Institut sur la retraite et l'épargne
HEC MONTRÉAL

Housing in Medicaid: Should it Really Change?

CAHIER DE RECHERCHE N° 3
WORKING PAPER No. 3

Bertrand Achou

Mars / *March* 2020

Retirement and Savings Institute

Les opinions et analyses contenues dans les cahiers de recherche de l'Institut ne peuvent en aucun cas être attribuées aux partenaires ni à l'Institut lui-même et elles n'engagent que leurs auteurs.

Opinions and analyses contained in the Institute's working papers cannot be attributed to the Institute or its partners and are the sole responsibility of the authors.

Dépôt légal : Bibliothèque et Archives nationales du Québec et Bibliothèque et Archives Canada, 2020.
ISSN 2561-9039

Housing in Medicaid: Should it Really Change?

Bertrand Achou*

March 10, 2020

Abstract

Housing is mostly exempted from Medicaid and Supplemental Social Insurance means tests. Reforms of this special treatment have been debated but little is known about its costs, benefits and redistributive implications. I estimate a life-cycle model of single retirees accounting for this exemption. The model shows that the homestead exemption explains important patterns of Medicaid recipiency, that it is highly valued and may be of limited cost as it incentivizes saving and reduces Medicaid recipiency at older ages. The model also predicts that removing the homestead exemption or enforcing more systematically estate recovery programs would reduce redistribution towards lower-income retirees.

JEL codes: D15, H51, I13
Key words: Medicaid, Housing, Savings, Retirement, Life-Cycle

* Retirement and Savings Institute, HEC Montreal. Contact: bertrand.achou@gmail.com.
Acknowledgements: I am thankful to Tatyana Koreshkova, Minjoon Lee as well as seminar participants at Concordia University and the Canadian Economic Association conference for useful comments. This research was enabled in part by support provided by Calcul Québec (www.calculquebec.ca) and Compute Canada (www.computecanada.ca). Part of this research was conducted while I was a researcher at CIRRIS and adjunct professor at Université Laval. Errors are mine.

1 Introduction

In 2012, spending on Long-Term Care Services and Support (LTSS) in the US amounted to $220 billion (9.3% of all health care spending), and about two thirds of these costs were borne by Medicaid.[1] Due to population aging, the latter is expected to grow in size and there has been debates about the best ways to finance LTSS and potentially reform Medicaid, notably within the Federal Comission on Long-Term Care (2013). However, the lack of knowledge on budgetary and welfare consequences of various aspects of Medicaid has been one of the main impediments of reforms (Chernof and Warshawsky, 2014).[2] To this end, recent works by De Nardi *et al.* (2016) and Braun *et al.* (2017) have evaluated some general features of Medicaid for the elderly. Such works, however, have not considered a debated and important feature of the program: the fact that housing is treated differently than other assets by Medicaid. This paper is the first to provide estimates of the costs of this special treatment, of its valuation by retirees and of its redistributive implications, using a model which successfully replicates a large set of patterns related to Medicaid and medical spending. It also investigates the potential consequences of a more systematic enforcement of the Medicaid estate recovery program, another feature which has largely been ignored in the literature.

Medicaid is means-tested and retirees can qualify for it through two pathways. First, if they have both low income and assets they can receive an income supplement through Supplemental Social Insurance (SSI) and benefit from Medicaid for their uninsured medical expenditures (notably, the long-term care services not covered by Medicare). Second, if their income is higher than the income threshold for SSI they can receive Medicaid if they face high uninsured medical expenditures and have insufficient income and assets to pay for them. However, an important dimension not considered in previous works evaluating the consequences of Medicaid for the elderly is that primary residences, the largest asset for many retirees, are usually excluded from the asset tests of Medicaid and SSI.[3]

First, using the Health and Retirement Study (HRS), I document that a large share of Medicaid recipients qualify thanks to the homestead exemption: among single retirees 70 and over (the population I focus on), about a third

[1] http://www.nhpf.org/library/the-basics/Basics_LTSS_03-27-14.pdf

[2] They note that: "By and large, Commissioners asserted that designing a viable approach to LTSS risk protection, public or private, is possible, although it would require a considerable amount of new data, design work, and careful analysis of costs and consequences before a fiscally responsible proposal could be put forward that would gain broad support."

[3] As De Nardi *et al.* (2016), I often refer to the combination of SSI and Medicaid as Medicaid.

of Medicaid beneficiaries are homeowners.[4] Also, the share of Medicaid recipients who are homeowners is substantial for both low and high-pension-income retirees, suggesting that the homestead exemption plays a key role for both Medicaid pathways.

To assess to which extent the homestead exemption affects Medicaid recipiency and its cost, and to evaluate how much it is valued, I build a life-cycle model of single retirees featuring housing and endogenous medical expenditures. The key parameters of the model are estimated using a two-step simulated method of moments and the model matches its data targets well. In particular, the model successfully reproduces the slow decline in homeownership rates with age, Medicaid-rates age profiles by permanent income and the permanent-income gradient of out-of-pocket medical expenditures in the HRS.

The first finding from the model is that the homestead exemption is key for reproducing important aspects of the age profiles of Medicaid recipiency. In models without the homestead exemption, Medicaid recipiency is steeply increasing with age for low-permanent-income retirees, while it is rather flat in the data. I show that this discrepancy is explained by the omission of the homestead exemption. When the latter is absent, these low-permanent-income retirees must deplete all their wealth (including housing) before qualifying for Medicaid. This mechanically lowers Medicaid recipiency rates among them at younger ages. More surprisingly, Medicaid recipiency rates are *higher* at older ages without the homestead exemption. With the homestead exemption, many retirees can remain homeowners until late in life and, as housing can be difficult to liquidate, this also reduces the incentives to dissave which are normally induced by means-tested programs.[5] As a consequence, when the homestead exemption is removed savings are lower late in life, which increases Medicaid costs, notably on nursing-home care.

One of the main contributions of this paper is to provide an estimate of the cost and relative valuation of the homestead exemption, a debated aspect of the Medicaid program.[6] At the current distribution of wealth and housing in my data, I find that the homestead exemption is valued at more than its cost on average. This results mostly from the fact that homeownership is estimated to be highly valued by retirees. From a budgetary standpoint, the model predicts that removing the homestead exemption would reduce Medicaid spending for current retirees by about 5%-6%. However, removing the homestead exemp-

[4]Singles represent 48% of retirees aged 70+, 74% of Medicaid recipients, and 58% of Medicaid recipients who are homeowners, a non-negligible share of the population of interest. For those in a couple, the share of homeowners among Medicaid beneficiaries is even higher, at about two thirds.

[5]Hubbard *et al.* (1995) first showed the negative effects of means-tested programs on savings.

[6]See the alternative approach A by the Comission on Long-Term Care (2013) or Warshawsky and Marchand (2017) which also discuss the fact that estate recovery programs could be more systematically enforced.

tion reduces homeownership rates significantly, which suggests that incentives to save through housing may be reduced way before retirement. As a result, the cost savings reported here are likely an upper bound as they do not consider the accumulation phase of the life cycle. The homestead exemption actually provides incentives to save (through housing) for lower-income retirees that would otherwise be absent due to the negative effect of means-tested programs on saving incentives. Due to this behavioral effect, Medicaid savings from removing the homestead exemption may end up small while the negative effects on retirees welfare is likely to remain. In other words, the homestead exemption may actually provide large benefits at little cost, in particular as it incentivizes saving.

The baseline model does not account for estate recovery by Medicaid as, in practice, its enforcement appears limited (De Nardi *et al.*, 2012; Warshawsky and Marchand, 2017). However, enforcing it more systematically is often mentioned as a possible way to improve the sustainability of the Medicaid program. In the counterfactual analysis, I use the model to estimate the amounts that could be recuperated if estate recovery was fully enforced. In practice, introducing estate recovery transforms the homestead exemption into a loan, and I find that estate recovery could represent up to 10% of Medicaid spending for my sample, which seems significantly larger than what is being recuperated to date. However, if bequest motives are prevalent, the amount recuperated could end up significantly smaller as estate recovery (similarly to an estate tax) affects savings negatively. Due to the uncertainty about how prevalent bequest motives are, conclusions about the overall desirability of estate recovery remain however uncertain.

In terms of redistribution, I find that lower-income retirees are those experiencing the largest absolute decrease in Medicaid transfers when removing the homestead exemption. Thus, contrary to some beliefs, my findings suggest that those who receive the largest transfers from the homestead exemption may not be middle- or high-income retirees but low-income ones. Including redistributive concerns would thus reinforce the desirability of the homestead exemption. I also find that estate recovery would have the largest absolute negative effect on the expected bequests of lower-income retirees.

I also use the model to reevaluate the overall valuation of Medicaid relative to its cost accounting for the homestead exemption. While the latter changes quite significantly the age profiles of Medicaid recipiency, I still find, in line with De Nardi *et al.* (2016) and Braun *et al.* (2017), that retirees value Medicaid at more than its cost on average. This result is robust despite significant differences with those models and is robust across specifications relying on very different saving motives, notably those globally in line with the low demand for long-term care insurance (such as in Lockwood (2018) or Achou (2018)).

Finally, this paper makes two additional contributions. First, it provides an alternative formulation to the one in De Nardi *et al.* (2016) with respect to the modeling of Medicaid expenditure floors in a setting with endogenous medical spending. This formulation has many desirable properties and is more in line with standard insurance theory. Second, I find that medical consumption in old age is quite inelastic and, as a result, that the positive gradient between out-of-pocket medical spending (after Medicaid) in the HRS and permanent income can mostly be explained by differences in Medicaid recipiency. This quite low elasticity is not obvious a priori and is crucial to generate Medicaid payments very much in line with the data. This result has also important implications on how well models with exogenous medical expenditures can fit some key data patterns, and on how medical expenditures should be calibrated in such models. It highlights that many works may significantly understate medical expenditure risk.

Section 2 discusses the related literature. Section 3 presents some rules and facts about housing and Medicaid. Section 4 presents the model. Section 5 discusses the first stage of the estimation. Section 6 presents the results from the second stage. Section 7 contains the counterfactual analysis and policy experiments. An online appendix provides additional details.

2 Literature

This paper is mostly related to the recent works on the relative value of social insurance programs for retirees with respect to their costs. De Nardi *et al.* (2016) estimate a partial equilibrium model with incomplete markets. They find that even rich retirees value the insurance provided by Medicaid and that the program may be of the right size. Braun *et al.* (2017) build and calibrate a general-equilibrium model and find that means-tested social insurance programs improve welfare despite the saving distortions they create. Relative to these works, my main contribution is to explicitly consider the homestead exemption and estate recovery, and to evaluate these features of the Medicaid program.[7]

In a recent paper which came out while finishing the writing of the current one, McGee (2019) attempts to disentangle precautionary and (heterogeneous) bequest motives in a model with housing and exogenous medical spending, and also evaluates the welfare benefits of the homestead exemption for the UK

[7] Barczyk and Kredler (2018), in a related work but further away in terms of modeling, evaluate policies which may incentivize informal care and their effects on welfare.

Medicaid-like program. Given the focus of the current paper, and apart from studying the US, an important difference is that my model successfully matches a rich set of moments related to Medicaid, in particular the age profiles of Medicaid recipiency by permanent income and those for out-of-pocket medical spending. This is key to capture closely Medicaid costs and how much people are willing to use it. A related point is that I model both Medicaid pathways and allow for different insurance in the community and in nursing homes, elements which are key to replicate Medicaid recipiency rates in the data. The model also allows for endogenous medical spending and borrowing, which can be important in the US context, and considers estate recovery.

My paper also complements those by Nakajima and Telyukova (2017, 2019) who insist on the importance of housing in explaining wealth decumulation patterns of retirees. An important methodological difference is that, as in De Nardi *et al.* (2016), I estimate the parameters related to medical expenditures by matching out-of-pocket medical expenditures along Medicaid recipiency rates in the second stage of the estimation. This is important as out-of-pocket medical expenditures in the HRS do not include those paid by Medicaid. Hence, calibrating out-of-pocket medical expenditures in the first stage based on all retirees as in Nakajima and Telyukova (2017, 2019) usually results in an underestimation of medical expenditures before Medicaid transfers, and thus in an underevaluation of medical expense risk and of Medicaid costs. As I show below, this underestimation is likely large for low-income retirees who rely the most on Medicaid.

