The Impact of Medical and Nursing Home Expenses on Savings and Welfare *

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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 U.S. and using a general equilibrium analysis, we show that (1) nursing home risk is the largest determinant of precautionary savings after earnings risk; (2) surprisingly, old-age health expense risk is welfare improving due to the presence of earnings risk and Medicaid; (3) old-age health expenses, especially nursing home expenses, stimulate capital accumulation; and (4) the impact of health expenses on savings varies across the income distribution.

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1 Introduction

The elderly in the United States face large, volatile out-of-pocket health expenses that increase quickly with age as Medicare only provides limited coverage of some health care costs. In 2000, average annual out-of-pocket (OOP) expenditure for households with heads aged 65 and over was approximately $3,000 with a standard deviation of over $6,000.[1] Furthermore, individuals aged 85 years and over spent more than twice as much on health care as those aged 65 to 74. With high costs and limited insurance options, nursing home expenses are a significant driver of large and highly skewed OOP expenditures. Rates for nursing home care in 2005 were in the range of $60,000 to $75,000 per year, and a significant fraction of the elderly face nursing home costs that persist for years. Of the 36 percent of 65-year-olds who will require nursing home care at some point in their lifetime, nearly one in five will require more than 3 years of care, and nearly one in ten will require more than 5 years.[2]

Private savings and social insurance programs are the two main ways in which the elderly insure against medical and nursing home expense risk and finance medical and nursing home expenses not covered by Medicare. What are the contributions of OOP medical and nursing home expenses and their risk to savings? What are the welfare effects of OOP health expense risk?

To answer these questions we build a general equilibrium, life-cycle model with overlapping generations of individuals. Individuals work till age 65 and then retire. During the working stage of their lives, individuals 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 and nursing home expenses. We allow the insured consumption floor to be specific to the type of health shock (medical or nursing home).

To calibrate the model to the U.S. economy we pin down the stochastic process for medical costs using data from the Health and Retirement Study (HRS). Since in the data we only observe OOP health expenditures and not total expenditures (before Medicaid subsidies), we cannot directly infer the medical cost process. Instead, we calibrate the process such that the

[1]Authors calculation based on data from the 2000 Health and Retirement Study.

[2]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).

model matches a set of both cross-sectional and mobility moments on OOP expenses from the HRS data. In addition, our calibration procedure identifies 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 differential insurance against medical versus nursing home 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.

Our study contributes to a growing literature on the importance of old-age OOP health expenses for savings.[3] In contrast to previous work, our study is the first to assess the roles of both medical and nursing home expenses, together and in isolation. Furthermore, it is the first to use a full life-cycle, general equilibrium framework. Two works closely related to ours are De Nardi et al. (2010) and Ameriks et al. (2011). De Nardi et al. (2010) show that old-age OOP health expenses are an important driver of the saving behavior of the elderly. However, they do not assess the impact of old-age OOP health expenses on aggregate savings or the relative importance of nursing home versus medical expenses. Ameriks et al. (2010), like us, explicitly model long-term care costs. However, they have a different objective: to disentangle the precautionary savings motive from the bequest motive using a strategic survey.

Our analysis also extends a large literature on precautionary savings and the welfare costs of idiosyncratic risk.[4] Most of this research has focused on earnings and survival risk. There are a few studies that look at the importance of health expense risk for savings, such as Hubbard et al. (1994), Palumbo (1999), and De Nardi et al. (2010). However, none of these studies separate medical expense risk from nursing home expense risk and all are conducted using a partial equilibrium analysis. Furthermore, to the best of our knowledge, the welfare effects of neither medical nor nursing home expense risk have been assessed quantitatively.

Our main results are as follows. First, we find that, after earnings risk, nursing home risk is the next most important determinant of precautionary savings, accounting for 2.3 percent of aggregate capital accumulation. This is because 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, especially the rich, who are least insured by the Medicaid program, to hold significant

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

[4] Examples include Aiyagari (1994), Attanasio and Davis (1996), Fehr and Habermann (2008), Heathcote et al. (2007), Huggett (1996), and Storesletten et al. (2004) to name a few.

precautionary savings at very old ages.

Second, we find that, due to the presence of both earnings risk and Medicaid, old-age health expense risk is welfare improving. That is, since Medicaid is means-tested it induces a positive correlation of OOP health expenses with lifetime earnings. Thus OOP health expenses undo some of the variation in individual resources generated by the earnings shocks. On average, this effect is large enough to dominate the negative effect of increased consumption risk during the retirement period.

Third, by comparing capital accumulation in the benchmark economy with capital accumulation in an economy in which the government finances all health expenses, we find that 11 percent of capital is accumulated to pay for and insure against old-age health expenses. Moreover, nursing home expenses, because they are riskier and occur mostly at very old ages, account for nearly half of these savings, despite being only a quarter of total OOP expenses.

Fourth, the effect of nursing home and medical expenses and their risks on savings differs across the lifetime earnings distribution. While nursing home expense risk is more important for the savings of wealthier individuals, poorer individuals, for which private nursing home care is largely unaffordable, save mostly for expected old-age medical expenses.

Unlike previous studies, our analysis is conducted in general equilibrium, which we find to be important for assessing the effects of nursing home expense risk. In particular, our results indicate that bequests play a major role in the effects of nursing home expense risk on savings and welfare because individuals hold on to their wealth into very old ages in the event of high nursing home costs.

The paper proceeds as follows. Section 2 provides motivation for explicitly modeling nursing home expenses and their risk. In Section 3, the benchmark model is presented. Section 4 presents the calibration procedure and features of the benchmark economy. In Section 5, we first consider a series of experiments in which we remove OOP medical and nursing home expense risk from the benchmark economy. We use these experiments to assess the effects of these health expense risks on savings and welfare. We then consider a series of experiments that remove old-age OOP expenses entirely. We use these experiments to assess the importance of old-age OOP expenses for savings. Potential avenues of future research are discussed in Section 6 and, finally, Section 7 concludes.

2 Why Nursing Home Expenses?

Nursing home expenses differ from other medical expenses for the following reasons. First, nursing home costs are one of the largest expenses faced by the elderly. According to the Medicare Current Beneficiary Survey (MCBS), in 2002 nursing home care accounted for 19 percent of personal health expenditures for individuals ages 65 and over. However, since only 4 percent of the elderly resided in nursing homes (Federal Agency Forum of Aging-Related Statistics), the cost per resident was substantially higher — 190 percent of income per capita. Moreover, while the majority of entrants spend less than 1 year in a nursing home (a short-term stay), the risk of staying for more than 1 year (a long-term stay) is significant. For example, Brown and Finkelstein (2008) estimate that approximately 38 percent of entrants will spend more than 1 year, while approximately 9 percent will spend more than 5 years.[5]

Second, compared to other health expenses, nursing home costs are poorly insured. As shown in Table 1, 37 percent of nursing home expenses are paid for OOP compared to only 16 percent of all the elderly's health expenses. While Medicare and private insurance cover 48 and 16 percent of all health expenses, respectively, they only cover 18 and 2 percent of nursing home expenses.[6] Furthermore, although Medicaid covers 37 percent of nursing home costs, there are important differences in the Medicaid qualifications for medical expenses versus nursing home expenses. In particular, non-nursing home recipients of Medicaid are allowed to keep their income and assets. However, nursing home residents on 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. However, Medicaid does not pay for a single room, personal television and cable, phone and service, radios, clothes, personal care services, among 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 public long-term care due to its low quality of life.

In light of this evidence, we explicitly model the need for long-term nursing home care so as to directly capture the risk of large and persistent nursing home costs, as well as to allow for differential treatment of individuals by the social insurance system based on their nursing home status. We capture the differential by allowing the consumption floor guaranteed under impoverishing health expenses to vary by type of expense — medical or nursing home.

[5] These estimates of nursing home utilization rates are consistent with those found by Dick et al. (1994).

[6] Medicare only pays for the first 6 months of nursing home care and partially subsidizes the next 6 months. Thus while Medicare is the primary payer of nursing home costs for residents with short-term stays it covers only a small fraction of long-term stayers' total costs. It is argued that the small size of the long-term care insurance market is in part due to supply-side problems and in part due to the structure of the public insurance system. See Brown and Finkelstein (2008) and the references therein for details.

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

Source of Payment	*Fraction of Total, %*	
	Nursing Home	All
Private	43	34
Out-of-pocket	37	16
Private insurance	2	16
Other private	4	2
Public	57	66
Medicare	18	48
Medicaid	37	14
Other public	2	4

Source: Federal Interagency Forum on Aging-Related Statistics.

3 The Model

3.1 Economic Environment

Time is discrete. The economy is populated by overlapping generations of individuals. An individual lives to a maximum of J periods, works during the first R periods of his life, and retires at age $R+1$. While working, an individual faces uncertainty about his earnings, and starting from the retirement age, he faces uncertainty about his survival, medical expenses, and nursing home needs. The government runs a social insurance program that guarantees a minimum consumption level. This consumption level differs by the type of destitution: due to low earnings of workers, or due to impoverishing medical or nursing home expenses of the retired. In addition, the government runs a pay-as-you-go social security program. Markets are competitive.

Individual earnings evolve over the life-cycle according to a function $\Omega(j,d,z)$ that maps individual age j, permanent type d and current earnings shock z into efficiency units of labor, supplied to the labor market at wage rate w. 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 Γ_d and Γ_z.

Similarly, medical expenditures evolve stochastically according to a function $M(j,h)$ that maps individual age j and current expenditure shock h into out-of-pockets costs of health care. The medical expenditure shock h follows an age-invariant Markov process with transition probabilities $\Lambda_{hh'}$. The initial distribution of medical expenditure shocks is given by Γ_h and it is independent of the individual state.

