Working Group and endorsed by 415 physicians and other health professionals in 1991.

<sup>47</sup>We model the need for nursing home care as an exogenous shock. Therefore, the utilization of nursing home services will not be affected by changes in the social insurance system. This assumption is consistent with empirical evidence. Grabowski and Gruber (2007) find, using National Long-Term Care Survey data, that the demand for nursing home care is relatively inelastic with respect to changes in state rules for Medicaid coverage of nursing home costs.

in the presence of risky old-age health expenses, accidental bequests are significant. We also report the welfare effects of the policy changes by permanent productivity types for our preferred welfare measure. We denote by  $ECV_{low}^*$  the welfare effect on low types and  $ECV_{high}^*$  the welfare effect on high types. Results are presented in Table 9.

## 7.1 Medicaid Extension

As we demonstrated above, the large impact of cross-sectional OOP nursing home expense risk on savings is, in part, due to the relatively low consumption floor provided to nursing home residents on Medicaid. We now ask how much agents in our benchmark economy would value an increase in this floor. In particular, we assess the welfare implications of raising the floor,  $\underline{c}^n$ , so that it equals the floor provided to Medicaid recipients who are not receiving nursing home care,  $\underline{c}^m$ . This change corresponds to increasing  $\underline{c}^n$  from 12 percent of average earnings to 16.5 percent. The extra transfers are financed in the same way as the rest of the Medicaid transfers: out of general revenue raised through a proportional income tax.

We find that this extended Medicaid insurance increases the number of nursing home residents receiving Medicaid transfers from 64 to 69 percent and reduces nursing home expenses paid OOP from 56 to 52 percent. The associated welfare benefit, adjusted for bequests, is 0.12 percent of lifetime consumption. Surprisingly, the welfare benefits are distributed uniformly across permanent productivity types. Although it is not shown in the table, they are also distributed uniformly across permanent earnings quintiles.

Even though the distribution of welfare gains is uniform, poor and rich individuals benefit from the higher floor for different reasons. For poorer individuals who rely heavily on Medicaid to finance their nursing home care, the higher floor means more government transfers and higher average consumption levels during retirement. Since the higher floor is financed by income taxes, the burden of that higher consumption falls disproportionately on wealthier individuals. However, despite this higher tax burden, wealthier individuals value the additional insurance the higher floor provides. This insurance allows them to reduce the amount of resources they set aside in the anticipation of nursing home costs. Moreover, it increases their ability to smooth consumption during retirement.

## 7.2 Medicare Extension

We now consider an alternative way to extend social insurance for nursing home care — universal coverage of nursing home expenses. We loosely term this alternative the ‘extended Medicare’ program. We assume that this program covers the entire non-consumption component of nursing home expenses. To facilitate discussion, we also consider two additional

Table 9: Welfare effects of Medicaid and Medicare extensions

Extended Policy Expenses Covered	Welfare Metric			
	ECV	ECV*	ECV <sub>low</sub> *	ECV <sub>high</sub> *
<b>Medicaid</b> ( <i>financed by income tax</i> )				
Nursing Home	0.03	0.12	0.12	0.12
<b>Medicare</b> ( <i>financed by payroll tax</i> )				
Nursing Home	-0.48	-0.19	-0.26	-0.04
<b>Medicare</b> ( <i>financed by tax on Social Security income</i> )				
Nursing Home	-0.08	0.14	0.03	0.39
Medical	0.28	0.29	0.35	0.17
Nursing Home & Medical	0.18	0.43	0.33	0.63

Newborn welfare is measured as an equivalent consumption variation. A positive welfare number indicates that the corresponding policy change generates a welfare benefit. The first two columns are measures of the average welfare benefit to a newborn of the policy change. The welfare metric ECV is computed using an alternative economy in which both taxes and bequest transfers adjust. The welfare metric ECV\* is computed using an alternative economy in which bequest transfers are kept at their benchmark level. ECV<sub>low</sub>\* (ECV<sub>high</sub>\*) is the welfare gain of a low (high) permanent productivity newborn using the welfare metric that holds bequests fixed. Under the extended Medicare policy only the non-consumption component of nursing home care is covered.

policy experiments: an extension of Medicare such that it covers all medical expenses of retirees and an extension of Medicare such that it covers all health expenses. In each economy that we consider, consumption transfers are still available to individuals that meet the means test and means-testing still varies by nursing home status.