This paper also complements a paper of mine (Achou, 2018) where I study quantitatively the interaction between housing liquidity and the demand for long-term insurance following the theoretical insights in Davidoff (2009, 2010). I show that, in a model rationalizing the low demand for long-term care insurance, the quantitative impact of housing liquidity on long-term care insurance demand is limited. In this paper, as in De Nardi *et al.* (2016) and Braun *et al.* (2017), I do not model long-term care insurance, but assess the robustness of the results to preferences globally consistent with the low demand for it.

This paper is also related to the literature on old-age savings. Noticeable examples include Palumbo (1999), De Nardi *et al.* (2010), Kopczuk and Lupton (2007), Ameriks *et al.* (2011), Kopecky and Koreshkova (2014), Lockwood (2018) and Ameriks *et al.* (2019). Finally, to my knowledge, only Greenhalgh-Stanley (2012) provides an empirical investigation of the effects of Medicaid estate recovery program, and there is no prior structural works on the matter.

3 Housing and Medicaid

3.1 Medicaid Rules and their Applications

As documented in De Nardi *et al.* (2012), the primary residence, or for simplicity housing, is generally exempted from SSI and Medicaid calculations. For the categorically needy (those with low enough assets and income to be eligible for SSI), housing tends to be completely exempted. For the medically needy (those eligible because of high medical expenditures), housing is only partly exempted but home equity limits, which are set by states, are generous and were usually above $500k in 2009. Few single retirees actually have houses worth that much, so for the vast majority of them housing does not affect Medicaid eligibility. The homestead exemption is, however, not supposed to apply for permanently-institutionalized single retirees. On the contrary, for those going temporarily to nursing homes (for instance, when recovering from an hospitalization) the exemption generally still applies.

In principle, states are supposed to recover estates from deceased beneficiaries for medical and long-term care transfers. Although Greenhalgh-Stanley (2012) shows that the introduction of estate recovery programs had some effects on homeownership rates, the amounts recovered by Medicaid remain small today despite the fact that a large majority of states has estate recovery programs. De Nardi *et al.* (2012) report that, in 2004, it amounted to 0.8% of Medicaid spending on nursing homes. Warshawsky and Marchand (2017) report similar results with Medicaid estate recovery amounts between 2002 and 2011 which fluctuate around 0.4% of LTSS expenditures. De Nardi *et al.* (2012) suggest as a potential explanation the complexity of estate laws and the fact that Medicaid may be one of many claimants. Warshawsky and Marchand (2017) argue that states may also have week incentives to recuperate estates as as "the federal government generously matches state Medicaid spending, some states get only 25 cents on the dollar for their collection efforts".

3.2 Housing and Medicaid: Empirical Facts

Table 1 presents important facts related to housing and Medicaid based on the RAND version of the HRS data. The first line shows the share of Medicaid recipients by pension income among singles aged 70+. 14.7% of retirees aged 70+ rely on Medicaid.[8] As already documented in De Nardi *et al.* (2016), Medicaid recipiency rates decline with yearly pension income going from 44.7%

[8] French *et al.* (2017) show that the Medicaid rates in the HRS are understated relative to evidence from the Medicare Current Beneficiary Survey (MCBS) which use administrative information. I correct for this in the estimation of the model but use the "non-corrected" HRS data in this section.

Table 1: Medicaid facts for singles aged 70+

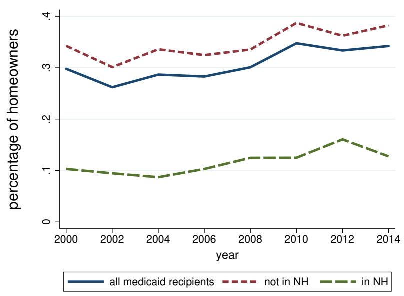
	Care status	pension income					N
		all	$\leq 5k$	$(5k; 10k]$	$(10k; 15k]$	$> 15k$	
Medicaid recipients	all	14.7	44.7	27.1	7.1	3.0	29,896
homeowners	all	30.8	27.0	31.6	32.5	34.0	4,982
among Medicaid	not in NH	34.8	29.5	34.9	40.5	46.1	4,077
recipients	in NH	11.4	7.0	12.6	13.2	8.6	905

Notes: Weighted statistics using HRS data from 2000 to 2014. First line: share receiving Medicaid by pension income (in 1998 dollars). Second line: share of homeowners among Medicaid recipients. Third and fourth lines: share of homeowners among Medicaid recipients for nursing home and non-nursing home residents. Nursing home residents are those having spent more than 300 days in a nursing home consistent with the model's definition.

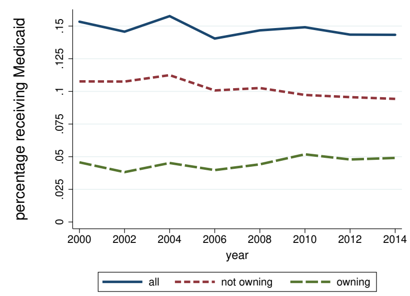
for those with pension income equal or below 5,000 (1998) dollars and to 3% for those with pension income above $15,000. Medicaid recipients in the former group usually satisfy the SSI criteria, while those in the latter usually become eligible to Medicaid when facing large uninsured medical expenditures.

A much less documented fact is that about 31% of Medicaid recipients are homeowners. This share is significant even among Medicaid recipients with income equal or lower than $5,000, at 27%. The share in other income groups is above 30%. These shares are even higher if one focuses only on those who are not in nursing homes or have been there for less than 300 days. On average, the share of homeowners among Medicaid recipients in this group is 34.8% and is above 40% for those with relatively high pension income. For those who have been in nursing homes for more than 300 days, 11.4% of Medicaid recipients are homeowners reflecting the fact that the homestead exemption does not apply in principle for permanent nursing home residents. Although some homeowners living in nursing homes seem to benefit from Medicaid, they represent only 0.3% of singles over 70. The population of homeowners not in a nursing home and benefiting from Medicaid is about 15 times larger, representing 4.2% of those aged 70+.

Figure 1a also shows, if anything, that the proportion of homeowners among Medicaid recipients has actually increased over time, both for nursing home and non-nursing home residents. Figure 1b shows that Medicaid rates have slightly declined, but that the share of Medicaid homeowners among single retirees has, if anything, slightly increased. Hence, the homestead exemption continues to play a significant role today.



(a) Share of Medicaid recipients who are homeowners



(b) Share of the population receiving Medicaid

Figure 1: Evolutions of Medicaid and the homestead exemption

Notes: Weighted statistics using HRS data from 2000 to 2014 for singles aged 70+. Panel a: share of homeowners among Medicaid recipients in different (care) settings. Panel b: share of Medicaid recipients among all retirees. The figure also shows the contribution to this share of those owning and receiving Medicaid, and of those not owning and receiving Medicaid.

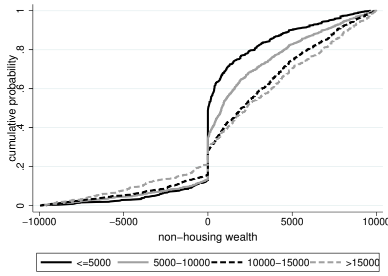
3.3 Housing Liquidity

Before presenting the model, I discuss briefly the issue of housing liquidity. One argument for possibly reforming the homestead exemption is indeed that housing can now be (at least partly) liquidated notably using reverse mortgages (Warshawsky and Marchand, 2017). However, few retirees decumulate housing equity either through the use of standard or reverse mortgages, and the reasons behind this low decumulation of housing equity is still debated.

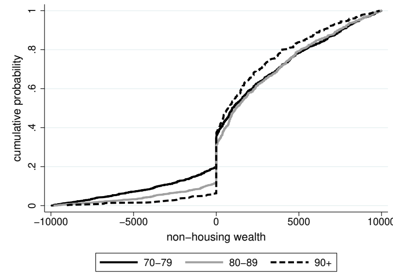
Venti and Wise (1989, 1990, 2004) highlight that retirees rarely decumulate home equity, and show that they do so mainly following the death of a spouse or the entry into a nursing home. This suggests i) a potential attachment to one's home beyond purely financial motives and ii) constraints or an unwillingness to take on debt. Models attempting to rationalize this low decumulation usually need both to explain homeownership and debt patterns in the data (e.g. Nakajima and Telyukova, 2019; Achou, 2018). In particular, a striking fact displayed in figure 2a and 2b is that *among homeowners* there is significant bunching of non-housing wealth at zero.[9] Such bunching is hard to replicate without strong elements limiting the possibility or willingness to have debt. Figure 2 also shows that this bunching is present for homeowners with different pension incomes and of different ages, but is larger for low-pension-income and older homeowners.[10]

[9]Non-housing wealth is the difference between all wealth components in the HRS minus all debt (h*atotb in the RAND HRS) minus the value of the primary residence (h*ahous).

[10]The figures do not account for the HRS weights. CDFs accounting for these weights are almost identical.



(a) By pension income



(b) By age

Figure 2: Cumulative distribution of non-housing wealth of homeowners

Notes: Based on HRS data from 2000 to 2014 for singles aged 70+.

To explore these features of the data, I consider both market-related and self-imposed liquidity constraints.[11] This allows to test the robustness of my results to different assumptions about what generates the patterns in figure 2. I also introduce a reverse-mortgage-type loan in some counterfactuals to assess the robustness of some of the results to realistically higher housing liquidity.

4 Model

The model is a modified version of the one in Achou (2018) and features similarities with Nakajima and Telyukova (2017, 2019). Compared to the latter, there are three key differences related to the purpose of the current paper. First, the nursing home state is modeled explicitly. It allows to account for the fact that the homestead exemption does not apply in principle for nursing home residents. It also allows Medicaid to provide different insurance levels in nursing homes and in the community. Second, I use a more detailed formulation of Medicaid following De Nardi *et al.* (2016). Third, as in De Nardi *et al.* (2016) the model features endogenous medical spending, allowing for medical spending to potentially change when simulating counterfactuals.

I consider single retired individuals. Considering couples is also of interest but is left for future research due to the significant additional complications that would arise in this setting. The model in this section is used to esti-

[11]Self-imposed liquidity constraints take the form of a utility cost of debt reflecting potential time and effort costs to manage debt, and/or debt aversion. Thaler (1990) suggests that debt aversion could be important to explain low debt rates of retirees. Survey evidence indicate that many retired homeowners do not want to have debt (Kaul and Goodman, 2017), and that reluctance to have debt is linked to actual behaviors (Almenberg *et al.*, 2018). Also, the possibility of experiencing dementia may make having to manage debt unattractive.

mate key structural parameters and assumes no estate recovery. The latter is introduced in the counterfactual analysis section.

4.1 Health

At each age t, a retiree can be in one of four health states (hs_t): low or no disability (ld), moderate disability (md), high disability (hd) or living in a nursing home (nh). Individuals also face a positive probability of death at each age. The nh state captures long, and likely permanent, nursing home stays which are, in principle, not subject to the homestead exemption.

4.2 Preferences

Consider a retired individual in year ty aged t who was alive at the end of the previous year. She draws a health state hs_t or dies with a probability that depends on gender gen, age t, previous health state hs_{t-1}, and permanent income category I. If she dies, she derives utility from leaving bequests Beq_t:

$$W\left(Beq_t\right) = \left(\frac{\phi_W}{1-\phi_W}\right)^{\gamma} \frac{\left(\frac{\phi_W}{1-\phi_W}c_W + Beq_t\right)^{1-\gamma}}{1-\gamma}$$

$\phi_W \in [0,1)$ and $c_W \geq 0$ are the intensity and the extent to which bequests are luxury goods (see Lockwood (2018)). If alive, the retiree maximizes expected utility with flow utility:

$$U\left(\cdot\right) = \begin{cases} \frac{\left((1+\phi_o d_t^o)c_t^{\omega}\tilde{h}_t^{1-\omega}\right)^{1-\gamma}}{1-\gamma} + \mu\left(t, hs_t, \varepsilon_t\right) \times \frac{m_t^{1-\sigma}}{1-\sigma} & \text{if } hs_t \neq nh \\ \frac{\left(c_t^{\omega}\tilde{h}_t^{1-\omega}\right)^{1-\gamma}}{1-\gamma} + \mu\left(t, hs_t, \varepsilon_t\right) \times \frac{m_t^{1-\sigma}}{1-\sigma} & \text{if } hs_t = nh \end{cases} \tag{1}$$

Let's first consider a retiree living at home: $hs_t \neq nh$. The first term on the right-hand side is the utility derived from consumption of non-medical and non-housing goods c_t and of housing $\tilde{h}_t$. Outside nursing homes, $\tilde{h}_t$ is simply equal to h_t which denotes the housing owned or rented in the market by the retiree. Homeowners, for whom the dummy d_t^o equals 1, derive a possibly higher utility from housing services which is captured by $\phi_o \geq 0$. The second term is the utility from medical goods m_t which depends on $\mu\left(\cdot\right)$, a function of age, health and a random term ε_t.