The need for nursing home care in the next period of life, at age $j+1$, arises with probability $\theta(j+1, \bar{e})$ at each age $j \geq R$. The probability of entering a nursing home next period is increasing in age and decreasing in average lifetime earnings. For simplicity, we assume that the nursing home is an absorbing state. The nursing home shock is both an expense shock and a bad health shock that reduces the agent's survival probability. While in a nursing home, agents must pay M^n, which covers their medical and nursing care costs but not the cost of their room and board (consumption).

There are no insurance markets to hedge either earnings, medical expenditure, nursing home, or mortality risks.[7] Self-insurance is achieved with precautionary savings (labor supply is exogenous). Individuals cannot borrow. The unintended bequests of each permanent type d are redistributed lump-sum to newborns of permanent type d.[8]

3.2 Demographics

Agents face survival probabilities that are conditional on both age and nursing home status. The probability that an age-$(j-1)$ individual survives to age j is s_j if he is not residing in a nursing home, and $s_j^n < s_j$ if he is in a nursing home. Since a working-age agent faces neither mortality nor nursing home risk, his survival probability is $s_j = 1$, $j = 1, 2, ..., R$. Let $\bar{\theta}_j$ denote the unconditional (independent of average lifetime earnings) probability of entering a nursing home at age j. Let λ_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 just the unconditional probability of entering a nursing home, so $\lambda_{R+1} = \bar{\theta}_{R+1}$. Finally, for a retired cohort of age $R+1 < j \leq J$, the fraction λ_j evolves according to

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

where the denominator, $\bar{s}_j = s_j(1 - \lambda_{j-1}) + s_j^n \lambda_{j-1}$, is the average survival rate from age $j-1$ to j and the numerator is a weighted sum of the survival rate of new entrants and the

[7] We also considered a version of the model in which agents could choose to buy a long-term care insurance (LTCI) contract to partially insure against nursing home expense risk. However, we found that the inclusion of LTCI into the model had very small effects on the results. Thus for simplicity, we decided not to use this version of the model as our benchmark. The reason that LTCI did not have a big effect is that we calibrated the model to match the take-up rates of LTCI in the data and these are fairly small. This version of the model, the calibration details and the results are available in the online appendix.

[8] We distribute bequests to newborns only to minimize their impact on the behavior of retirees whose Medicaid eligibility would be affected by such lump-sum transfers. By redistributing bequests conditional on permanent type we minimize the extent to which resources are unrealistically redistributed from wealthier agents to poorer ones.

survival rate of current residents.

Population grows at a constant rate n. Thus, if η_j is the size of cohort j then

$$\eta_j = \frac{\eta_{j-1}\bar{s}_j}{1+n}, \text{ for } j = 2, 3, ..., J.$$

3.3 Workers' Savings

The state of a working individual consists of his age j, assets a, average lifetime earnings to date $\bar{e}$, permanent type d, and current productivity shock z. The individual's taxable income y consists of his interest income ra and labor earnings e net of the payroll tax $\tau_e(e)$. The individual allocates his assets, taxable income less income taxes $\tau_y(y)$, transfers from the government $T(j, y, a)$, and, if $j = 1$, lump-sum transfers of bequests $\chi(d)$ between consumption c and savings a' by solving

$$V(j, a, \bar{e}, d, z) = \max_{c, a' \geq 0} \Big\{ U(c) + \beta E_z \big[V(j+1, a', \bar{e}', d, z') \big] \Big\} \tag{1}$$

subject to

$$c + a' = a + y - \tau_y(y) + T(y, a) + \mathbf{I}[j = 1]\chi(d), \tag{2}$$

$$y = e - \tau_e(e) + ra, \tag{3}$$

$$e = w\Omega(j, d, z), \tag{4}$$

$$\bar{e}' = (e + j\bar{e})/(j+1), \tag{5}$$

$$T(j, y, a) = \max \Big\{ 0, \underline{c}^w - \big[a + y - \tau_y(y) + \mathbf{I}[j = 1]\chi(d) \big] \Big\}. \tag{6}$$

where $\underline{c}^w$ is a minimum consumption level guaranteed to workers and $\mathbf{I}[j = 1]$ is an indicator function that takes the value 1 when $j = 1$ and 0 otherwise.

3.4 Old-age Health Care

Retired individuals face uncertainty about their medical and nursing home needs. The nursing home state is entered once and for all, but every period individuals can choose between private and public nursing home care.[9] An individual's nursing home status is denoted by the variable l, which takes a value of either 0, indicating that the individual is

[9]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 and Murtaugh et al. (1997) find that the majority of nursing home users die within one year of discharge.

currently not in a nursing home, 1, indicating that he is currently in a nursing home under private care, or 2, indicating that he is currently in a nursing home under public care.

3.4.1 Medical care

Conditional on surviving to the next period, a working individual of age R with state $(a, \bar{e}, d, z)$ will enter a nursing home upon retirement with probability $\bar{\theta}_{R+1}$. His future state contains a health shock, h', that determines his medical care costs. The problem of this individual is

$$\begin{aligned} V(R, a, \bar{e}, d, z) = \max_{c,a' \geq 0} \Big\{ & U(c) + \beta s_{R+1}(1 - \bar{\theta}_{R+1}) E\big[V(R+1, a', \bar{e}, h', 0)\big] + \\ & \beta s_{R+1} \bar{\theta}_{R+1} \max\big[V(R+1, a', \bar{e}, 1), V(R+1, a', \bar{e}, 2)\big] \Big\} \end{aligned} \tag{7}$$

subject to the constraints above.

Resources of a retired individual of age $j > R$ come from the return on his savings $(1+r)a$, his social security benefit $S(\bar{e})$, and government transfers $T(j, y, a, h)$. After paying health care costs $M(j, h)$ and income taxes, the individual allocates his remaining resources between consumption and savings. Conditional on survival, the agent will enter a nursing home next period with probability $\theta(j+1, \bar{e})$. We assume that the health shock does not directly affect agents' utility. An age-j individual with assets a, average lifetime earnings $\bar{e}$, health shock h, and who is not in a nursing home solves

$$\begin{aligned} V(j, a, \bar{e}, h, 0) = \max_{c,a' \geq 0} \Big\{ & U(c) + \beta s_{j+1}\big(1 - \theta(j+1, \bar{e})\big) E_h\big[V(j+1, a', \bar{e}, h', 0)\big] + \\ & \beta s^n_{j+1} \theta(j+1, \bar{e}) \max\big[V(j+1, a', \bar{e}, 1), V(j+1, a', \bar{e}, 2)\big] \Big\} \end{aligned} \tag{8}$$

subject to

$$c + M(j, h) + a' = a + y - \tau_y\left(\tilde{y}\right) + T(j, y, a, h), \tag{9}$$

$$y = S(\bar{e}) + ra, \tag{10}$$

$$\tilde{y} = \max\big\{0, ra - \max[0, M(j, h) - \kappa ra]\big\}, \tag{11}$$

$$T(j, y, a, h) = \max\big\{0, \underline{c}^m + M(j, h) - [a + y - \tau_y(\tilde{y})]\big\}, \tag{12}$$

where $\underline{c}^m$ is the minimum consumption level guaranteed under impoverishing medical expenses. Agents receive a medical expense income tax deduction. In other words, individuals pay taxes on their interest income minus the fraction of their medical expenses that exceed

κ percentage of their taxable income.

3.4.2 Nursing home care

Once nursing home needs arise, an individual has to choose between private and public nursing home care. We assume that private care differs from public care in the consumption value it provides but not in the quality of the medical care received. Specifically we assume that public nursing home residents receive a uniform level of consumption, denoted by $\underline{c}^n$. Private nursing home residents, on the other hand, can choose the consumption value of their nursing home care. By letting $\underline{c}^n$ differ from $\underline{c}^m$, we allow for differential insurance to be provided for medical versus nursing home expenses.

To qualify for public nursing home care, an individual must meet the following eligibility criteria: his income net of taxes plus the value of assets have to fall below the minimum consumption level $\underline{c}^n$. Note that it is always optimal for an agent who is eligible for public care to take it. In addition, since agents' income streams during retirement are deterministic and constant, an agent receiving public care would never choose to switch to private care in the future. Thus, for simplicity, we assume that when an individual enters public care he surrenders all of his assets as well as current and future pension income to the government and has no further decisions to make. To reflect the fact that Medicaid subsidies are provided under government-set prices for nursing home care, which are lower than those faced by private nursing home residents, we assume that the price that the government pays per resident for nursing home care relative to the per resident private cost is $P^g < 1$. The nursing home's budget is balanced by requiring each private resident to pay an extra cost f to cover the difference between the Medicaid and private prices.

An individual receiving private nursing home care chooses his current consumption level and savings, and whether to switch to public nursing care next period by solving

$$V(j,a,\bar{e},1) = \max_{c,a'\geq 0} \left\{ u(c) + \beta s^n_{j+1} \max \left[V(j+1,a',\bar{e},1), V(j+1,a',\bar{e},2) \right] \right\} \tag{13}$$

subject to

$$c + M^n + f + a' = a + y - \tau_y \Big(\max \left\{ 0, ra - \max[0, M^n + f + \underline{c}^n - \kappa ra] \right\} \Big), \tag{14}$$

$$y = S(\bar{e}) + ra, \tag{15}$$

where the value of entering a public nursing home is

$$V(j+1, a', \bar{e}, 2) = \sum_{i=j}^{J} \left[\beta^{i-j} \prod_{k=j}^{i-1} s_{k+1}^{n} u(\underline{c}^{n}) \right] \equiv \bar{V}_{j+1}^{n}.$$

The parameter M^n denotes the cost of the non-consumption component of the nursing home care.[10] Note that there are no government transfers to individuals receiving private nursing home care. However, such individuals are still eligible for a medical expense tax deduction.