As it turns out, the tax used to finance the ‘extended Medicare’ program has a crucial impact on the welfare effects. The Medicare system in the US is currently financed by payroll taxes. If the extended Medicare program is also financed by a payroll tax, everyone is made worse off as compared to the benchmark economy. This can be seen by looking at the second row of Table 9. Poorer individuals lose the most as their nursing home expenses are already heavily subsidized by the Medicaid program. However, even the rich experience a tiny welfare loss. We conjecture that the explanation for this result lies in the timing of costs and benefits under the pay-as-you-go structure of the Medicare system. The cost of the program is borne through higher payroll taxes paid when young while the benefits are mostly collected at very old ages when nursing home needs are most likely to arise. Since the benefits of the program are received so much later in life than the costs, they are discounted relatively more by newborn agents. Moreover, the return to this form of public ‘savings,’ given by the population growth rate, is well below the market rate of return.

Burman and Johnson (2007) propose instead to finance universal coverage of nursing home expenses with income taxes. Using income taxes instead of payroll taxes should, to some extent, alleviate the drawbacks discussed above as it distributes the program's costs more evenly over individuals' lifetimes. However, using a proportional income tax instead of higher payroll taxes still results in negative welfare effects albeit slightly higher ones.<sup>48</sup>

Given these findings, we consider an alternative financing arrangement: change the timing of the payroll tax from young ages to old by introducing a proportional tax on Social Security income. As the bottom panel of Table 9 shows, under this financing assumption, our preferred measure of welfare is positive for both permanent types. All agents prefer receiving a part of their retirement benefits in terms of long-term care insurance. Middle and high income agents, located in top three lifetime earnings quintiles, value this form of insurance the most. These primarily high-permanent-type agents gain an equivalent of 0.4 percent of lifetime consumption, an order of magnitude higher than the gains of low permanent types.

How do the welfare gains from universal coverage of nursing home expenses compare to those from universal coverage of medical expenses? In the previous section we found that nursing home expenses, cross-sectional nursing home expense risk in particular, was a relatively larger driver of the savings of wealthier individuals, whereas poorer individuals saved more for lifetime medical expenses. Our welfare results are consistent with these findings. Wealthier (high-type) individuals achieve welfare gains that are more than twice as high under universal coverage of nursing home expenses than under universal coverage of medical expenses. The reverse is true for poorer (low types). These individuals strongly prefer universal coverage of medical expenses under which their welfare gains are an order of magnitude higher than under universal coverage of nursing home expenses.

Averaging across types, we find that the welfare gain to a newborn is higher under universal coverage of medical expenses than under universal coverage of nursing home expenses. This is not surprising given that both high and low types experience significant welfare gains from the universal coverage of medical expenses, whereas the welfare gains for low types from the universal coverage of nursing home expenses are tiny.

Given that newborns like universal coverage of both medical and nursing home expenses, in a final experiment we consider the welfare effects of extending Medicare such that it covers all health expenses. The last row in Table 9 shows that the welfare benefit of Medicare coverage of all health expenses is 0.43 percent. The welfare gain for high types is nearly twice that of low types. This is consistent with our finding above that low types don't benefit much from universal coverage of nursing home care. It is also consistent with the

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<sup>48</sup>Given that overall the results of this policy experiment look very similar to the payroll tax experiment we do not report them in the table.

fact that the reductions in social security income that these extended Medicare programs require are more painful to low types since they rely on social security income more heavily during retirement.

## 8 Conclusions

As US retirees age they become more and more likely to incur large and persistent nursing home expenses. These expenses are poorly insured both in the private market and through public programs such as Medicare and Medicaid. In this paper we develop a full life-cycle, general equilibrium model in which retirees incur both medical expenses and nursing home expenses. We use the model to evaluate the importance of old-age OOP medical and nursing home expenses and cross-sectional OOP medical and nursing home expense risk for savings, and to assess the welfare effects of extending social insurance coverage of nursing home costs. We find that relative to their share of total OOP expenses, OOP nursing home expenses have a disproportionately large effect on aggregate savings. This is largely due to cross-sectional OOP nursing home expense risk which is a significant driver of slow wealth decumulation late in life, especially by wealthier individuals. From our welfare analysis we find that all newborns would be better off if Medicaid for nursing home care was made more generous. Moreover, all newborns like extending Medicare to cover more health expenses but only if these extensions are financed with taxes on social security income. Given the choice between extending Medicare to cover nursing home expenses and extending Medicare to cover medical expenses we find that there is disagreement over the two. High permanent productivity types would prefer universal coverage of nursing home care while low types would prefer universal coverage of medical expenses.