Homeowners in nursing homes do not derive direct utility from homeownership as they do not live in their homes. For them, housing services $\tilde{h}_t$ entering utility are those provided by the nursing home which differ from h_t (see below).

In some specifications, I allow for an age-dependent utility cost of debt κ_t^{debt} subtracted from the right-hand side of (1) for retirees with debt.

4.3 Housing

In the model, as in Nakajima and Telyukova (2019) and as retired homeowners rarely downsize, retirees do not switch houses unless they move out to a rented home. Once a retiree becomes a renter, she remains one for the rest of her life: $d_t^o = 0$ if $d_{t-1}^o = 0$. However, she can pick any home size. A renter pays a rent equal to $r^h(ty)\, h_t$. In addition, a homeowner who decides to become a renter sells her house and pays a transaction cost, and thus receives $p^h(ty)\, h_{t-1}(1-\phi_p)$. A homeowner who does not wish to become a renter, continues to stay in her own house: $h_t = h_{t-1}$. In this case, she pays a maintenance cost equal to $\psi^h p^h(ty)\, h_t$. House prices and rent prices are deterministic.

4.4 Expenditures

4.4.1 Expenditures in the Community

Let $x_t^{c,h,m}$ denote total expenditures on consumption, housing, and medical goods, including the part paid by Medicaid. For those living in the community, total expenditures are:

$$x_t^{c,h,m} = c_t + d_t^o \psi^h p^h(ty)\, h_t + (1-d_t^o)\, r^h(ty)\, h_t + q(hs_t)\, p_t^m m_t \tag{2}$$

where $q(hs_t)$ is a co-pay rate[12] and p_t^m is the relative price of medical goods which grows at a rate g_m. Maximizing (1) subject to (2) delivers the optimal allocation between c_t and m_t given h_t (see the online appendix):

$$m_t = \left[\frac{\mu(t, hs_t, \varepsilon_t)}{\omega q(hs_t)\, p_t^m}\left((1+\phi_o d_t^o)\, \tilde{h}_t^{1-\omega}\right)^{\gamma-1} c_t^{1+\omega(\gamma-1)}\right]^{1/\sigma} \tag{3}$$

It shows that the ratio of medical consumption over consumption rises with $\mu(\cdot)$, the random term affecting the marginal utility of medical consumption.

4.4.2 Expenditures in Nursing Homes

Nursing home expenditures can be split in two components: medical spending $q(hs_t)\, p_t^m m_t$ and non-medical spending $x_t^{c,h}$. Given the rental price $r^h(ty)$, $x_t^{c,h}$ is allocated optimally between consumption and housing services. Hence, in nursing homes $c_t = \omega x_t^{c,h}$ and $\tilde{h}_t = (1-\omega)\, x_t^{c,h}/r^h(ty)$, and total spending is:

$$x_t^{c,h,m} = x_t^{c,h} + d_t^o \psi^h p^h(ty)\, h_t + q(hs_t)\, p_t^m m_t \tag{4}$$

[12] $1 - q(hs_t)$ captures in particular the part of medical expenditures paid by Medicare.

where $\psi^h p^h(ty)\,h_t$ is the maintenance cost that must be paid by a nursing home resident who remains a homeowner. In the model, there are no incentives for renters who go to nursing homes to continue paying a rent while in a nursing home, so that $(1-d_t^o)\,r^h(ty)\,h_t$ does not appear.[13] The expression for m_t is the same as (3) but with $\phi_o = 0$.

4.5 Liquid Savings and Debt

This section presents the intertemporal constraints faced by retirees. It considers in turn the constraints faced by renters and homeowners.

4.5.1 Renters

I assume that renters cannot borrow ($b_t \geq 0$). To finance expenditures, they can rely on previous savings (b_{t-1}), pension income ($y_t = y(I)$) net of income taxes (τ_t), and Medicaid (see below). Their next-period (liquid) wealth is:

$$b_t = \quad Rb_{t-1} + y_t - \tau_t + Medicaid_t - x_t^{c,h,m} \tag{5}$$

4.5.2 Homeowners

Unlike renters, homeowners are allowed to use secured debt with:

$$b_t \geq -d_t^o \lambda_t p^h(ty)\,h_t \tag{6}$$

where λ_t mimics the constraint imposed by standard forward mortgages. Homeowners liquid wealth evolves according to:

$$\begin{aligned} b_t = \quad & (R + \mu \mathbf{1}\{b_{t-1} < 0\})\,b_{t-1} + y_t - \tau_t + Medicaid_t \\ & + d_t^s p^h(ty) h_{t-1}(1-\phi_p) - x_t^{c,h,m} \end{aligned} \tag{7}$$

The first line is the same as (5) except for the term $\mu\mathbf{1}\{b_{t-1} < 0\}$ indicating that borrowers pay an extra interest rate $\mu > 0$. The first term on the second line indicates that a homeowner can get additional money by selling her home ($d_t^s = d_{t-1}^o(1-d_t^o) = 1$).

4.6 Medicaid

This section describes the modeling of Medicaid. It presents the rules of the Medicaid program and its means test.

[13] As for those in nursing homes there is a positive (although small) probability to return to the community, there is possibly an incentive to pay the maintenance cost in order to benefit from the extra utility of homeownership ϕ_o if returning to the community.

4.6.1 Medicaid Rules

Primary residences are mostly excluded from Medicaid's asset test except for institutionalized retirees (De Nardi *et al.*, 2012). I thus assume that the homestead exemption does not apply to those in the nh state.[14] The amount of housing wealth taken into account in Medicaid's asset test ($\overline{ph}_t^{med}$) is given by:

$$\overline{ph}_t^{med} = \begin{cases} \max\left\{0, d_t^o p^h(ty)h_t - \overline{ph}\right\} & \text{if } hs_t \neq nh \\ \max\left\{0, d_t^o p^h(ty)h_t\right\} & \text{otherwise} \end{cases} \tag{8}$$

where $\overline{ph}$ is the exemption level. The formula for assets $\tilde{A}_t^{med}$ considered in Medicaid's asset-test is:

$$\tilde{A}_t^{med} = \begin{cases} \mathbf{1}\left\{b_{t-1} \geq 0\right\} Rb_{t-1} + \overline{ph}_t^{med} & \text{if } d_{t-1}^o = 0 \text{ or } d_t^o = 1 \\ \max\Big\{ \left(R + \mu \times \mathbf{1}\left\{b_{t-1} < 0\right\}\right) b_{t-1} & \text{if } d_t^s = 1 \\ +p^h(ty)h_{t-1}\left(1 - \phi_p\right); 0\Big\} & \end{cases}$$

For previous renters ($d_{t-1}^o = 0$), only liquid assets are considered. For homeowners ($d_t^o = 1$), the assets considered are the sum of liquid assets (if positive) and of the homestead exemption amount $\overline{ph}_t^{med}$. For those selling their homes, all their now-liquid assets are counted. I also define the final level of assets entering Medicaid's means tests:

$$A_t^{med} = \max\left\{0, \tilde{A}_t^{med} - A_d\right\}$$

where A_d is an asset disregard, that is only countable assets above A_d affect Medicaid eligibility. There are two pathways to qualifying for Medicaid. The *categorically-needy* (cn) pathway allows a retiree to qualify for Medicaid if her income and assets are below certain thresholds:

$$Medicaid_t = \begin{cases} \max\Big\{0; \max\left\{\underline{Y}, \underline{x}_{cn}^{c,h,m}\left(\mu\left(\cdot\right), p_t^m, hs_t\right)\right\} & \text{if } y_t + rb_{t-1} - y_d \leq \underline{Y} \\ -\max\left(y_t + rb_{t-1} - y_d; 0\right)\Big\} & \text{and } A_t^{med} = 0 \\ 0 & \text{otherwise} \end{cases}$$

[14] In reality, some individuals go into nursing homes for limited periods of time after an hospitalization for instance. In this case, the exemption would apply. However, I define the nh state as applying to those who are in nursing home for 300 days or more so that for them the homestead exemption should not apply.

An individual with income less than $\underline{Y}+y_d$ and with $A_t^{med}=0$ receives at least $\underline{Y}$ minus her income above the asset disregard y_d. If she has high medical needs, she can receive larger transfers as indicated by the expenditure floor $\underline{x}_{cn}^{c,h,m}(\cdot)$ which depends on medical needs $\mu(\cdot)$ (see below). For the categorically-needy, $Medicaid_t$ includes both SSI and Medicaid transfers.

Someone not satisfying the SSI criteria can qualify through the *medically-needy* (mn) pathway if her resources are insufficient to cope with medical needs:

$$Medicaid_t = \max\left\{0; \underline{x}_{mn}^{c,h,m}\left(\mu\left(\cdot\right), p_t^m, hs_t\right) - \left(A_t^{med} + y_t - \tau_t\right)\right\}$$

where $\underline{x}_{mn}^{c,h,m}(\cdot)$ is an expenditure floor which varies with medical needs.

To prevent homeowners receiving Medicaid from having total spending $x_t^{c,h,m}$ larger than what is normally intended by the program, I impose the following constraints for the categorically-needy:

$$Medicaid_t = 0 \text{ if } x_t^{c,h,m} > \max\left\{\underline{Y}, \underline{x}_{cn}^{c,h,m}\left(\cdot\right)\right\} + y^d + \min\left\{A_d, \max\left\{0, \tilde{A}_t^{med}\right\}\right\}$$

and for the medically-needy:

$$Medicaid_t = 0 \text{ if } x_t^{c,h,m} > \underline{x}_{mn}^{c,h,m}\left(\cdot\right) + \min\left\{A_d, \max\left\{0, \tilde{A}_t^{med}\right\}\right\}$$

Without such constraints, Medicaid recipients could potentially borrow large amounts and cumulate it with Medicaid. Such withdrawal of housing equity may however be considered as additional income and could thus make them ineligible. These equations account for this in a parsimonious way. Medicaid recipients are nonetheless allowed to consume their countable assets below the asset disregard A_d on top of the expenditure floors which reflects the fact that they do not have to run down all their countable assets to qualify for Medicaid.