3.5 Nursing Home

There is a representative nursing home in the economy that houses both public and private residents, earns zero profits and takes the price P^g that the government pays per public resident as given. Hence it receives $P^g(M^n + \underline{c}^n)$ in revenue per publicly-financed resident. It sets the extra fee charged to private-payers f to balance its budget.

3.6 Goods Production

Firms produce goods by combining capital K and labor L according to a constant-returns-to-scale production technology: $F(K, L)$. Capital depreciates at rate δ and can be accumulated through investments of goods: $I = K' - (1-\delta)K$. Firms maximize profits by renting capital and labor from households. Perfectly competitive markets ensure that factors of production are paid their marginal products. Goods can be consumed by individuals, used in health care, and invested in physical capital.

3.7 Definition of Equilibrium

We consider a stationary competitive equilibrium in this economy. For the purposes of defining an equilibrium in a compact way, we suppress the individual state into a vector (j, x), where

$$x = \begin{cases} x_W \equiv (a, \bar{e}, d, z), & \text{if } 1 \leq j \leq R, \\ x_R \equiv (a, \bar{e}, h, l), & \text{if } R < j \leq J. \end{cases}$$

Accordingly, we redefine value functions, decision rules, taxable income and transfers to be functions of the individual state (j, x). Let the state spaces be given by $X_W \subset [0, \infty) \times [0, \infty) \times (-\infty, \infty) \times (-\infty, \infty)$ and $X_R \subset [0, \infty) \times [0, \infty) \times (-\infty, \infty) \times \{0, 1, 2\}$, and denote by $\Xi(X)$ the Borel σ-algebra on $X \in \{X_W, X_R\}$. Let $\Psi_j(X)$ be a probability measure of

[10] Nursing homes expenses consist of both room and board costs and the cost of medical and nursing care. The latter, termed the non-consumption component, is captured by M^n.

individuals with state $x \in X$ in cohort j. Note that these agents constitute $\eta_j \Psi_j(X)$ fraction of the total population.

DEFINITION. Given a fiscal policy $\{S(\bar{e}), G, P^g, \underline{c}^w, \underline{c}^m, \underline{c}^n, \kappa\}$, a steady-state equilibrium is $\{c(j,x), a'(j,x), l(j,x_R), V(j,x)\}$, $\{\Psi_j\}_{j=1}^J$, $\{w, r, K, L\}$ and $\{\tau_s(e), \tau_y(y), f, \chi(d)\}$ such that

1. Given prices, taxes and transfers, the decision rules $c(j,x)$, $a'(j,x)$ and $l(j,x_R)$ solve the dynamic programming problems of the households.

2. Prices are competitive: $w = F_L(K,L)$ and $r = F_K(K,L) - \delta$.

3. Markets clear:

   (a) Goods: $\sum_j \eta_j \int_X c(j,x) d\Psi_j + (1+n)K + \tilde{M} + G = F(K,L) + (1-\delta)K$, where $\tilde{M} = \sum_{j=R}^J \eta_j \int_{X_R} \{M(j,h)\mathbf{I}[l(j,x)=0] d\Psi_j + M^n \mathbf{I}[l(j,x)>0]\} d\Psi_j$.

   (b) Capital: $\sum_j \eta_j \int_X a'(j,x) d\Psi_j = (1+n)K$.

   (c) Labor: $\sum_j \eta_j \int_X \Omega(j,d,z) d\Psi_j = L$.

4. Distributions of agents are consistent with individual behavior:

$$\Psi_{j+1}(X_0) = \int_{X_0} \left\{ \int_X Q_j(x,x') \mathbf{I}\left[j' = j+1\right] d\Psi_j \right\} dx',$$

   for all $X_0 \in \Xi$, where $Q_j(x,x')$ is the probability of an age-j agent going from current state x to future state x' and is given in the online appendix.

5. The government's budget is balanced: $IT + ST = MT + PP + G$, where income taxes are

$$IT = \sum_{j=1}^J \eta_j \int_X \tau_y(y(j,x)) d\Psi_j + \frac{1}{1+n} \sum_{j=R+1}^J \eta_{j-1} \int_X \{\mathbf{I}[l(j-1,x)=0](1-s_j) + \mathbf{I}[l(j-1,x)>0](1-s_j^n)\} \tau_y(ra'(j-1,x)) d\Psi_{j-1},$$

   social security taxes are $ST = \sum_{j=1}^R \eta_j \int_{X_W} \tau_e(e) d\Psi_j$, total means-tested transfer payments are

$$MT = \sum_{j=1}^J \eta_j \int_X T(j,x) d\Psi_j + \sum_{j=R+1}^J \eta_j \left[P^g(M^n + \underline{c}^n) - S(\bar{e})\right] \int_{X_R} \mathbf{I}[l(j,x)=2] d\Psi_j - \frac{1+r}{1+n} \sum_{j=R+2}^J \eta_{j-1} \int_{X_R \times X_R} \mathbf{I}[l(j-1,x)<2, l(j,x')=2] a'(j-1,x) Q(x,x') d\Psi_{j-1} d\Psi_j,$$

and pension payments are $PP = \sum_{j=R+1}^{J} \eta_j \int_{X_R} S(\bar{e}) d\Psi_j$.

6. For each permanent type $\tilde{d}$, accidental bequests are redistributed lump-sum to newborns: $B(\tilde{d}) = \eta_1 \chi(\tilde{d}) \Gamma_d(\tilde{d})$ where bequests are

$$B(\tilde{d}) = \frac{1}{1+n} \sum_{j=R+1}^{J} \eta_{j-1} \int_{d=\tilde{d}} \{\mathbf{I}[l(j-1,x)=0](1-s_j)$$
$$+\mathbf{I}[l(j-1,x)>0](1-s_j^n)\} \left[(1+r)a'(j-1,x) - \tau_y(ra'(j-1,x))\right] d\Psi_{j-1}.$$

7. Nursing home budget is balanced:

$$(1-P^g)(M^n + \underline{c}^n) \sum_{j=R+1}^{J} \eta_j \int_{X_R} \mathbf{I}[l(j,x)=2] d\Psi_j = f \sum_{j=R+1}^{J} \eta_j \int_{X_R} \mathbf{I}[l(j,x)=1] d\Psi_j.$$

4 Calibration

4.1 Parameters and Targets

The model is calibrated to match a set of aggregate and distributional moments for the U.S. economy, including demographics, earnings, medical and nursing home expenses, as well as features of the U.S. social welfare, Medicaid, social security and income tax systems. Most of the data statistics used are averages over or around 1994–2008. More fundamental model parameters rely on long-run data averages. Some parameters are set using direct estimates from the data. Others are determined in a calibration procedure that minimizes the difference between the targets from the data and model-predicted values. For expositional purposes, we divide the parameters into groups to discuss empirical targets and calibration results. The algorithm used to compute the equilibrium is discussed in the online appendix.

Many of the moments targeted are calculated using 1996–2008 HRS data. The data includes the 1995 and subsequent AHEAD waves. 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. The measures of OOP health expenses include insurance premia and expenses in the last year of life. We use the average of social security, defined-benefit pension, and annuity income in retirement during all observable periods as a proxy for lifetime earnings. More details about the data are available in the online appendix.

4.1.1 Age structure

In the model, agents are born at age 21 and can live to a maximum age of 100. The model period is one year, hence 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 U.S. Census Bureau, this ratio was 0.18 in 2000. 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.

4.1.2 Preferences

The momentary utility function is assumed to be of the constant-relative-risk-aversion form

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

so that $1/\gamma$ is the intertemporal elasticity of substitution. Based on estimates in the literature, we set γ to 2. The subjective discount factor, β, is determined in the calibration procedure such that the rate of return on capital in the model is consistent with an annual rate of return of 4 percent. The resulting value of β is 0.95.

4.1.3 Technology

Consumption goods are produced according to a production function,

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

where capital depreciates at rate δ. The parameters α and δ are set using their direct counterparts in the U.S. data: a capital income share of 0.3 and an annual depreciation rate of 7 percent (Gomme and Rupert, 2007). The parameter A is set to 0.95 so that the wage per an efficiency unit of labor is 1.

4.1.4 Productivity Process

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

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

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

	Quintiles				*Top Percentiles*			*Gini*
	Q2	Q3	Q4	Q5	10	5	1	
Earnings of the Young (30 and under)[a]								
	fraction young, %							
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
Earnings Distribution[b]								
	share of total, %							
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
Lifetime earnings Distribution[c]								
	share of total, %							
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.

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

The coefficients for the age profile are set to estimates from Heathcote, Storesletten, and Violante (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 Panel Study of Income Dynamics (PSID) data for 25–59 year old, non-self-employed, married males whose work hours and wages exceed some minimum values.

To identify the remaining 30 independent parameters (average earnings are normalized to 1), we choose 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 for the following reasons. First, the cross-sectional moments are obtained using Survey of Consumer Finance (SCF) data which represents earnings inequality in the U.S. better than the PSID.[11] Second, using mobility

[11]For more details on the data sets see Heathcote, Perri, Violante (2010) and Rodriguez et al. (2002).

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

	5-year transition probabilities, %				
Stayers	Q1 to Q1	Q2 to Q2	Q3 to Q3	Q4 to Q4	Q5 to Q5
Data	58	44	43	46	65
Model	57	46	42	45	62
Extreme Movers	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 Qi who are in earnings quintile Qj 5 years later. Data source: Rodriguez et al. (2002), Table 16. Data: 1989 and 1994 waves of the PSID, households with positive earnings.