## Appendix

### A.1 Data

As noted in Section 4.5, we use 1995–2008 HRS and AHEAD data to estimate the coefficients in the medical expense process and calculate many of the targeted empirical moments. Our measure of OOP medical expenses includes hospital, physician and clinical services, prescription drugs, dental care, other professional and personal health care, home health care, nondurables and durables. We also include insurance premia but not expenses covered by insurance. OOP nursing home expenditures include expenditures on skilled nursing facilities (facilities for individuals who require daily nursing care and living assistance) but not the

costs of services provided by retirement homes or assisted-living facilities.<sup>49</sup> Expenses are reported as total expenses over a 2 year period. We use average annual expenses over the 2 year period as our measure of annual expenses. Expenditures during the last year of life taken from the HRS and AHEAD exit files are also included.

We consider retired individuals, ages 65 and above, single or married but with retired spouses. Our sample consists of 13,287 individuals, of whom 5,455 are men, 7,832 are women, 6,231 are single, and 7,056 are married. Singles include individuals who are widowed, never married, divorced, and partnered. All our empirical results are robust to dropping divorced and partnered individuals from the sample. In order to compute the lifetime earnings distribution, we define household heads as individuals who are either single, or married and male.

To obtain the medical expense profiles in Figure 1 we regress log medical expenses on a quartic in age, lifetime earnings quintile dummies, and lifetime earnings quintile dummies interacted with age using a fixed-effects regressor. Observations from periods where an individual spent any time in a nursing home are not included. We also run this regression for total (medical and nursing home) expenses. We then estimate cohort effects by regressing the estimated fixed-effects on cohort dummies. All the OOP expense moments targeted our calculated net of the estimated cohort effects.

## A.2 Computation

To compute the benchmark equilibrium, first a guess on the constant ratio of accidental bequests  $\chi(\bar{e})$  to average lifetime earnings  $\bar{e}$  is made. Second, individual maximization problems are solved starting at age  $T$  and working back to age 1. Decision rules are computed using piecewise linear interpolation. The grids for assets and average lifetime earnings consist of 200 and 100 nonlinearly-spaced points, respectively. Third, the distribution of the population over the discrete state is computed using forward iteration. Finally, an updated value of  $\chi(\bar{e})/\bar{e}$  is computed. This procedure is iterated on until the bequest constraint holds. Note that we do not need to also iterate on the cost of nursing home care for private payers  $M^n$ . Instead we can set this and use the nursing home budget constraint to calculate the fraction of nursing home costs paid by the government  $p^G$ . Computation of equilibrium under the various policy experiments is similar expect that guesses on both the bequests to earnings ratio and the tax rates that satisfy the government budget constraint under the

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<sup>49</sup>Retirement home expenses are not included as they are not eligible for Medicaid coverage. The cost of assisted-living services within an assisted-living facility is counted as a medical expense however room and board in such facilities is not. Medicaid does not cover room and board expenses in assisted-living facilities and the criteria for eligibility of assisted-living services differs from that for nursing home care. See Mollica (2009) for details.

policy changes must be made and iterated on until convergence.

### A.3 Probability Transition Matrices

As a result of the calibration, the probability transition matrix for productivity is

$$\Lambda_{zz'} = \begin{bmatrix} 0.5326 & 0.1268 & 0.2722 & 0.0651 & 0.0033 \\ 0.0075 & 0.8641 & 0.1241 & 0.0039 & 0.0005 \\ 0.0083 & 0.1443 & 0.7984 & 0.0482 & 0.0008 \\ 0.0190 & 0.0345 & 0.0045 & 0.8909 & 0.0511 \\ 0.0034 & 0.0047 & 0.0312 & 0.3142 & 0.6465 \end{bmatrix},$$

and the probability transition matrix for medical expenses is

$$\Lambda_{hh'} = \begin{bmatrix} 0.7165 & 0.1894 & 0.0783 & 0.0158 \\ 0.1746 & 0.5130 & 0.2901 & 0.0224 \\ 0.0772 & 0.2784 & 0.6233 & 0.0211 \\ 0.0633 & 0.3851 & 0.4576 & 0.0940 \end{bmatrix}.$$

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