4.7 Medicaid Floors

Finally, we need to specify how the Medicaid expenditure floors $\underline{x}_k^{c,h,m}\left(\mu\left(\cdot\right), p_t^m, hs_t\right)$ ($k = cn, mn$ for categorically and medically-needy) vary with the medical needs $\mu(\cdot)$. I depart from De Nardi *et al.* (2016) who assume that Medicaid specifies a utility floor and then solves for the minimum level of expenditures which enables to reach it. I opt for an approach more in line with standard insurance theory which assumes instead that Medicaid specifies a minimum level of non-medical expenditures and adjusts the amount of medical expenditures according to the medical needs. This stems from the fact that an insurance is supposed to help smooth *marginal* utility, not utility.[15]

To see this, consider the following one-period problem of an individual having access to a fair insurance. Suppose the individual maximizes the following expected utility:

$$\pi\left(\frac{c^{1-\gamma}}{1-\gamma}+\mu\frac{m^{1-\sigma}}{1-\sigma}\right)+(1-\pi)\left(\frac{\tilde{c}^{1-\gamma}}{1-\gamma}+\tilde{\mu}\frac{\tilde{m}^{1-\sigma}}{1-\sigma}\right) \tag{9}$$

There are two possible states occurring with probabilities π and $1-\pi$. The only difference between them is that the (marginal) utility of medical expenditures is affected by a stochastic term with $\tilde{\mu}>\mu$. The individual seeks to allocate wealth b between two fair insurance policies ι and $\tilde{\iota}$, and to allocate expenditures between non-medical and medical goods. Her constraints are:

$$\begin{aligned} b =&\iota+\tilde{\iota} \\ \frac{\iota}{\pi} =&c+p^m m \\ \frac{\tilde{\iota}}{1-\pi} =&\tilde{c}+p^m\tilde{m} \end{aligned}$$

Although the solution to this problem delivers perfect consumption smoothing ($c=\tilde{c}$), it does not deliver equal utility in the two states. To see this, notice that: $m=\left(\mu/p^m\right)^{1/\sigma}c^{\gamma/\sigma}$ and $\tilde{m}=\left(\tilde{\mu}/p^m\right)^{1/\sigma}c^{\gamma/\sigma}$. If, for instance, $\mu=0$ and $\tilde{\mu}>0$, the utility in the good state is $c^{1-\gamma}/\left(1-\gamma\right)$ while the one in the bad state is $c^{1-\gamma}/\left(1-\gamma\right)+\tilde{\mu}\tilde{m}^{1-\sigma}/\left(1-\sigma\right)$ with $\tilde{m}>0$. Perfect insurance thus implies i) that marginal utility of consumption is equalized across states and ii) that within states the marginal utility of medical expenditures equals the one of consumption. Given (i), (ii) implies that more funds need to be allocated to the state with $\tilde{\mu}>\mu$ but does not imply equal utility across states in general.[16]

To the extent that a social insurance program attempts to provide a minimum level of insurance, it is thus natural to assume that (at least within a given branch of the program) it attempts to provide benefits allowing for a minimal smoothing of the marginal utility of consumption. A simple way to model this is to assume that Medicaid specifies a target for minimum consumption $\underline{c}$ and then gives to the retiree the minimal amount making her reach $\underline{c}$. In the simple model, the (total) expenditure floor would thus be $\underline{c}+p^m\left(\mu/p^m\right)^{1/\sigma}\underline{c}^{\gamma/\sigma}$ in the good state and $\underline{c}+p^m\left(\tilde{\mu}/p^m\right)^{1/\sigma}\underline{c}^{\gamma/\sigma}$ in the bad one.

[15]De Donder and Leroux (2020) study theoretically the demand for long-term care insurance in a framework close to the one here.

[16]Similar results easily generalize to an intertemporal problem with more than two states.

Expenditure floors defined in this way parallel well those in models with exogenous medical spending such as Hubbard *et al.* (1995). In such models, means-tested social insurance provides a minimum level of consumption $\underline{c}$ and pays for all *exogenous* medical expenditures. Here, the social insurance program also provides a minimum level of consumption $\underline{c}$ and pays for all the *endogenous* medical expenditures corresponding to this $\underline{c}$. Also, with floors defined this way, transfers always increase with medical needs μ. With a utility floor, if $\sigma < 1$ transfers can actually decline with medical needs because the term $m^{1-\sigma}/(1-\sigma)$ is positive. Finally, if $\gamma > 1$ and $\sigma > 1$ (the situation in De Nardi *et al.* (2016)) setting a utility floor $\underline{u}$ results in an increase in consumption for larger values of μ. Indeed, in this case:

$$\underline{u} = \frac{c^{1-\gamma}}{1-\gamma} + \mu \frac{\left(\left(\mu / p^m \right)^{1/\sigma} c^{\gamma/\sigma} \right)^{1-\sigma}}{1-\sigma}$$

As μ increases, the second term of the right-hand side becomes more negative for a given c. As a matter of fact c must increase alongside μ to keep utility equal to the utility floor $\underline{u}$. It is important to keep these conclusions in mind when comparing my estimates with those in De Nardi *et al.* (2016).

We now need to implement this in the richer model which requires some additional assumptions. First, Medicaid is assumed to target a minimum level of non-medical consumption spending $\underline{x}_k^{c,h}(hs_t)$ $(k = cn, mn)$, where the latter is allowed to be different in the community and in nursing homes: $\underline{x}_k^{c,h}(hs_t) = \underline{x}_{k,\cancel{nh}}^{c,h}$ for those in the community and $\underline{x}_k^{c,h}(hs_t) = \underline{x}_{k,nh}^{c,h}$ for nursing home residents. Medicaid is further assumed to consider the case of a typical renter to determine the amount $\underline{x}_k^{c,h,m}(\cdot)$ for medical and non-medical consumption corresponding to $\underline{x}_k^{c,h}(hs_t)$. A typical renter spending $\underline{x}_k^{c,h}(hs_t)$ on non-medical goods would have $c_t = \omega \underline{x}_k^{c,h}(hs_t)$ and $\tilde{h}_t = (1-\omega)\, \underline{x}_k^{c,h}(hs_t) / r^h(ty)$. Plugging this into equation (3) allows to compute the required expenditure floors:

$$\begin{aligned}
\underline{x}_{cn}^{c,h,m}\left(\mu(\cdot), p_t^m, hs_t\right) + y_d =& \underline{x}_{cn}^{c,h}(hs_t) + \left(q(hs_t)\, p_t^m\right)^{(\sigma-1)/\sigma} \mu(\cdot)^{1/\sigma} \\
& \times \left(\omega^\omega (1-\omega)^{1-\omega} r^h(ty)^{\omega-1}\right)^{(\gamma-1)/\sigma} \left(\underline{x}_{cn}^{c,h}(hs_t)\right)^{\gamma/\sigma}
\end{aligned}$$

$$\begin{aligned}
\underline{x}_{mn}^{c,h,m}\left(\mu(\cdot), p_t^m, hs_t\right) =& \underline{x}_{mn}^{c,h}(hs_t) + \left(q(hs_t)\, p_t^m\right)^{(\sigma-1)/\sigma} \mu(\cdot)^{1/\sigma} \\
& \times \left(\omega^\omega (1-\omega)^{1-\omega} r^h(ty)^{\omega-1}\right)^{(\gamma-1)/\sigma} \left(\underline{x}_{mn}^{c,h}(hs_t)\right)^{\gamma/\sigma}
\end{aligned}$$

The setting of these floors follows the logic of the simple model above. Consistently with reality, Medicaid transfers increase with medical needs $\mu(\cdot)$. Considering the case of a typical renter makes sure that Medicaid payments are independent of tenure status.

4.8 Value Function and Solution Method

The vector of state variables is:

$$\boldsymbol{S}_t = \left(I, cht, gen, t, hs_t, \varepsilon_t, b_{t-1}, d^o_{t-1}, h_{t-1}\right)$$

There are three time-invariant states: income category I, gender gen and cohort cht. There are three exogenous time varying states: age t (or equivalently year ty), health hs_t and the medical needs shock ε_t. And there are three endogenous state variables: financial wealth b_{t-1}, tenure status d^o_{t-1} and housing size h_{t-1}. We can also define a vector of controls:

$$\boldsymbol{C}_t = \left(b_t, d^o_t, h_t; c_t, m_t, \tilde{h}_t, Medicaid_t\right)$$

On top of the new values for the endogenous states, it includes: consumption c_t, medical consumption m_t, housing consumption $\tilde{h}_t$ and the amount received from Medicaid. The problem is solved recursively from the final possible age $T = 105$ up to $t = 72$, under the constraints presented above:

$$V\left(\boldsymbol{S}_t\right) = \max_{\boldsymbol{C}_t}\left\{U\left(\cdot\right) + \beta s\left(\cdot\right) E_t\left[V\left(\boldsymbol{S}_{t+1}\right)\right] + \beta\left(1 - s\left(\cdot\right)\right) W\left(Beq_{t+1}\right)\right\}$$

with $Beq_{t+1} = \max\left\{\left(R + \mu\mathbf{1}\left\{b_t < 0\right\}\right) b_t + p^h(ty+1)h_t\left(1 - \phi_p\right); 0\right\}$. β is the time preference parameter and $s\left(I, gen, t, hs_t\right)$ is the survival probability. The expectation E_t is conditional on income, gender, cohort, health state and age. The solution method is standard (see online appendix).

5 Data and Estimation

5.1 Data Selection

Data are from the HRS (mostly from the RAND version). Sampled individuals must meet all the following criteria: they are observed in 1998; they are single in all the waves considered; they receive no more than \$3,000 of labor earnings in all the waves. I consider 5 cohorts defined according to birth year: 1924-1928, 1919-1923, 1914-1918, 1909-1913, 1904-1908. In the model, their age in 1998 is set to 72, 77, 82, 87 and 92 respectively. I also drop all those with more than 2 million dollars of total (net) wealth in 1998 or more than \$500,000 of housing wealth in 1998 which removes 0.7% of individuals. For the estimation, I use data from 1998 to 2006 to avoid dealing with the great recession period. The final sample has 3,258 single retirees of which 79% are female.

Table 2: Pension income distribution

Income quintile	1^{st} (bottom)		2^{nd}		3^{rd}	4^{th}	5^{th} (top)
Income category I	1	2	3	4	5	6	7
Pension income $y(I)$	3,300	5,960	7,370	8,510	10,480	13,901	23,146

5.2 Income

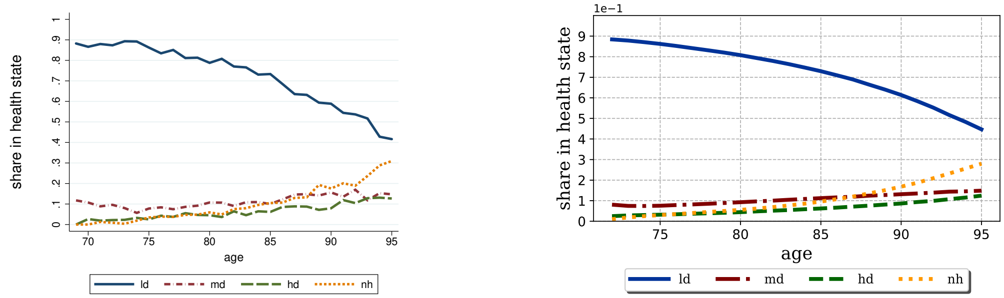
Pension income includes individual income from employer pension or annuities, Social Security, veterans' benefits, welfare, and food stamps. It does not include income from SSI. For each individual, permanent income is defined as the average pension income over the period she is observed. The sample is then split in five income quintiles. The bottom two income quintiles are further split in two to allow for more precision for those most likely to rely on Medicaid. This results 7 permanent-income categories I. Pension income $y(I)$ for an individual in group I is set to the mean of the permanent income of her group. Table 2 shows that pension income ranges from \$3,300 in income group 1 to \$23,146 in income group 7.

5.3 Health States and Transition Matrices

An individual is considered to be in a nursing home nh if he has spent more than 300 days in it. For those who die between waves, I also account for the number of days they spend in a nursing home before death. Individuals not in nh are classified in ld (resp. md and hd) if they have 0 or 1 difficulty with activities of daily living (ADLs) (resp. 2 or 3, and 4 or 5). To compute the transition matrix between these states, I use a procedure based on multinomial logit regressions as De Nardi *et al.* (2016). The probability to be in a given health state at age $t+1$ is assumed to be a function of an indicator variable for health state in t, an indicator variable for permanent income quintile, a cubic in age, an interaction term between age and income, and an interaction term between health state and age. Figure 3 shows that the transition matrix is successful in replicating the health patterns by age in the data. It reproduces well the significant decrease of the proportion of those with low disability, and the significant increase of those in nursing homes or with high disability.