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.

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 in the model. The moments characterizing the lifetime earnings distribution are calculated using our HRS sample. However, 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 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 following moments: the distribution of earnings for all ages (the Gini and percentile shares of earnings — the Lorenz curve), the distribution of lifetime earnings (the Gini and Lorenz curve), and mobility across the earnings quintiles. Targeted mobility moments consist of both the high probabilities (above 40 percent) of staying in the same quintile over a 5-year period as well as the low probabilities (6 percent or less) of moving from bottom quintiles to top quintiles and vice versa. As a result of the calibration the ratio of α_H to α_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 online appendix.

4.1.5 Survival Probabilities

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

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

Allowing for the differential in survival rates allows us to match nursing home utilization rates by age and aggregate nursing home costs.[12] The value of ϕ^n targets the average time from first nursing home admission to death which Dick et al. (1994) estimate to be 33 months. The survival probabilities s_j for $j = R+1, \ldots, J$, are set such that the unconditional age-specific survival probabilities are consistent with those observed in the data.[13] The calibration results in a value for ϕ^n of 0.72.

4.1.6 Government

Social Security and Taxes The social security benefit function in the model captures the progressivity of the U.S. 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, respectively. The threshold levels, τ_1, τ_2, and τ_3, are set respectively to 20 percent, 125 percent and 246 percent of average earnings.

The payroll tax is

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

[12]It is also consistent with the evidence that nursing home residents have higher mortality relative to the rest of the population, although there are no reliable estimates as to the magnitude of this differential.

[13] 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. 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, for the sake of simplicity, we model nursing homes as an absorbent state. The cost of this assumption is that 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. Our results are robust to the assumption of nursing home being an absorbent state because even though nursing home exit after a long-term stay does occur, the probability of imminent nursing home re-entry or death is very high (Dick et al., 1994).

where the tax rate $\hat{\tau}_e$ is set to 15.3 percent — a 12.4 percent social security tax and a 2.9 percent Medicare tax. The parameter $e_{\max}$ is set to match the maximum taxable earnings level in 2000 of $76,200. 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:

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

where $\tau_0 = 0.258$ and $\tau_1 = 0.768$. The parameter τ_2 is normalized so that, in equilibrium, the marginal tax rate, evaluated at the average individual income, is the same in the model and the data. Following U.S. tax policy, taxable income excludes health expenses exceeding 7.5 percent of income, i.e. κ is set to 0.075. Finally, government spending, G is set such that, the government budget constraint holds in equilibrium.

Welfare Program The welfare program in the model economy represents a variety of public assistance programs in the U.S., 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.[14] Estimates of the government-guaranteed consumption level for a household consisting of 1 adult and 2 children range over the period 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.[15] Thus we set $\underline{c}^w$ and $\underline{c}^m$ to 15 percent of average earnings. Note that since we do not require $\underline{c}^n = \underline{c}^m$, the amount of social insurance a retiree receives depends on his nursing home status.

4.1.7 Health Expenses

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

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

[14] All dollar amounts are 2000 dollars.

[15] However, this statement should be taken with caution. 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 then found above. By estimating their model, DeNardi et al. (2006), 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.

where $h \in \{h_1, ..., h_4\}$ follows a finite state Markov chain with probability transition matrix $\Lambda_{hh'}$ and initial distribution Γ_h. The medical expense process is calibrated by targeting both moments constructed from our HRS sample and aggregate moments taken from the U.S. 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.

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.[16] 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. Consistent with our assumption, 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 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 — the share of OOP health expenditures in GDP — to pin down the level parameter in the health expense profile specification, $\beta_{m,0}$.

Eighteen parameters remain: 3 grid points, 3 elements of the initial distribution Γ_h, and 12 probabilities in $\Omega_{hh'}$. The grid points and initial distribution are chosen by targeting 8 moments characterizing the OOP 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 online appendix, are calibrated to match the percent of stayers in each OOP expense quintile over a two-year period (5 moments) and quintile and top percentile shares for the overall distribution of OOP expenses (8 moments). To make sure the model economy is consistent with aggregate health expenditures in the data, we also target Medicaid expenses as a share of GDP.

The targeted empirical moments and model counterparts are listed in Tables 4 and 5.

[16] As pointed out by De Nardi et al. (2010), the fixed effects estimator overcomes the problem with the variation in the sample composition due to differential mortality as well as accounts for cohort effects.

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	
OOP Expense Distribution of 65-69 Year-Olds[a]									
				shares of expenses, %					
Data		4.1	11.0	21.5	62.9	45.1	32.3	15.7	.62
Model		3.7	8.5	26.0	61.4	46.9	39.5	17.1	.62
OOP Expense Distribution of All Retirees[b]									
				shares of expenses, %					
Data		3.7	9.0	16.8	70.0	56.1	45.2	24.3	.69
Model		2.7	6.6	20.2	70.0	55.2	45.8	16.8	.70
Mobility over OOP Medical Expense Distribution[c]									
		2-year stayers, %							
Data	59	36	33	37	52				
Model	50	39	34	45	47				

a and *b*. The share of total (nursing home and medical) OOP 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 distribution of OOP health expenses across the elderly is highly unequal, with a Gini coefficient of 0.69. In addition, the expenses are highly concentrated at the top of the distribution, with the top 10 percent of the elderly accounting for more than half and the top 1 percent for more than a fifth of total OOP expenses. Even though the model is able to match the medical expense moments remarkably well, 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 16.8 percent in the model.

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. Specifically, $\underline{c}^n$ is chosen by targeting Medicaid's share of the elderly's (individuals 65 and over) nursing home expenses net of Medicare. According to the MCBS, over the period 2000–2003, this share was, on average, approximately 45 percent. The medical cost of nursing home care, M^n, is then chosen by targeting the share of total nursing home expenses net of Medicare in GDP.

Since Medicare pays most of the nursing home costs of individuals with short-term (less than 1 year) stays, this share captures well the total expenditure on long-term residents. According to statistics drawn from the 2000–2003 MCBS, the expenditure on nursing home care net of Medicare payments was 0.68 percent of GDP.[17]

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 less educated than the rest of the population. To allow 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:

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

Then, to correctly identify the 2 parameters, $\underline{c}^n$ and M^n, we choose the nursing home entry probability parameters $\beta_{n,1}^j$ and $\beta_{n,2}^j$ for $j = R, \ldots, J$ 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 $j = R, \ldots, J$ 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 as result of the calibration we set $\beta_{n,2}^{65-74} = 0.71$, $\beta_{n,2}^{75-84} = 0.30$ and $\beta_{n,2}^{85+} = 7.2 \times 10^{-4}$. The unconditional nursing home entry probabilities are 0.43, 1.7, ad 6.8 percent for each age group, respectively.

The extra fee f charged to private nursing home residents 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 Medi-

[17]For the same reasons as in footnote 13 we can not 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.

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[a]		
65–74	2.1	2.2
75–84	7.1	7.1
85+	20.8	21.7

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

caid per diem rate was \$91 while the private per diem rate for the same services and amenities was \$102. Thus f is pinned down by requiring that

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

The government price of nursing home services, P^g, is determined in equilibrium by the nursing home's budget constraint.

The calibration procedure results in values for $\underline{c}^n$, M^n, and f of 10, 90, and 6 percent of average earnings, respectively, and a value for P^g of 0.97. Note that M^n is the cost of the non-consumption component of an individual's nursing home care only. The total cost for a private payer includes, in addition to M^n, the extra fee f and his consumption c, while the total cost for a public resident is $P^g(M^n + \underline{c}^n)$. Calculating the average total expenditure on nursing homes of private payers in the model and converting to year 2000 dollars yields \$68,238, while the same calculation for public residents yields \$38,797. 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

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	0.62	0.61	8	7	0.16	0.17	32	26
75–84	0.52	0.55	25	25	0.21	0.22	49	47
85+	0.36	0.34	54	57	0.23	0.23	67	71

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

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.

4.2 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.

4.2.1 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 expenditures 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 and slightly overestimates this fraction for individuals ages 85 and above.

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

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

	Quintiles					*Top Percentiles*			*Gini*
	Q1	Q2	Q3	Q4	Q5	10	5	1	
	share of total, %								
Data	-0.3	1.3	5.0	12.2	81.7	69.1	57.8	34.7	.80
Model	0.0	0.4	3.3	11.3	84.9	68.6	50.3	17.7	.81

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

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 and nursing home's share of Medicaid expenses for older residents may be due to our rudimentary modeling of Medicaid. First, in the U.S. 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 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.

4.2.2 Wealth Distribution

The model is able to replicate well the degree of wealth inequality observed in the data. Table 7 reveals that cross-sectional wealth inequality in the benchmark economy has a remarkable fit of the U.S. wealth distribution. In particular, the wealth Gini in the model economy is 0.81 and the share of wealth held by the top 1 percent of the population is 17.7 percent. The high degree of wealth inequality is due to the presence of earnings risk and Medicaid. When we remove earnings risk from the benchmark the wealth Gini falls to 0.67 and 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.

5 Quantitative Analysis

How important are old-age, OOP medical and nursing home expenses for savings and what are the welfare cost of these OOP health expense risks? We address these questions as follows. First we shut down different sources of uncertainty in the benchmark model and quantify the importance of old-age OOP medical and nursing home expense risk for precautionary savings and welfare. Then we remove agents' OOP expenses entirely, making the government pay for these expenses instead, and assess the importance of old-age health expenses for savings. Removing first OOP expense risk, then OOP expenses entirely, we are able to assess the role that medical and nursing home expense risk play in savings for old-age health expenses.