5.4 Medical Expenditures

Out-of-pocket medical expenditures, not including what is paid by Medicaid, are defined as in De Nardi *et al.* (2016). They include out-of-pocket expenditures on: private and Medicare Part B insurance premia, drugs, hospital and



(a) Data

(b) Simulated

Figure 3: Health profiles

Notes: Panel a: shares of individuals in different health states in the data. Panel b: similar shares simulated using estimated transition matrix and health distribution between 70 and 74.

nursing home care, doctor visits, dental visits, outpatient surgery, and home health care and special facilities or services. I also include out-of-pocket medical expenditures on hospital and nursing home stays from the exit interview of the HRS. Out-of-pocket medical expenses in the HRS do not include those paid by Medicaid, and thus correspond to $q\left(hs_t\right) p_t^m m_t$ in the model *minus* medical and long-term care Medicaid transfers.[17]

5.5 Calibrated Parameters

The interest rate is 4% as in De Nardi *et al.* (2016). Following Brown and Finkelstein (2008), the growth rate of the price of medical expenditures $g_m =$ 1.5%, and the income and asset disregards are $y_d = \$360$ and $A_d = \$2,000$. The co-pay rate for medical spending is an in De Nardi *et al.* (2016) with $q\left(hs_t \neq nh\right) = 0.34$ and $q\left(hs_t = nh\right) = 0.69$. Following Yao and Zhang (2005), the housing transaction cost ϕ_p is 6%, the maintenance cost is 1.5% and the share of housing in consumption $\omega = 0.8$. The homestead exemption limit is $\overline{ph} = \$400,000$ based on the figures in De Nardi *et al.* (2012), and the extra interest on standard mortgages $\mu = 1.6\%$ as in Nakajima and Telyukova (2019). The income tax formula is taken from French and Jones (2011).

For house prices and rents, I use data from the FHFA series from the Lincoln Institute. The annual growth rate of house prices is 1.7% based on the growth rate of house prices between 1980 and 2016. The rent-price ratio is 4.7%, its average between 1980 and 2016. [18]

[17] Medical spending on nursing homes also include the consumption and shelter components.

[18] The rent-price ratio premium is about 1%. Indeed: $premium_{ty} = r^h\left(ty\right)/p^h\left(ty\right) -$

In specification 1 below, the constraint for standard mortgages is set so that it has to be repaid by age 95, an age at which few retirees still have debt. To calibrate it, I impose that principal and interest payments do not exceed 28% of pension income (a standard value in mortgage calculators) using a 5.6% interest rate, and that $\lambda_t \leq 0.8$, a standard downpayment constraint. In specification 2, as in Nakajima and Telyukova (2019), λ_t is a function of age and is estimated in the second stage.

5.6 Parameters Estimated in the Second Stage

The parameters estimated in the second stage include: the degree of preference for the present β, the curvature of the utility function for non-medical goods γ, the one for medical goods σ, the preference for homeownership parameter ϕ_o, and the two bequest parameters ϕ_W and c_W. The following Medicaid parameters are estimated: the SSI income threshold $\underline{Y}$, the floor for the categorically-needy who are not in nursing homes $\underline{x}^{c,h}_{cn,\cancel{nh}}$, the floor for the medically-needy who are not in nursing homes $\underline{x}^{c,h}_{mn,\cancel{nh}}$, and the floor for nursing home residents which is assumed equal for categorically and medically-needy: $\underline{x}^{c,h}_{cn,nh} = \underline{x}^{c,h}_{mn,nh}$.

In specification 1, there is a utility cost of debt $\kappa^{debt}_t = \kappa^{debt}_0 \left(1 + \kappa^{debt}_1 \times (t - 72)\right)$, and κ^{debt}_0 and κ^{debt}_1 are estimated. In specification 2:

$$\lambda_t = \begin{cases} \max\{0; \lambda_{72} + (t-72) \times (\lambda_{82} - \lambda_{72})\} & \text{if } t \leq 82 \\ \max\{0; \lambda_{82} + (t-82) \times (\lambda_{92} - \lambda_{82})\} & \text{if } t > 82 \end{cases}$$

and λ_{72}, λ_{82}, and λ_{92} are estimated in the second stage and $\kappa^{debt}_t = 0$.

Finally, the variable $\mu(t, hs_t, \varepsilon_t)$, which drives the marginal utility of expenditures over medical goods, is:

$$\mu(t, hs_t, \varepsilon_t) = \overline{\mu}(t, hs_t) + \overline{\sigma}(t, hs_t)\,\varepsilon_t;\ \varepsilon_t \sim \mathcal{N}(0,1)$$

with

$$\begin{aligned} \overline{\mu}(t, hs_t) =& \mu_0 + \mu_1 t + \mu_2 t^2 + \mu^{md} \times \mathbf{1}\{hs_t = md\} + \mu^{hd} \\ & \times \mathbf{1}\{hs_t = hd\} + \mathbf{1}\{hs_t = nh\} \times \left(\mu^{nh}_0 + \mu^{nh}_1 t + \mu^{nh}_2 t^2\right) \end{aligned} \tag{10}$$

$$\begin{aligned} \log \overline{\sigma}(t, hs_t) =& \sigma_0 + \sigma_1 t + \sigma_2 t^2 + \sigma^{md} \times \mathbf{1}\{hs_t = md\} + \sigma^{hd} \\ & \times \mathbf{1}\{hs_t = hd\} + \mathbf{1}\{hs_t = nh\} \times \left(\sigma^{nh}_0 + \sigma^{nh}_1 t + \sigma^{nh}_2 t^2\right) \end{aligned} \tag{11}$$

The parameters in (10) and (11) are estimated in the second-stage.

$(1 - (p^h(ty+1)/p^h(ty))/R) - \psi^h = 4.7\% + (1.017/1.04 - 1) - 1.5\% \simeq 0.99\%$.

5.7 Targeted Moments and Identification

The set of moments includes median non-housing (or simply liquid) wealth by cohort, permanent-income (PI) quintile and age (see footnote 9 for the definitions of wealth). Although parameters are identified jointly, this serves, in particular, to identify β and γ. It also includes the 75^{th} percentile of liquid wealth by cohort, PI and age. By imposing the model to match the upper part of the wealth distribution, this can help identify the bequest parameters ϕ_W and c_W. To help identify the preference for homeownership ϕ_o, the model is required to match homeownership rates by cohort, PI and age. The four Medicaid parameters are identified by matching Medicaid rates by cohort, PI and age along the other targeted moments. The parameters relative to the utility cost of debt κ_0^{debt} and κ_1^{debt} or alternatively the parameters λ_{72}, λ_{82}, and λ_{92} help match the share of individuals with debt by cohort, PI and age. The parameters determining the marginal utility of medical goods are identified by matching the median and the 90th percentile of out-of-pocket medical expenditures by cohort, PI and age alongside Medicaid rates. I also require the model to match mean out-of-pocket medical spending by wave in my sample. This is important as I focus extensively on changes in average Medicaid transfers in the welfare analysis. Finally, I also require the model to match the health/homeownership rate gradient for the different cohorts.[19]

5.8 Simulation Procedure

To simulate the model, I use the distribution of the state vector $\boldsymbol{S}_t$ (apart for ε_t) in 1998. A simulated individual is initially endowed with one of these vectors and draws randomly a medical needs shock $\varepsilon_t \sim \mathcal{N}(0,1)$. Based on this, I simulate the values for her next-period state variables b_t, d_t^o and h_t. At $t+1$, she draws a new health state hs_{t+1},[20] based on the transition matrix for health, and a medical needs shock ε_{t+1}. We can then compute her choices for b_{t+1}, d_{t+1}^o and h_{t+1}. At $t+2$, we repeat the procedure but use as hs_{t+2} the health state of the corresponding individual in the data rather than drawing it stochastically as health states are observed every two years. The procedure is repeated until an individual dies or until the last wave used for the estimation. Each individual in the data has 20 simulated counterparts, and the same stochastic draws are used across the different estimations.

[19] The online appendix gives additional details on the estimation and the definition of the moments. There are a total of 816 moments so the model is largely overidentified. An overidentification test rejects the model formally, which is not surprising given the large number of targeted moments and the many dimensions that the model attempts to reproduce. The model however matches its data targets quite well as shown below.

[20] If an individual is alive in $t+2$ in the data, the possible health states in $t+1$ do not include death.

6 Second-Stage Estimation Results

6.1 Parameters Estimates

Table 3 displays the estimated parameters (except those for $\mu(\cdot)$ which are in the online appendix). The results from two specifications are displayed: one allowing for a utility cost of debt (specification 1), and another in which the borrowing constraint is estimated (specification 2).

The estimates of β are 0.95 and 0.98 respectively, which is in the range of standard estimates for this parameter. The estimate for the curvature parameter γ is 3.01 in specification 1, while it is significantly higher at 7.06 in specification 2. All else equal, the higher values for β and γ in specification 2 would lead to significantly more savings relative to specification 1. This is partly compensated by the fact that specification 1 relies on stronger bequest motives. In specification 1, ϕ_W is larger implying a higher marginal propensity to leave bequests, while c_W is lower implying more widespread bequest motives. Overall the fact that the two specifications produce different relative strengths of the various saving motives reflects the well-known difficulty to perfectly disentangle patience, aversion to risk and the willingness to leave bequests. The preference for homeownership parameter ϕ_o is very similar in both specifications and large (around .20), suggesting that retirees value homeownership significantly. Nakajima and Telyukova (2019) estimate a value of ϕ_o of .16. The utility cost of debt in specification 1 is significantly positive which helps reproduce the low debt rates in the data. Specification 2, as in Nakajima and Telyukova (2019), relies on a borrowing constraint that tightens significantly with age.

A surprising output of the estimation is that σ, the curvature of the utility over medical consumption, is more than 5 times as large as γ. By comparison, it is only 1.06 times larger in De Nardi *et al.* (2016). To understand why, it is useful to rewrite equation (3), assuming for simplicity $\phi_o = 0$ and $\omega = 1$:

$$\log q\left(hs_t\right) p_t^m m_t = \frac{1}{\sigma} \log \mu\left(t, hs_t, \varepsilon_t\right) + \left(\frac{\sigma - 1}{\sigma}\right) \log\left(q\left(hs_t\right) p_t^m\right) + \frac{\gamma}{\sigma} \log c_t$$

Controlling for health and age, we see that γ/σ is mostly pinned-down by the gradient between the log of out-of-pocket medical expenditures (*before* Medicaid) and the log of consumption. A high value of σ relative to γ implies that medical consumption increases little with consumption, or with measures positively correlated with it (such as income or wealth), after controlling for health. De Nardi *et al.* (2016) tend to significantly overestimate this gradient which can be seen from table 5 of their paper. Their model implies that out-

Table 3: Parameters estimates

		(1)		(2)	
		estimate	s.e.	estimate	s.e.
Preference					
β	time preference	0.95	(0.01)	0.98	(0.01)
γ	curvature (non-medical)	3.01	(0.02)	7.06	(0.06)
σ	curvature (medical)	16.28	(0.12)	37.61	(0.25)
ϕ_0	homeownership preference	0.19	(0.01)	0.20	(0.00)
ϕ_W	bequest strength	0.92	(0.01)	0.46	(0.04)
c_W	bequest curvature	8,962	(63)	10,989	(1,049)
κ_0^{debt}	disutility of debt (intercept)	2.37e-4	(3.08e-5)	na	
κ_1^{debt}	disutility of debt (slope)	1.13e-2	(4.61e-3)	na	
Medicaid					
$\underline{Y}$	SSI income threshold	5,875	(53)	5,904	(48)
$\underline{x}^{c,h}_{cn,\cancel{nh}}$	categorically-needy floor	5,299	(21)	5,242	(33)
$\underline{x}^{c,h}_{mn,\cancel{nh}}$	medically-needy floor	6,380	(33)	6,445	(40)
$\underline{x}^{c,h}_{cn,nh}$, $\underline{x}^{c,h}_{mn,nh}$	floor in nursing home	13,148	(119)	19,972	(235)
Borrowing constraint					
λ_{72}	at age 72	na		0.299	(0.016)
λ_{82}	at age 82	na		0.096	(0.004)
λ_{92}	at age 92	na		0.037	(0.002)

Notes: The model is solved by scaling all dollars value by 1,000. The estimates for c_W and the Medicaid parameters in this table are however remultiplied by 1,000 to ease interpretation.

of-pocket medical expenditures (*after* Medicaid) are respectively \$2,210 and \$10,600 in the bottom and top permanent income quintiles. By contrast the figures in their data are \$2,550 and \$7,000. The same figures in the estimated models here are \$1,710-\$5,310 and \$1,660-\$5,770, while those for my sample are \$2,080-\$4,880. Thus, the two specifications here still overestimate the income gradient of out-of-pocket medical expenditures but to a much lower extent. Finally, the fact that $\sigma >> \gamma$ suggests that a model in which medical expenditures are exogenous and do not depend on income or wealth could fit well the targeted moments. I confirm this in the online appendix, although the model with endogenous medical spending better fits the targeted moments as, notably, the elasticity of medical consumption with respect to consumption is estimated not to be 1 but not 0 either ($\gamma/\sigma \simeq 18.5\% - 18.8\%$).[21] [22]

The SSI income threshold as well as the (non-medical) expenditure floors in the community for the medically and categorically-needy range between \$5,200-\$6,500, which is in line with the usually reported thresholds for SSI. The estimates of the expenditure floor in nursing homes are significantly larger at \$13,148 and \$19,972. These relatively high values tend to be in line with models rationalizing the low demand for long-term care insurance such as Lockwood (2018) or Achou (2018). This floor is mostly identified by matching the fact that some high-permanent-income retirees rely on Medicaid late in life. De Nardi *et al.* (2016) match this pattern of the data with what may appear as a less generous floor. But this difference can, at least partly, be explained by the fact that with a utility floor consumption provided by Medicaid increases with $\mu(\cdot)$ (see section 4.7).[23]

Finally, in light of this high nursing home floor, it is instructive to compare the estimates obtained here to those in De Nardi *et al.* (2010), who show that the slow dissaving of retirees can be rationalized by a model with exogenous health expenditures. In their benchmark model without bequest motives, they estimate a consumption floor of \$2,663, $\beta = .97$ and $\gamma = 3.81$. In specification 1, both β and γ are lower than these values, and the nursing home floor is much larger than the consumption floor they estimate. All else equal, this would lead to stronger dissaving. Two forces counter this: the preference for housing combined with limited willingness/possibilities to decumulate it through borrowing and a strong bequest motive. In specification 2, the large nursing home floor is mostly compensated by the large estimated γ of 7.06.

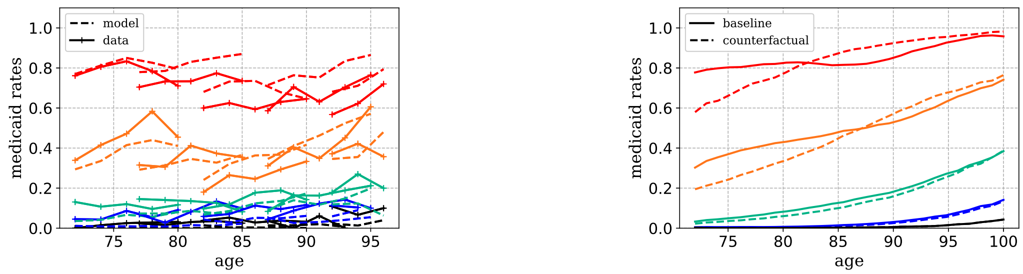
6.2 Model Fit

Figure 4a shows Medicaid recipiency rates for specification 1. Overall, it matches Medicaid rates well. While it overpredicts a little Medicaid rates in the bottom permanent-income quintile and underpredicts them in the upper income quintiles, it matches the overall gradient of Medicaid rates by permanent income well. The fit for specification 2 is very similar (see the online

[21] In the online appendix, I show that the high estimated σ relative to γ is globally consistent with the estimates, obtained using strategic survey questions, of the utility when needing long-term care in Ameriks *et al.* (2019). Their identification strategy rests on answers to hypothetical questions and a very different sample, and it is quite remarkable that actual behaviors also point to such a low elasticity.

[22] As a result of a high σ, the elasticity of medical consumption m_t to changes in the copay rate $q(\cdot)$ is quite low in absolute value. Computing arc-elasticities between 1.25-1.00, 1.00-.75, .75-.50 and .50-.25 times the initial copay rates gives elasticities around -8% specification 1 and -6% in specification 2 sample in my sample. This is significantly lower than the elasticities reported in Fonseca *et al.* (2020) and may reflect the fact that the model here is mostly identified from information on long-term care expenditures, which may be less elastic than other types of health expenditures earlier in life.

[23] Their utility floor corresponds to consumption spending of \$4,600 for $\mu(\cdot) = 0$.



(a) Data vs Model

(b) Effect of removing the homestead exemption

Figure 4: Medicaid recipiency rates - specification 1

Notes: Panel a: Medicaid recipiency rates. Solid lines: data. Dotted lines: model. Each line corresponds to retirees in a given PI quintile and cohort followed over time. Red, orange, green, blue, and black lines correspond to retirees in the bottom (first) to top (fifth) PI quintiles. Panel b: medicaid recipiency rates when simulating the youngest cohort with 2,000 replications between 72 and 100. Solid lines: baseline model. Dotted lines: no homestead exemption ($\overline{ph} = 0$).

appendix). One slight difference is that it generates higher Medicaid rates in upper income quintiles relative to specification 1, in part due to the higher Medicaid floor in nursing homes.

One noticeable feature of the model is that, as in the data, it generates quite flat age profiles for Medicaid rates in the bottom permanent-income quintile. By contrast, in De Nardi *et al.* (2016) these profiles increase quite steeply with age. The model replicates this feature of the data thanks to the homestead exemption as is seen from figure 4b. For lower permanent-income quintiles, removing the homestead exemption leads Medicaid rates to drop at younger ages as a significant share of retirees need now to deplete housing wealth to become eligible to Medicaid. As these retirees deplete their housing wealth, Medicaid rates increase. Surprisingly, at older ages, Medicaid rates are higher compared to when the exemption is in place. This is due to the fact that these same individuals have now (almost) no wealth left at older ages notably when needing nursing home care. Hence, part of the budgetary savings of removing the homestead exemption is lost because Medicaid would end up paying for a higher share of nursing home expenses.

Figures 5a and 5b show that the model fits generally well the median and 90^{th} percentile of out-of-pocket medical expenditures *after* Medicaid transfers for specification 1.[24] The permanent-income gradient of median out-of-pocket medical expenditures is very well reproduced. The model however somehow underpredicts the 90^{th} percentile of out-of-pocket medical expenditures at older

[24] The results for specification 2 are very similar for what concerns medical expenditures.

ages. Figure 5c shows that the model fits well the mean of out-of-pocket expenditures in the different waves.[25]

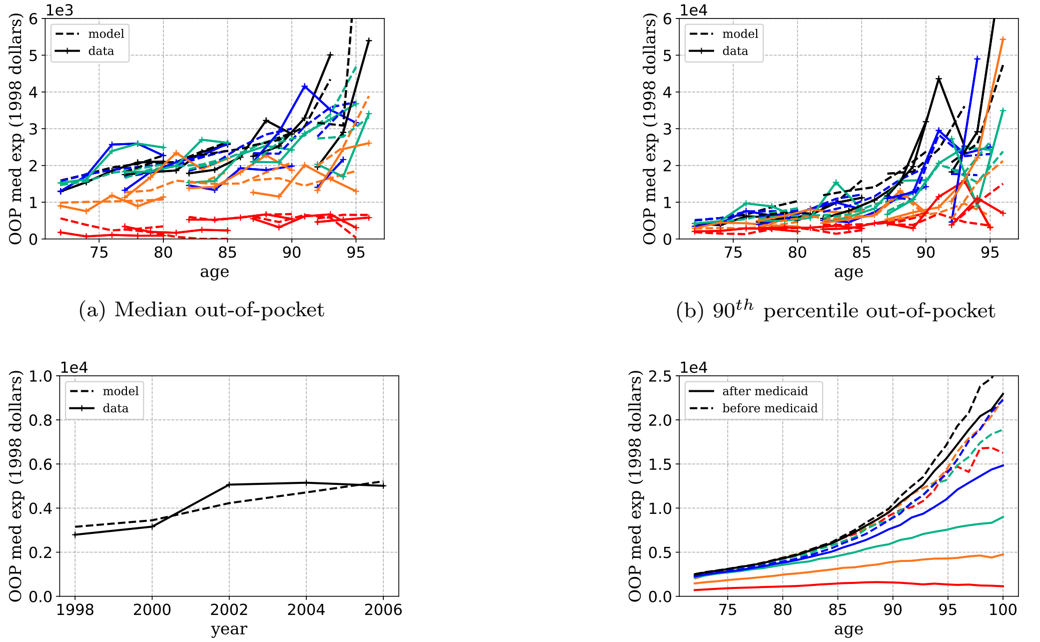
Figure 5d provides an additional perspective on why the estimates point to a low elasticity of medical consumption with respect to consumption (low γ/σ). The solid lines show mean out-of-pocket medical expenditures *after* Medicaid for different permanent-income quintiles generated by the model. The mean of this measure of out-of-pocket medical spending, which corresponds to the one in the HRS, displays a strong positive permanent-income gradient (as documented in De Nardi *et al.* (2010)). In theory, the latter can be the result of both higher medical consumption of the rich and a lower share of them receiving Medicaid transfers, the relative contribution of each being an empirical question. My estimates show clearly that the largest chunk of this gradient can be explained by the difference in Medicaid recipiency by permanent income. This can be seen from the dotted lines which plot mean out-of-pocket medical spending *before* Medicaid ($q\left(hs_t\right)p_t^m m_t$ in the model). This tells us that once accounting for the heterogeneity in Medicaid rates by income (which the model does), there is little need for heterogeneity in medical spending *before* Medicaid by permanent-income to explain the overall heterogeneity in mean out-of-pocket medical expenditures *after* Medicaid observed in the HRS data. As matter of fact, papers which use as inputs out-of-pocket medical expenses in the HRS by permanent income but do not control for differences in Medicaid rates are likely to greatly understate medical spending before Medicaid for low-permanent-income retirees.[26]

Figure 6 shows the fit of the model for the median and 75^{th} percentile of non-housing wealth for specification 1. The model matches quite well the slow decline of non-housing wealth. It however overpredicts median savings for those in the top permanent-income quintile, and underpredicts the 75^{th} percentile for this same group. In specification 2, median savings for this group match well the data, but the underprediction of the 75^{th} percentile seems to increase slightly. Although additional elements may be added to attempt to improve the model fit relative to these dimensions, it does a decent job at matching the overall patterns for non-housing wealth observed in the data.

In addition, it matches well the slow decline in age profiles for homeowner-

[25]The standard deviation is also close to the one in the data. In my sample, the mean and standard deviation of out-of-pocket medical spending (after Medicaid) are \$3,937 and \$10,819. In specification 1 and 2, these figures are \$3,911 and \$9502, and \$4,010 and \$10,065 respectively.

[26]These results globally validate the simple approach in Braun *et al.* (2017). They regress out-of-pocket medical spending in the HRS on age and health variables and on pension income, but use as an input to their model medical spending estimated for higher-income individuals. This approach assumes that medical spending before Medicaid are the same for the poor and the rich, potentially resulting in an overstatement of the medical expense risk of the poor. My results however indicate that this overstatement is likely much lower than the understatement usually resulting from not correcting for differences in Medicaid recipiency.



(a) Median out-of-pocket

(b) 90^{th} percentile out-of-pocket

(c) Mean out-of-pocket

(d) Mean out-of-pocket before and after Medicaid transfers (model)

Figure 5: Medical expenditures - specification 1

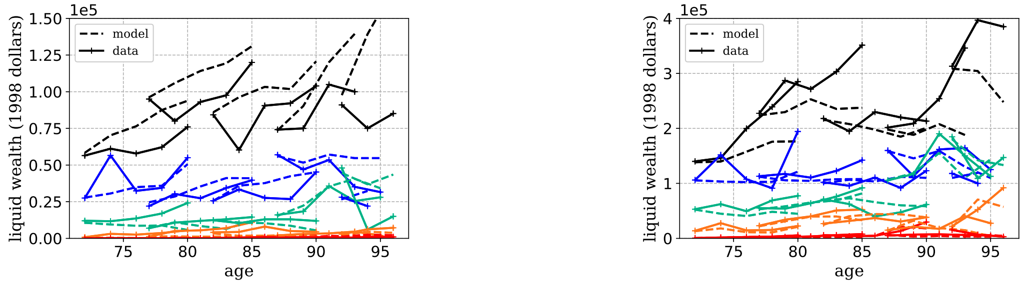
Notes: Panel a and b: median and 90^{th} percentile of out-of-pocket (oop) medical expenditures. Solid lines: data. Dotted lines: model. Each line corresponds to retirees in a given PI quintile and cohort. Panel c: mean oop medical expenditures by year. Solid lines: data. Dotted lines: model. Panel d: mean oop medical expenditures for the youngest cohort. Solid lines: after Medicaid. Dotted lines: before Medicaid. Red, orange, green, blue, and black lines correspond to retirees in the bottom (first) to top (fifth) PI quintiles.

ship rates (in the online appendix). As can be seen from table 4, the model also matches reasonably well the proportion of homeowners and renters receiving Medicaid (not targeted),[27] although the share of owners receiving Medicaid tends to be understated while the share of renters receiving Medicaid tends to be overstated by the model. The model underpredicts the share of Medicaid recipients who are homeowners. This is particularly the case in higher permanent-income quintiles. All else equal this should make the valuation of the homestead exemption in the model more conservative as retirees use it less in the model than in the data.[28]

Finally, specification 1 matches debt rates well while specification 2 gener-

[27] By contrast, Nakajima and Telyukova (2019) quite largely underestimate the proportion of renters relying on Medicaid.