5.1 Effects of Health Expense Risk

To assess the effects of medical and nursing home expense risk on precautionary savings and welfare we consider a series of economies in which we shut down one or more sources of uncertainty at a time. For each alternative economy, we compute a new equilibrium and then compare capital and welfare to their benchmark values. To put our results in perspective, we also compute the effects of earnings and survival risk. When shutting down earnings (health expenses) risk we only remove the *insurable* part of the risk by replacing each agent's lifecycle earnings (health expense) profile with the average profile conditional on their permanent type.

Medical and nursing home expense risk are removed as follows. Medical expense risk is shut down by replacing each agent's *OOP* medical expenses with a single deterministic profile equal to mean OOP medical expenses by age and permanent type. Similarly, to shut down 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 the mean of OOP nursing home expenses conditional on age and permanent type (but unconditional on nursing home status). Furthermore, in the economy without medical expense risk we remove means-tested transfers to retirees and in the economy without nursing home expense risk we remove means-tested transfers to nursing home residents. In both of these alternative economies the government still finances the same fraction of aggregate health expenses, but all subsidies take place at the aggregate level rather than through means-tested Medicaid.[18]

To eliminate survival risk we introduce actuarially-fair, one-period, annuities into the economy. Just like his survival probability, the rate of return that an agent receives on an annuity purchased at age j depends on his age-j nursing home status. Since retired agents

[18]We shut down *OOP* health expense risk as opposed to *pre-Medicaid* (total) health expense risk for the following reasons. Assessment of OOP risk effects using the strategy adopted in the literature — by shutting down shocks to pre-Medicaid health expenses, as in De Nardi et al. (2010) and Hubbard et al. (1994) — produces a biased welfare cost due to induced changes in the levels of Medicaid transfers, and hence 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 face survival uncertainty.

have no bequest motive, they hold all their wealth in annuities.

To illustrate the importance of Medicaid for our results, we also consider a version of the economy without Medicaid. In this economy the minimum consumption levels guaranteed to retired individuals both in and out of the nursing home are set to very low levels. We shut down health expense risk in this economy in the same way as in the benchmark. However, the extent of OOP risk and thus the amount of risk removed is not the same.

In all economies considered below, survival probabilities are kept at their benchmark levels conditional on the nursing home state, even in the absence of nursing home expense risk. All experiments are performed in general equilibrium and are revenue neutral, with a proportional earnings tax on newborns used to balance the government budget.[19] Individual welfare is measured as expected utility of a newborn; welfare effects are expressed in terms of equivalent consumption variation (ECV) — 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 we are not considering policy reforms, we omit transitions from our welfare calculations. Results are presented in Table 8.

5.1.1 Precautionary Savings

We find that removal of all four types of risk from the benchmark economy reduces aggregate capital by 39 percent, with over 90 percent of this reduction accounted for by earnings risk. Among the remaining three types of risk, nursing home risk contributes the most to precautionary savings. When nursing home expense risk is removed the capital stock falls by 2.3 percent. In contrast, when medical expense risk is removed, it falls by 0.07 percent. The relative importance of nursing home expense risk is even larger in partial equilibrium. Furthermore, compared to medical expense risk, nursing home expense risk generates substantially more saving at very old ages. The two panels on the left-hand-side of Figure 3 show the average precautionary savings profiles for medical expense risk and nursing home expense risk of agents in the second and top lifetime earnings quintiles. Notice that, in contrast to savings for medical expense risk, savings for nursing home expense risk increases throughout old-age, peaking after the age of 85 when nursing home entry risk is the highest. These results indicate that nursing home expenses are riskier than medical expenses. In fact, the nursing home shock is the most persistent shock, one of the largest health cost realizations in the model economy, and the least insured by the government.

Part of the reason that nursing home expense risk is so important for precautionary sav-

[19] We use a proportional earnings tax to minimize the redistributional effects caused by changes in taxation. Lump-sum taxes are distortionary in our environment due to the safety nets. However, since labor supply is exogenous, the proportional earnings tax generates minimal distortions.

Table 8: Effects of removing different sources of risk from the benchmark economy and the benchmark economy with no Medicaid.

Economy	Benchmark						No-Medicaid
Removed Risk	Earnings	Survival	Medical	Nursing	Health	All	Health
Capital stock							
Aggregate	-35.09	-0.12	-0.07	-2.26	-1.98	-38.63	-21.11
Decomposition							
Risk	-61.99	2.60	-0.04	-2.63	-1.86		-24.50
Prices	23.56	0.70	0.08	0.77	0.33		8.46
Bequests	3.35	-3.42	-0.11	-0.40	-0.44		-5.08
Low type	5.18	6.24	6.81	-0.19	10.89	13.38	-44.08
High type	-38.88	-0.72	-0.72	-2.45	-3.19	-43.52	-15.18
Bequests							
Aggregate	18.85	-100	-1.59	-10.47	-10.46	-100	-44.66
Low type	12.02	-100	1.06	-8.43	-1.57	-100	-53.52
High type	24.18	-100	-1.86	-10.54	-11.58	-100	-39.78
Consumption							
Aggregate	-5.78	-0.01	-0.00	-0.21	-0.19	-6.75	-1.04
Low type	-13.53	-1.21	-0.33	-0.62	-0.89	-10.30	-1.56
High type	-4.10	0.25	0.06	-0.13	-0.03	-5.98	-0.93
Welfare							
Aggregate	10.96	-7.16	-0.60	-1.04	-1.36	0.24	-1.20
Decomposition							
Risk	20.90	0.29	-0.58	-0.15	-0.87		10.57
Prices	-11.30	0.38	0.01	-0.23	-0.14		-1.25
Bequests	1.36	-7.84	-0.03	-0.65	-0.35		-10.52
Low type	8.02	-3.93	-0.80	-0.87	-1.36	1.72	0.97
High type	18.76	-14.16	-0.09	-1.44	-1.34	-3.19	-6.30

All numbers are percentage change from the benchmark level except that the numbers in the last column are percentage change from the benchmark economy with no Medicaid. A proportional earnings tax is imposed to balance the government budget due to changes in tax revenues. 'Health' refers to the removal of both medical and nursing home risk. 'Low (high) type' refers to agents with the low (high) permanent productivity type. The benchmark economy features stochastic earnings, survival, medical and nursing home expenses. Earnings and health expense risk are removed conditional on permanent type. Survival risk is removed by introducing actuarially fair annuities. Partial equilibrium decomposition is obtained by first shutting down risk with prices, taxes and transfers from bequests fixed, then shutting down risk and changing prices and taxes to their general equilibrium levels while holding transfers at their benchmark levels. Welfare is measured as an equivalent consumption variation — a constant percentage change in consumption of each agent at each age which makes an agent indifferent between the benchmark economy and an alternative economy. A positive welfare number indicates that the corresponding risk generates a welfare loss. Similarly, negative numbers indicate welfare benefits from the risk.

ings is because it is less insured by the government than medical expense risk. In the baseline economy, the minimum consumption floor guaranteed to agents under nursing home care is only 66 percent of that guaranteed to the rest of the population. How important is the differential consumption floor for the effect of nursing home expense risk on capital accumulation? To answer this question we remove nursing home expense risk from an economy equivalent to the benchmark but with $\underline{c}^n = \underline{c}^m$ so that the minimum consumption level guaranteed to nursing home residents is the same as that guaranteed to the rest of the population. When the degree of public insurance for nursing home care is equal to that for medical expenses, removal of nursing home expense risk results in a 1 percent decline in aggregate capital which is about 42 percent of the decline when nursing home expense risk is removed from the benchmark.

Even though the effects of medical expense risk on aggregate savings are at least an order of magnitude smaller than those of nursing home risk, this does not imply that medical expense risk has little effect on individual saving behavior. As Table 8 shows, the wealth of both high and low permanent types changes substantially, albeit in opposite directions, when medical expense risk is removed. What explains the differential responses of poor and rich agents? The answer is Medicaid. When medical expense risk is shut down the poor increase, instead of decrease, their savings because means-tested Medicaid no longer discourages their wealth accumulation.

The strong impact that Medicaid has on the saving behavior can be seen when both medical and nursing home risks are removed: savings of the low-type increase by nearly 11 percent. In contrast, in the economy without Medicaid, health expense risk generates positive precautionary savings for all agents, accounting for 44 percent of the wealth of low types and 15 percent of the wealth of high types. On aggregate, precautionary savings in this economy account for 21 percent of the capital stock — an order of magnitude larger than in the benchmark economy. From this we conclude that Medicaid has a large crowding-out effect on the precautionary savings of both rich and poor agents.

5.1.2 Welfare

We find that, jointly, earnings, survival, medical expense and nursing home expense risks carry only a small welfare cost — a quarter of a percent of lifetime consumption. This result, surprising at first, is obtained because only one out of the four types of risks — the earnings risk — is detrimental to the welfare of a newborn, with a welfare cost of 11 percent.[20] The

[20]The welfare cost of insurable earnings risk is smaller than the cost found by Storesletten et al. (2004) of 26 percent of lifetime consumption. However, in contrast to Storesletten et al., agents in our benchmark economy are already partially insured against earnings risk by the means-tested welfare program making the

remaining risks have a large enough joint, welfare-improving effect to nearly offset this cost. Survival risk generates the highest welfare benefit (7.2 percent), followed by nursing home risk (1 percent) and medical expense risk (0.6 percent).

Why are survival, medical expense, and nursing home expense risk beneficial to agents? First, consider survival risk. As the partial equilibrium decomposition in Table 8 shows, elimination of bequests explains the positive effect of survival risk on welfare: newborns of both high and low type value transfers of accidental bequests and thus prefer to live in an economy with no annuities.[21] When bequest transfers are held at their benchmark levels, survival risk carries a small cost (0.67 percent).