[28] It is possible that some frictions absent in the model explain some of these discrepancies such as time to sell. Also, Medicaid may not enforce the "non-exemption" for nursing homes fully. It is however unclear how the latter should enter the model.



(a) Median (b) 75^{th} percentile

Figure 6: Non-housing wealth moments - specification 1

Notes: Wealth moments. Solid lines: data. Dotted lines: model. Each line corresponds to retirees in a given PI quintile and cohort followed over time. Red, orange, green, blue, and black lines correspond to retirees in the bottom (first) to top (fifth) PI quintiles.

Table 4: Medicaid statistics

	medicaid rates			share of Medicaid recipients who are owners (by permanent-income)					
	all	owners	renters	all	1	2	3	4	5
data	24.3	15.4	35.3	35.1	32.1	35.7	38.9	43.9	43.4
specification 1	23.3	12.3	37.1	28.5	27.4	32.1	27.5	11.6	5.2
specification 2	22.6	11.1	37.0	26.3	29.1	27.5	15.7	3.5	4.5

ates higher debt rates than in the data (figures in the online appendix) despite the fact that the estimated constraint tightens significantly with age. This may be due to the fact that the mortgage in the model may be more flexible than those that retirees have access to in reality. The features presented in section 3.3 suggest that borrowing out of housing equity is difficult and/or costly and that it is important to account for this. Both specifications here rely on limited or costly borrowing (as in Nakajima and Telyukova (2019) for instance) although in different ways. This allows to evaluate how sensitive the counterfactual results below are to different sources of housing illiquidity. I also perform counterfactuals with looser collateral constraints, as further robustness, by introducing a reverse-mortage-type loan.

7 Counterfactual Analysis

In the counterfactual analysis below, I use a procedure similar to one in De Nardi *et al.* (2016). I consider individuals aged 72 and simulate their decisions for their remaining lifetime with one of the estimated models in section 6.[29] I then compare the output of the model with a variant of it, notably introducing changes to Medicaid. Two measures will be of particular interest: the difference in the present discounted value (PDV) of Medicaid payments following a change and the compensating variation necessary to equalize welfare after a change to the one before a change. More specifically, for a given individual, the compensating variation CV is given by:

$$V^0\left(\cdot, t = 72, \cdot, b_{71}, \cdot\right) = V^1\left(\cdot, t = 72, \cdot, b_{71} + CV, \cdot\right)$$

where V^0 and V^1 are the value functions before and after a change respectively. Compensated variations are then averaged across individuals and compared to changes in the average PDV of Medicaid payments.

7.1 Changes in Medicaid Generosity

I first perform an exercise, similar to the one performed in De Nardi *et al.* (2016) and Braun *et al.* (2017), which is to decrease or increase the Medicaid floors. Therefore, I can reevaluate the finding that the combined Medicaid/SSI program is valued at more than its cost on average while accounting for the fact that many retirees qualify for Medicaid thanks to the homestead exemption.

For specification 1, reducing Medicaid floors by 10% leads to a decline of \$976 (-9.5%) in the PDV of Medicaid payments (see table 5).[30] The corresponding average compensating variation is about 80% larger at \$1,977. Hence, this suggests that, at the margin, Medicaid is valued at more than its cost on average. This holds true within all permanent-income quintiles, in particular for the top one for which the average compensating variation is 16 times larger than the reduction in the PDV of Medicaid payments. However, a 10% increase of Medicaid floors would be valued on average at less than its cost. There is however heterogeneity by income. For those in higher income quintiles, an expansion of Medicaid is valued at more than its cost, suggesting

[29] I use 2,000 replications per retirees aged 72 and use the 1998 individual HRS weights when computing profiles and averages. These weights are zero for those in nursing home in 1998 but the share of these individuals is small. In any case, unweighted profiles and averages appear very similar to weighted ones.

[30] The PDVs displayed here are significantly lower (except for the bottom income quintile) than those in table 7 of De Nardi *et al.* (2016). The difference can mostly be traced back to the fact that their model generates Medicaid payments significantly larger than those in the MCBS data. The figures in their table 5 suggest that their model overestimates Medicaid payments by factors of 1.1, 1.4, 2.1, 2.0 and 1.8 for those in the bottom to top income quintile. Adjusting the PDVs in their paper by these factors suggest PDVs (reexpressed in 1998 dollars) of \$26.4k, \$18.2k, \$8.4k, \$6.2k and \$3.8k for those in the bottom to top income quintile. These figures are globally in line with those obtained here (one difference is that their PDVs are for retirees aged 74, which affects mostly the value for SSI beneficaries), showing that the low elasticity of medical consumption that I estimate is also key to reproduce more closely Medicaid payments.

Table 5: Costs and benefits of changing in Medicaid generosity

	specification 1					specification 2				
		floors down 10%		floors up 10%			floors down 10%		floors up 10%	
income quintile	PDV	ΔPDV	CV	ΔPDV	CV	PDV	ΔPDV	CV	ΔPDV	CV
1	31,129	-1,487	3,337	5,648	-2,987	33,614	-997	6,130	5,979	-5,468
2	16,300	-2,543	3,758	3,327	-2,385	19,261	-2,961	12,870	3,892	-7,929
3	7,668	-977	1,394	1,009	-1,372	10,159	-1,284	10,262	1,406	-9,448
4	3,308	-249	906	250	-800	6,080	-652	20,314	676	-13,578
5	1,380	-70	1,121	69	-911	3,720	-450	46,770	455	-26,742
all	10,282	-976	1,977	1,746	-1,569	12,888	-1,231	21,516	2,173	-13,789

that an increased generosity of the medically-needy pathway would be valued at more than its cost by current retirees.[31]

For specification 2, the compensating variation corresponding to a reduction in Medicaid generosity is an order of magnitude larger and it is particularly large for those in the upper permanent-income quintiles. This can be traced back to the fact that the curvature of the utility function is estimated to be much larger in this specification ($\gamma = 7.06$ compared to 3.01). As a consequence of this high curvature increases in consumption (especially at already high levels of consumption) are not much valued, while decreases in consumption (especially when going from high levels of consumption to those offered by Medicaid) are very costly. In the model, richer individuals respond to the lower floors by self-insuring significantly more through higher savings (which reduces consumption). In addition, given the incomplete market environment that they face, this self insurance cannot restore fully the insurance they have lost from a reduction in Medicaid generosity. In addition, the lower value placed on bequests for this specification increases the opportunity cost of self insurance with respect to specification 1. All this implies that an expansion of Medicaid is highly valued in this specification.

It is nonetheless quite plausible that specification 2 significantly overestimates the loss (gain) from a reduction (expansion) in Medicaid generosity. Indeed, the high compensated variations, high value of γ and relatively week bequest motives suggest a high valuation of long-term care insurance and life

[31] Although informative, these welfare computations are evidently partial as they do not account for adjustments which could occur prior to retirement. Considering the full life cycle, and thus allowing for more time to adjust to the considered changes, may reduce some of the welfare costs of reducing Medicaid generosity.

Table 6: Costs and benefits of removing of the homestead exemption

	specification 1			specification 2		
income quintile	PDV	ΔPDV	CV	PDV	ΔPDV	CV
1	31,129	-1,369	3,055	33,614	-1,815	5,446
2	16,300	-1,344	2,178	19,261	-1,360	3,441
3	7,668	-573	610	10,159	-277	894
4	3,308	-179	241	6,080	-47	773
5	1,380	-1	5	3,720	-24	441
all	10,282	-611	1,049	12,888	-608	1,930

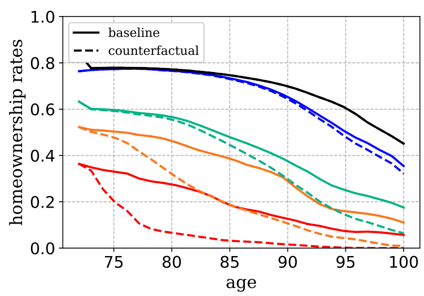
annuities, while the demand for these products is quite low in the data.[32] The results in Lockwood (2018) and Achou (2018) suggest that the parameter estimates in specification 1 are more consistent with such low demands. As a consequence, I have reestimated specification 2 imposing $\gamma = 3$, $\phi_W = .95$ and $c_W = 15,000$ (parameters globally in line with those estimated in Lockwood (2018)). The results for this specification (in the online appendix) are qualitatively similar to those in specification 1, suggesting that the results are generally robust to specifications globally consistent with the low demand for long-term care insurance.

7.2 Removing the Homestead Exemption

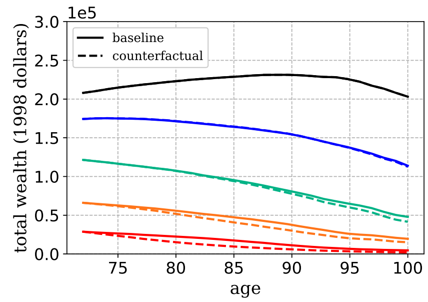
I now turn to the evaluation of the Medicaid features which are the main focus of this paper and first evaluate the consequences of removing the homestead exemption, that is of setting $\overline{ph}$ to \$0. Taking the distribution of wealth and housing at age 72 as given, specification 1 and 2 suggest that removing this exemption would reduce Medicaid payments by 5.9% (611/10,282) and 4.7% (608/12,888) (table 6), which is not negligible. This is roughly three fifths and one half of the reductions that arise from reducing Medicaid floors by 10%. The cost reduction at the given distribution may however be understated for higher-income retirees as they rely less on the homestead exemption than in the data.

Tables 6 also shows that, in both specifications, the average compensating variation turns out to be larger than the average reduction in PDV and this

[32]Long-term care insurance, in particular, are far from perfect insurance products as they can feature significant loads, far from complete coverage (Brown and Finkelstein, 2007), and as people with pre-existing conditions may not be allowed to purchase them (Hendren, 2013; Braun *et al.*, 2019). In addition, existing policies have experienced significant increases in premia and several companies have stopped selling new ones. Nonetheless, with the compensating variations computed for specification 2 it would be very difficult to rationalize the small size of the market even with significant loads and far from complete coverage.



(a) Homeownership



(b) Total wealth

Figure 7: Effect of removing the homestead exemption - specification 1

Notes: Panels a and b: homeownership rates and total wealth. Solid lines: baseline model. Dotted lines: no homestead exemption ($\overline{ph} = 0$). Each line corresponds to retirees in a given PI quintile. Red, orange, green, blue, and black lines correspond to retirees in the bottom (first) to top (fifth) PI quintiles.

is true within all permanent-income quintiles. Thus, removing the homestead exemption while redistributing the proceeds would result in a reduction of welfare on average. This is in large part due to the large estimated value for the extra utility from homeownership ϕ_o, and in part because of bequest motives. All else equal, figure 7a shows that removing the homestead exemption generates a significant decline in homeownership rates for those in the lower permanent-income quintiles, and thus to significant reductions in utility because of the high estimated ϕ_o. This also translates in lower wealth (and thus lower bequests) especially at older ages (see figure 7b).[33] These figures can be linked to figure 4b which showed the effect of removing the homestead exemption on Medicaid rates. As highlighted earlier, this would postpone Medicaid recipiency for many lower-income retirees, but would increase Medicaid rates at older ages because of faster wealth decumulation.