Unlike survival risk, both health expense risks are, on aggregate, welfare-improving even in partial equilibrium. Just like for savings, the key to these welfare benefits is Medicaid. To see this, note that OOP expenses are essentially negative income shocks. Redistribution through means-tested Medicaid induces a positive correlation of these shocks with individual resources at retirement. Thus, OOP health expense shocks undo some of the variation in individual resources generated by the earnings shocks. In aggregate, in the presence of health expense risk, the redistributional effect of Medicaid turns out to be large enough to reduce the overall variation in consumption and thereby enhance welfare.[22] This redistributional effect is completely absent in the no-Medicaid economy.[23] As the last column of Table 8 shows, health expense risk in this economy generates a substantial welfare cost in partial equilibrium: 11 percent of lifetime consumption.

Larger bequests account for the higher welfare benefit from nursing home risk than medical expense risk.[24] Notice that, in partial equilibrium, the welfare benefit of nursing home risk is about a quarter of the benefit of medical expense risk. This is due to the fact that nursing home expenses are riskier than medical expenses and OOP nursing home expenses are less correlated with income due to the lower consumption floor guaranteed to nursing home residents.

It is interesting to note that, although the effect of OOP health expense risk on welfare is positive for both high and low-type agents, this occurs for different reasons. In fact, in partial equilibrium, unlike low types, high types prefer the economies without health expense

value of removing that risk smaller.

[21] Fehr and Habermann (2008) show that annuities can reduce welfare in a model without bequest motives.

[22] Note that the change in the redistribution, and hence the welfare benefit of health risks, would have been even larger if we made the OOP expenses unconditional on the permanent type.

[23] Recall that our identifying assumption for pre-Medicad health expenses was that health expenses are independent of individual income.

[24] The importance of bequests for welfare is not because they are unrealistically large. Bequests as a fraction of output is 2 percent in the baseline economy. Hendricks (2001) estimate that aggregate inheritances amount to between 1.2 and 2 percent of GNP and Gale and Scholz (1994) estimate them to be 2.65 percent.

risks. In particular, OOP nursing home and medical expense risk generate welfare costs for high types of 0.2 percent and 0.1 percent, respectively. Relative to low types, high types are less likely to be eligible for Medicaid transfers and, therefore, their OOP expense shocks are larger and less correlated with their income. As a result, while for low types the welfare benefit of OOP expense risk is driven by the redistributional effect of Medicaid, for high types it is driven by changes in bequests.

5.2 Effects of Health Expenses

Having learned that health expense risk has significant aggregate and distributional effects, we now assess the impact of old-age medical and nursing home expenses for savings. To this end, we consider three experiments. In the first experiment, all health expenses — medical and nursing home — are paid for by the government. In the second experiment, social insurance for nursing home residents is the same as in the benchmark, while the medical expenses of the rest of the population are paid by the government. In the third experiment, the government pays for the medical expenses of all nursing home residents regardless of their income, while the social insurance coverage of all other health expenses is as in the benchmark economy.[25]

As before, we assume that non-health government expenditure remains fixed at the benchmark level and a proportional earnings tax is used to balance the government's budget in each economy. Note that our goal is not to conduct an analysis of alternative public healthcare programs. Instead, we compare savings in the benchmark economy with savings in economies with publicly funded health expenses to isolate the contribution of old-age health expenses to life-cycle savings under the current U.S. old-age social insurance system. Moreover, by conducting our analysis in general equilibrium with expenses financed by a proportional earnings tax, we can use the results obtained in the previous section to assess the roles that medical and nursing home expense risk play in generating savings for old-age health expenses.

5.2.1 Aggregate Effects

As the first row of Table 9 shows, publicly financing health expenses reduces aggregate capital accumulation. Public coverage of all health expenses reduces the capital stock by 10.9 percent. Public coverage of medical and nursing home expenses alone reduces the capital stock by 5.6 and 5.0 percent, respectively. Thus, 52 percent of savings for health

[25]Recall that the cost of nursing home includes consumption and non-consumption (medical) components. Under the public coverage of nursing home expenses, only the non-consumption component (M^n) of the nursing home cost is eliminated.

Table 9: Effects of the publicly funded medical expenses, nursing home expenses, and both in the benchmark economy.

Publicly funded expense	Medical	Nursing	Health
Capital Stock			
Aggregate	-5.6	-5.0	-10.9
Decomposition			
OOP expenses	-6.2	-6.0	-12.7
Prices	0.6	1.7	2.7
Bequests	-0.1	-0.7	-0.9
Lifetime earnings quintile			
1	1.7	2.8	7.1
2	-9.9	-2.1	-11.9
3	-12.6	-7.9	-21.2
4	-8.9	-9.2	-19.0
5	-3.7	-4.0	-7.9
Gini (BE=0.804)	0.004	0.007	0.013
Bequests			
Aggregate	-5.4	-17.6	-25.1

All numbers are percentage change from the benchmark economy (BE) level expect for the Ginis which are absolute changes. A proportional earnings tax is imposed to finance expenses and to balance the government budget due to changes in tax revenues. Only the non-consumption component of nursing home care is publicly financed. 'Health' refers to publicly financed medical and nursing home expenses. Partial equilibrium decomposition is obtained first by removing OOP expenses with prices, taxes and transfers from bequests fixed, then removing OOP expenses and changing prices and taxes to their general equilibrium levels while holding transfers at their benchmark levels.

expenses is generated by medical expenses and 46 is generated by nursing home expenses. The remaining 2 percent is due to an interaction effect. Recall that, in aggregate, OOP nursing home expenses are approximately a third of OOP medical expenses. Hence, per unit of expense, life-cycle savings for nursing home expenses are nearly 3 times as large as for medical expenses. Furthermore, when prices, taxes and bequests are fixed, the impact of nursing home expenses relative to medical expenses for capital accumulation is even larger.

Why do nursing home expenses generate so much savings? As discussed in Section 5, nursing home expenses are riskier than medical expenses and as such generate larger precautionary savings. In fact, using results from Table 8, we conclude that 45 percent of life-cycle savings for nursing home expenses is precautionary savings for nursing home expense risk while the remaining 55 percent is savings for expected nursing home expenses. In contrast, 99 percent of savings for medical expenses is for expected expenses and only 1 percent is for medical expense risk.

Per unit of expense, savings for expected OOP nursing home expenses are 1.5 times larger than savings for expected OOP medical expenses. This is due to the timing of nursing home expenses. Specifically, in contrast to medical expense shocks, the nursing home expense shock primarily hits agents at very old ages. This is especially true for wealthier individuals who are more likely to pay for nursing home care OOP. When the government pays for nursing home care retirees can dissave faster, as they no longer face large expected levels of nursing home expenses late in life.

5.2.2 Distributional Effects

As we learned from Section 5, old-age health expenses have dramatically different effects on the precautionary savings of poor and rich agents. To examine the differential impact of OOP health expenses on life-cycle savings across the income distribution, we divide individuals into lifetime earnings quintiles and compute percentage changes in each quintile's wealth relative to the benchmark. As Table 9 shows, we find that middle-income agents — those in lifetime earnings quintiles three and four — hold the highest fraction, about a fifth, of their wealth as savings for OOP health expenses. In contrast, only 8 percent of the wealth held by the top quintile is savings for health expenses, and health expenses actual reduce the savings of the first quintile. Moreover, comparing the changes in the wealth holdings of each quintile upon the transfer of medical and nursing home expenses to the government reveals that nursing home expenses have a bigger impact on the saving behavior of the top two lifetime earnings quintiles, and the reverse is true for the second and third quintiles. As a result, the presence of OOP health expenses slightly reduces overall cross-sectional wealth inequality.

The differential impact that OOP health expenses have on savings across the lifetime earnings distribution is explained by both their composition — medical versus nursing home — and their size relative to the quintile's income. To illustrate this point, the right-hand-side of Figure 3 shows the savings profiles of the second and top quintile for medical and nursing home expenses from age 50 to age 100. Due to their size and persistence and the fact that they tend to occur very late in life, nursing home expenses require a higher level of savings than medical expenses. As a result, lower-income individuals, for whom in some cases nursing home care is altogether unaffordable, are more likely to allow Medicaid to cover their nursing home care costs, saving instead for smaller OOP medical expenses. The wealthier individuals, on the other hand, save primarily for nursing home expenses. Self-insurance against nursing home expense risk by wealthier individuals is particularly important given the relatively low consumption floor provided to nursing home residents, which makes destitution due to nursing home expenses more painful than destitution due to medical expenses.

Figure 4 shows that the main nursing home beneficiaries of Medicaid in the model are those in the bottom 40 percent of the lifetime earnings distribution and older individuals from higher quintiles. Note that the take-up rate of Medicaid is much higher among nursing home residents. This is not surprising given the size, persistence and timing of this shock. 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.

Finally, we find that the removal of health expenses reduces wealth accumulation over the entire life-cycle. Notice in Figure 3 that agents start to accumulate savings for health expenses well before the retirement period. In fact, a decrease in the savings of workers accounts for 68 percent of the decline in aggregate savings under government coverage of medical expenses and 41 percent upon government coverage of nursing home expenses.

To conclude, we have found that (1) nursing home risk is the largest determinant of precautionary savings after earnings risk, (2) old-age health expense risk is welfare improving in the presence of both earnings risk and Medicaid, (3) old-age health expenses, particularly nursing home expenses, stimulate capital accumulation, and (4) while nursing home expense risk is a more important driver of the savings of wealthy individuals, poorer individuals save instead for expected medical expenses. Our analysis was conducted in general equilibrium, which we show is important for assessing the effects of nursing home expense risk.

6 Discussion and Future Research

Given that this is one of the first attempts to explicitly model nursing home costs in a general equilibrium, life-cycle, heterogeneous-agent model, for the sake of a transparent analysis, we chose to abstract from a number of features, leaving them for future research. We now discuss a few of these features in more detail. First, health expenses in our model are exogenous. As a result, agents cannot adjust their demand for healthcare in response to changes in the structure of the social insurance system. Endogenizing the healthcare utilization decision would allow us to analyze the impact of alternative healthcare policies. Given our finding that nursing home expense risk has important effects on savings and welfare under the U.S. social insurance system, it would be particularly interesting to do a study of long-term care that addresses the large differences across countries in public coverage of nursing home care costs and its means-testing. The number of countries providing universal nursing home care coverage has been growing and include Austria, Germany, Japan, Luxemburg, and the Netherlands. However, nursing home care in France, Israel, and New Zealand is still provided through means-tested social insurance.

Moreover, countries differ in their total expenditure on nursing home care as well as in the fraction of these expenditures which are made OOP. Among the OECD countries, in 2000, expenditure on nursing home care varied from 0.3 percent of GDP in France to 2.3 percent of GDP in the Netherlands. Even within the group of countries with a universal long-term care system (no means-testing for either home or institutional care), there is a substantial variation in the private costs due to different beneficiary cost-sharing requirements.[26] Our analysis suggests that these differences should manifest themselves in countries' savings and economic inequality, giving a nice ground for a formal policy analysis. Financing the growing costs of nursing home care, and long-term care in general, has become a key concern for policymakers as well as individuals in aging societies around the world. According to the OECD report on long-term care by Fujisawa and Colombo (2009), in the past decade, real per capita long-term nursing care spending has increased by an average of 6.5 percent per year across 24 OECD countries. In 16 OECD countries, per capita private expenses on long-term nursing care have, on average, tripled between 2000 and 2006.

Second, we assume that the relative prices between medical care, nursing home care, and consumption are constant even though the costs of medical and nursing home care have been increasing at a faster rate than the CPI. If the cost of health care in the model was increasing over time, then OOP expenses would likely have an even larger effect on savings, especially if agents faced additional uncertainty over the rate of inflation of health care costs.

[26] These expenses may include food, housing, and other copayments; these may be related to income.

Third, we do not model the Medicare program since it is not necessary in order to achieve our objective. Since we do not model the demand for healthcare, the presence of an entitlement program such as Medicare has no effect on individual behavior apart from the tax distortions induced by its public finance. However, explicitly modeling Medicare would be necessary to analyze the impact of removing the program, reducing its coverage, or changing its public finance.[27]

Fourth economic 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 (Hubbard et al. (1995) is the closest example to us). The main tradeoff is that, on the one hand, the distributions of earnings and wealth — two crucial dimensions of heterogeneity for the questions we address — are a result of joint decision-making within the household, 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. Thus we view our agents as households when working and as individuals when 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.[28]

In order to make our results transparent, we simplified our analysis by abstracting from endogeneity of labor supply, utility derived from health and care, the household's life-cycle, caregiving and other transfers within the family. Abstraction from labor supply decisions means we have not taken into account distortions caused by the earnings tax and social safety nets as well as self-insurance through intertemporal substitution in labor in response to earnings shocks. We also assumed that health shocks carry no disutility. While the evidence is mixed, lower marginal utility of consumption at older ages, especially for nursing home residents, would imply that individuals put a smaller weight on bad health states and hence require smaller savings for old age.

Extending the model by incorporating the household life-cycle – marriage, divorce, spousal death, and children – would allow additional and potentially important dimensions to be considered. For example the importance of differential health expense risk and mortality for men and women and for married individuals versus singles could be assessed. Marriages may be important because nursing home risk potentially differs by martial status, in part, because risk-sharing is available within a household.[29] Since a large fraction of lifetime health

[27] See Attanasio et al. (2011) for an example of such an analysis in a general equilibrium model which does not have explicit nursing home risk.

[28] Explicitly modeling marriage and nursing home expense risk is significantly more complicated for a number of reasons that are mentioned in more detail in Section 7.

[29] Heterogeneity in health and demand for nursing care open yet another avenue for modeling bargaining

expenses are experienced in the last year of life, often impoverishing the surviving spouse, the risk of spousal death and the extent to which survivor benefits provided by the social insurance system insure this risk may be important for individual savings decisions.

A household approach would also allow one to endogenize caregiving decisions within the family and nursing home entry. In the data, institutional care satisfies only a small part of long-term care needs. The majority of the elderly with needs receive their care informally from family members – mostly spouses and children – while some obtain formal in-home nursing care. In the previous section we showed that bequests play a major role in the effects of nursing home expense risk on savings and welfare because individuals hold on to their wealth into very old ages in the event of high nursing home costs. An intergenerational set-up would allow one to examine the exchange of wealth and care time between parents and children. As government programs in many countries use subsidies to encourage home care – a less costly alternative to institutional care, it would be interesting to examine the caregiver's labor supply response to such policies. We leave these issues for future research.

7 Conclusions

We used a full life-cycle, general equilibrium model to assess the importance of old-age OOP medical and nursing home expenses and their risks for savings, and to assess the welfare effects of medical and nursing home expense risk. Our analysis makes several contributions. First, ours is the first study that assesses the relative importance of nursing home expenses and nursing home expense risk. We found that, after earnings risk, nursing home expense risk is the second most important determinant of precautionary savings and is responsible for the slow dissaving rate of individuals at very old ages. Furthermore, nursing home expenses account for a disproportionately large share of savings for old-age health expenses. We also showed that nursing home expense risk is more important for the savings of wealthier individuals, whereas the poor save instead for expected medical expenses.

Second, our study is the first analysis of the welfare effects of old-age medical and nursing home expense risk. We showed that, in the presence of earnings risk and Medicaid, old-age health expense risks undo some of the variation in lifetime resources due to earnings risk and, as a result, have a welfare-improving role.

Third, our paper provides the first full life-cycle, general equilibrium analysis of the impact of OOP health expenses and their risk for savings. Our results show that old-age health expenses impact saving behavior over the entire life-cycle and that a general equilibrium analysis is important for assessing the effects of nursing home expense risk. In

within the household.

particular, our results indicate that bequests play a major role in the welfare costs of such risk because individuals hold on to their wealth into very old ages in the event of high nursing home costs.

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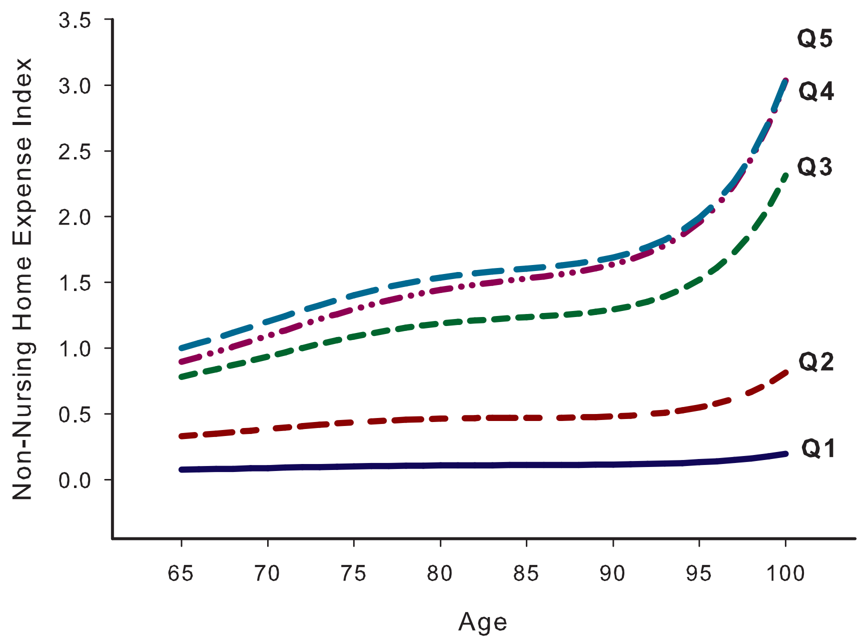

Figure 1: Average OOP medical (non-nursing home) expenses by age and lifetime earnings quintile for retired individuals, 65 and older. Estimated using HRS data and a fixed effects estimator. The average expense of 65 year-olds in quintile 5 is normalized to 1.

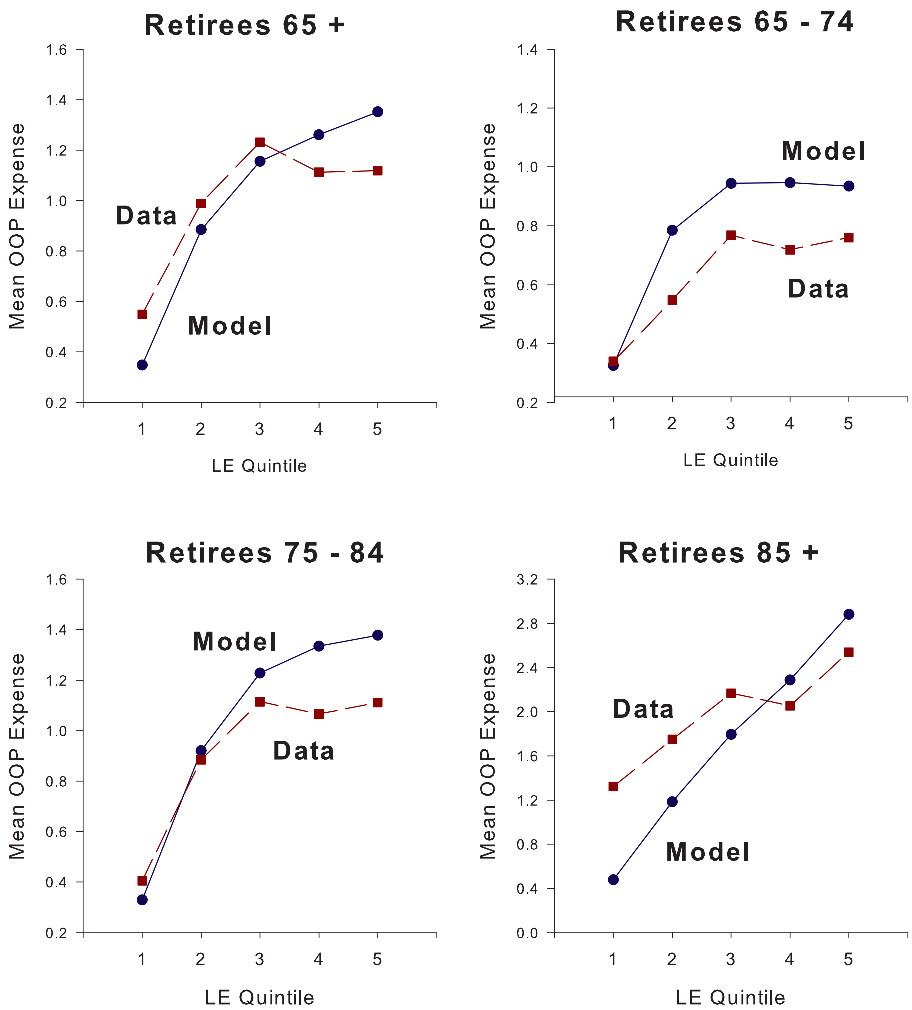

Figure 2: Mean OOP expenses by lifetime earnings quintile for all retirees (top left), retirees 65–74 (top right), retirees 75–84 (bottom left) and retirees 85+ (bottom right) in the model and the data (our HRS sample). OOP expenses are relative to mean OOP expenses of all retirees.

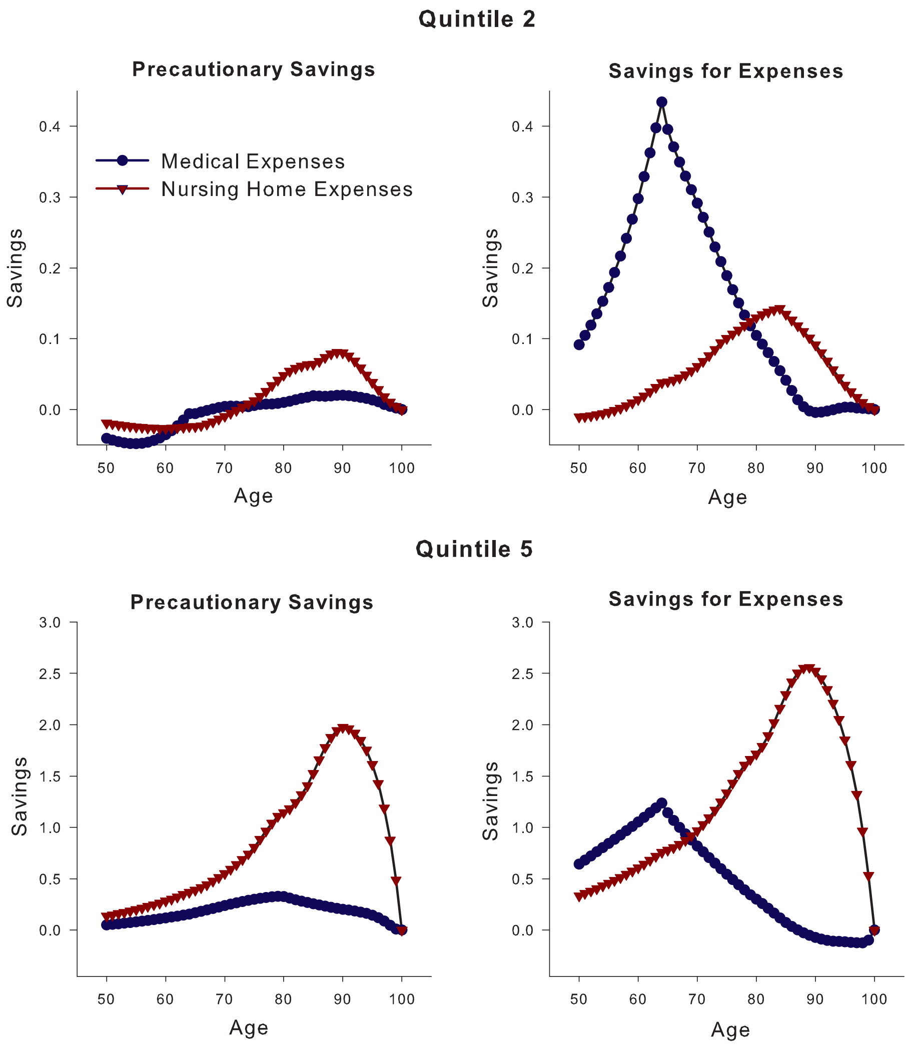

Figure 3: Precautionary savings for medical and nursing home expense risk (left-hand-side) and savings for medical and nursing home expenses (right-hand-side) by lifetime earnings quintile 2 (top) and 5 (bottom) in the model. Calculated by subtracting each quintiles wealth profile in the economy without the particular type of expense (risk) from the corresponding profile in the baseline economy.

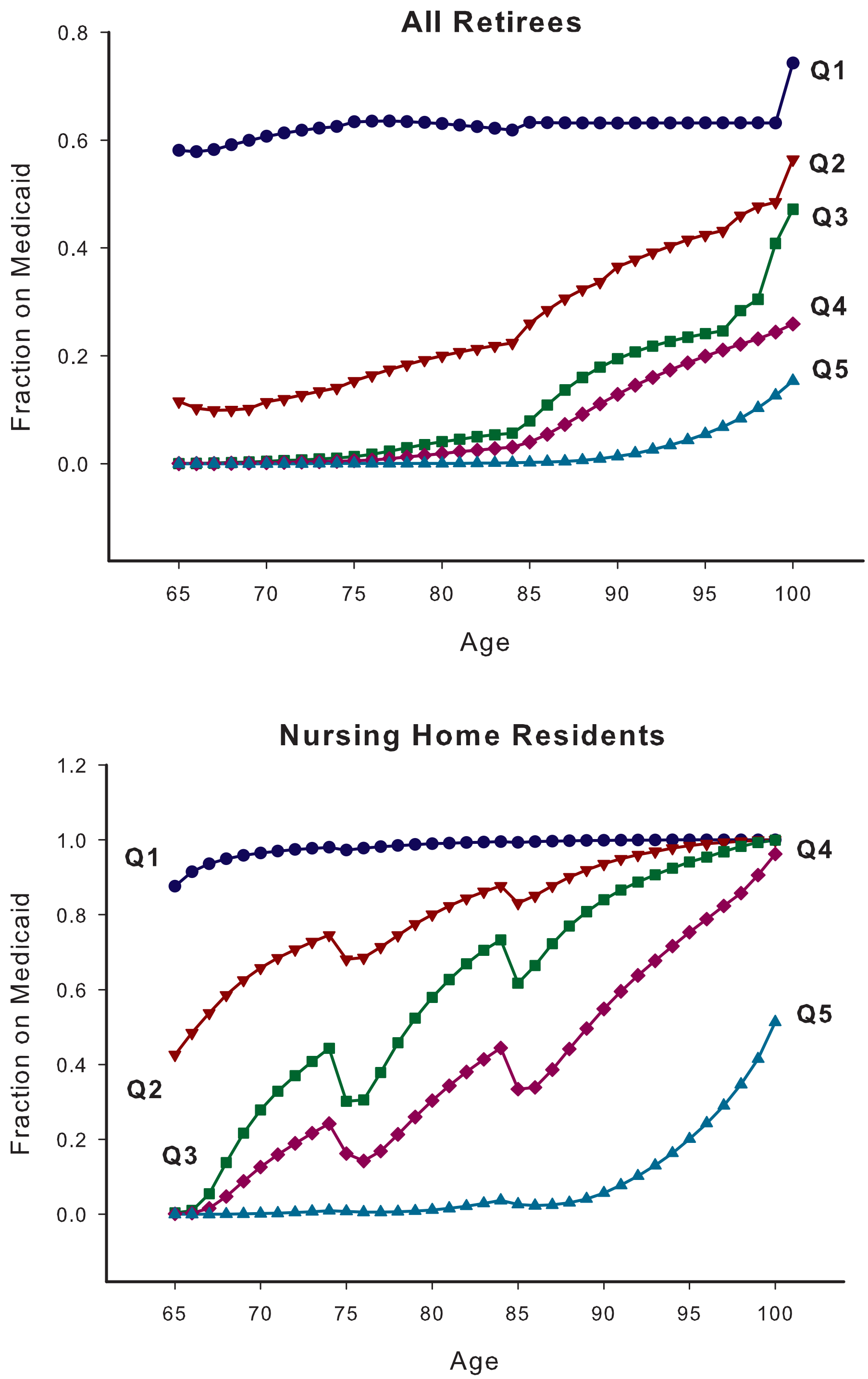

Figure 4: Fraction of retirees receiving Medicaid transfers (top) and fraction of nursing home residents receiving Medicaid transfers (bottom) in the benchmark economy by age and lifetime earnings quintile.