If we were to model the full life cycle, it is thus plausible that lower permanent-income retirees would actually enter retirement with lower homeownership rates and lower wealth and thus would qualify earlier for Medicaid than in the counterfactual here. In fact, removing the homestead exemption may amplify the adverse effect of means-tested programs on wealth accumulation highlighted in Hubbard *et al.* (1995). Indeed, the high valuation of homeownership combined with the homestead exemption incentives saving through housing. This housing wealth can in turn be used to finance nursing home stays if needed which alleviates some of Medicaid costs. Overall, this suggests that the cost reduction for the Medicaid program may be lower than the one

[33]Similar patterns are found for specification 2.

computed in this exercise, while the utility loss as measured by the compensating variations is likely to remain. Lower homeownership rates may also lower house prices through general equilibrium effects which would further reduce budgetary savings. Overall, the results in this section suggest that removing the homestead exemption may have large negative consequences on well-being with possibly limited budgetary savings for Medicaid in the long run.

Tables 6 also shows that, among current retirees, those receiving the largest absolute transfers from the homestead exemption are low-permanent-income ones, and not middle- or higher-income ones. Although transfers resulting from the homestead exemption are likely understated for higher-income retirees, it is unlikely, given the large differences in the numbers in table 6, that this result would be overcome. Thus, transfers resulting from the homestead exemption are mostly directed towards current low-income retirees.

7.2.1 Robustness with Higher Borrowing

As a robustness, I perform a similar exercise in specifications featuring a reverse-mortgage-type loan (see the online appendix).[34] In principle, by expanding borrowing possibilities, this may reduce the value retirees place in the homestead exemption. Despite this, I still find that average compensating variations needed to maintain utility at its level before the removal are higher than the reduction in the PDV of Medicaid payments. The above results thus appear robust to having (realistically) higher borrowing possibilities. This is despite the fact that the model with a reverse mortgage predicts more retirees in debt than observed in the data and that reverse mortgages in reality may not be available to all retired homeowners.[35] [36]

7.3 Estate Recovery

In principle, Medicaid is allowed to recover the payments it made to deceased beneficiaries if the latter have estates left at the end of their lives. Up to here, the model assumed there was no estate recovery as various sources suggest that the estate recovery program has been far from fully enforced to date.[37] However, given the policy discussions about a stricter enforcement of this part

[34] All the parameters were kept at their estimated values.

[35] In particular, not all types of dwellings do qualify for reverse mortgages and there are additional requirements for reverse mortgages in reality than those present in the model.

[36] Interestingly, all else equal, introducing a reverse mortgage slightly increases the PDV of Medicaid payments. Although introducing reverse mortgages can allow people to substitute away from Medicaid, it also makes the dissaving incentives highlighted in Hubbard *et al.* (1995) more operative. The model seems to indicate that the latter may dominate.

[37] Estate recovery also adds a continuous state variable which would increase estimation time significantly.

of the program, it is essential to understand its potential effects on Medicaid costs, the welfare of retirees, and on the level of redistribution.

I thus consider two types of recovery. The first one is closer to the one currently in place in principle. It recovers the part of medical spending paid by Medicaid but not SSI transfers. $\Sigma_t^{Medicaid}$ is defined recursively and records how much Medicaid can recover if a retirees dies at the end of t:

$$\Sigma_t^{Medicaid} = \begin{cases} R\Sigma_{t-1}^{Medicaid} + Medicaid_t & \text{if categorically needy} \\ -\left(\underline{Y} - \max\left(y_t + rb_{t-1} - y_d; 0\right)\right) & \\ R\Sigma_{t-1}^{Medicaid} + Medicaid_t & \text{otherwise} \end{cases}$$

The last term in parentheses for the categorically needy corresponds to the SSI transfer they would receive. So that $Medicaid_t$ minus this term is the transfer made by Medicaid to cope with medical spending. For the medically needy, only $Medicaid_t$ enters the formula of $\Sigma_t^{Medicaid}$. $\Sigma_t^{Medicaid}$ acts as an implicit debt to the Medicaid program and grows at a rate R. Estate recovery thus transforms the homestead exemption partly into a loan made by the Medicaid program to homeowners. I also consider a recovery program which would include SSI transfers as well. In this case, we have $\Sigma_t^{Medicaid} = R\Sigma_{t-1}^{Medicaid} + Medicaid_t$. Bequests are now given by:

$$Beq_{t+1} = \max\left\{ \left(R + \mu\mathbf{1}\left\{b_t < 0\right\}\right) b_t + p^h(ty+1)h_t\left(1-\phi_p\right) - R\Sigma_t^{Medicaid}; 0\right\}$$

and recovered amounts for a retiree dying at the end of t are given by:

$$recovery = \min\left\{ \left(R + \mu\mathbf{1}\left\{b_t < 0\right\}\right) b_t + p^h(ty+1)h_t\left(1-\phi_p\right); R\Sigma_t^{Medicaid}\right\}$$

In table 7, the column labeled "no behavioral reactions" displays how much Medicaid could recuperate, in PDV, if there were no behavioral reactions following the introduction of the estate recovery. This is simply done by simulating the model without estate recovery (so that the term $R\Sigma_t^{Medicaid}$ does not appear in Beq_{t+1}) but still computing $R\Sigma_t^{Medicaid}$ and the corresponding *recovery* at death. Focusing on specification 1 and the partial recovery, the model predicts a PDV of recovered estates of 9.9% of Medicaid payments without behavioral reactions. This is comparable to what Medicaid would save by reducing the floors by 10%. However, given the significant bequest motives for this specification, the actual recovered amounts represent only 5.4% of the PDV of Medicaid payments.[38] This stems from the fact that, once having

[38]By comparison, De Nardi *et al.* (2012) show that estate recovery was 0.8% of Medicaid's spending on

Table 7: Costs and benefits of estate recovery

		specification 1				specification 2			
type of recovery	income quintile	*PDV*	no behavioral reactions	actual	*CV*	*PDV*	no behavioral reactions	actual	*CV*
partial	1	31,129	2,111	1,439	1,095	33,614	3,761	3,759	90
	2	16,300	2,013	1,078	1,317	19,261	2,752	2,742	1,963
	3	7,668	923	458	850	10,159	1,121	1,102	4,724
	4	3,308	343	98	729	6,080	420	386	15,817
	5	1,380	164	25	1,251	3,720	213	161	69,875
	all	10,282	1,019	552	1,053	12,888	1,474	1,448	22,191
full	1	31,129	2,959	1,852	1,531	33,614	4,510	4,508	98
	all	10,282	1,164	626	1,116	12,888	1,608	1,582	22,192

Notes: No change between partial and full recovery for PI quintiles 2 to 5.

received Medicaid payments, incentives to dissave (in particular, for housing) become stronger following the introduction of estate recovery. Importantly, changes in the PDV of Medicaid payments (not shown) appear little affected by the introduction of the estate recovery so that the model does not predict that estate recovery would reduce Medicaid rates significantly. I even find a small increase overall in the PDV of Medicaid payments due to the higher incentives to dissave as leaving a bequest becomes less likely.

Compensating variations are on average higher than the amounts recovered although it is not the case for those in the bottom permanent-income quintile. This is due to the fact that bequest motives are usually not operative for them so that a reduction of \$1 of (expected) bequest is less valued than an increase of \$1 of initial wealth, which can be used to increase consumption. Bequests are however operative for higher permanent-income individuals who value significantly the "bequest insurance" under no estate recovery.[39]

The full estate recovery only changes recovered amounts for those in the bottom permanent-income quintile who qualify for SSI. In this case the actual recovered amounts go from 5.4% to 6.1% of Medicaid payments. The average compensating variation remains larger than the recovered amounts.

nursing homes and that for the most successful state (Oregon) this amount was 5.8%. The latter figure appears globally consistent with the figures I find although there is not a one-to-one mapping between the figures in De Nardi *et al.* (2012) and those in the current paper. First, the denominator here is combined spending by SSI and Medicaid (and not only spending by Medicaid on nursing homes). Second, in the model retirees do not benefit at all from the homestead exemption in nursing homes. While this is consistent with Medicaid rules, some retirees appear to still have homes while being in nursing homes and it is possible that Medicaid does not fully recuperate them when they die.

[39]It could be interesting to also analyze the quantitative effect on the welfare of potential heirs. This is however beyond the scope of this paper.

In specification 2, due to less widespread and weaker bequest motives, the difference between the theoretical and actual amounts recovered is small. As a matter of fact, actual amounts are about twice as large as in specification 1 at about 11.2%. However, compensating variations are much larger than recovered amounts in this specification. This is due to the fact that the high estimated γ implies a large value of insuring bequest for those with relatively high consumption.[40]

Finally, parallel to the findings for the homestead exemption, introducing estate recovery has the largest absolute negative effect on the expected bequests of low-income retirees, and not on those of higher-income retirees.

7.4 Main Takeaways

The first takeaway is that the homestead exemption is valued at more than its cost in all specifications considered. The stability of this result is probably linked to the fact that many homeowners do rely on Medicaid. In principle, these retirees could sell their homes and increase their consumption relative to what is enabled by Medicaid. This is especially the case for older homeowners who have a short life expectancy. As they usually do not sell their houses, it suggests that they value homeownership a lot and that this value must be higher than the utility they would gain from selling their homes and consuming more than what is available through Medicaid. ϕ_o is estimated to be large in great part because of the extent of this trade-off, and matching simultaneously wealth, homeownership and Medicaid usage is key to capture the latter well.

The second takeaway is that, for the sample considered, recovered estate could represent up to approximately 10% of Medicaid costs. If bequest motives are quite widespread recovered amounts could actually end up lower. In specification 1, in which bequest motives are quite strong, recovered amounts are just 5.4% of Medicaid costs. The availability of devices not in the model such as trusts (see for instance Greenhalgh-Stanley (2012)) could reduce these amounts further. Thus, the figure of 10% is most likely an upper bound. Regarding the overall effect on welfare of estate recovery, there is a quite large uncertainty due to uncertainty about how prevalent bequest motives are. While the qualitative results for the welfare analysis of the homestead exemption and

[40] To see this, notice that average consumption for those in the top permanent-income quintile is around $22k. Abstracting, for simplicity, from housing and medical spending this implies a marginal utility of consumption of $22^{-7.06} = 3.3 \times 10^{-10}$. The marginal utility of bequest is $W'(Beq) = (c_W + (1-\phi_W)/\phi_W \times Beq)^{-\gamma}$, so that the marginal utility at zero bequest is $c_W^{-\gamma} = 4.5 \times 10^{-8}$ which is more than 130 times larger. This implies a large willingness to insure bequests. On the other hand, for those with consumption initially lower than c_W the marginal utility of consumption is larger than the one at no bequest so there is no willingness to insure bequests.

Medicaid generosity are robust in all the specifications I considered (including some with exogenous medical spending), assessments of whether estate recovery is beneficial or not are more sensitive to the bequest motive.

The third takeaway is that Medicaid is generally valued on average at more than its cost, confirming the results in De Nardi *et al.* (2016) and Braun *et al.* (2017). This is despite the fact that allowing for the homestead exemption does change significantly the path of Medicaid usage, and that the model here generates patterns which are sometimes quite different from those generated by those models. Also, this result appears robust across specifications despite the fact that they sometimes rely on very different saving motives. Overall, it seems that matching simultaneously the relatively high Medicaid rates and the slow dissaving in the data quite systematically point to a significant valuation of Medicaid relative to its cost. In a model without bequest motives the reason is crystal clear: the slow dissaving suggests strong precautionary motives while the relatively high Medicaid rates suggest that people are willing to use this insurance device (and thus value it). Introducing bequest motives allows for possibly lower precautionary savings. However, bequest motives cannot be too prevalent (c_W cannot be too low) as this would induce lower permanent-income retirees to save significantly more than in the data, which would reduce their eligibility to Medicaid. So the data limit both the prevalence of bequest motives in the model and how valued they are relative to the insurance provided by Medicaid. Given the significant uncertainty relative to the importance of precautionary versus bequest motives for saving, the apparent robustness of this result seems quite remarkable.

Finally, removing the homestead exemption, introducing estate recovery, or reducing Medicaid generosity all tend to redistribute money away from low-permanent-income retirees.[41] It is thus plausible that these changes would reduce redistribution, and that including redistributive concerns would reinforce the welfare gains from the homestead exemption and Medicaid generosity.

8 Conclusion

The special treatment of housing is an important and debated part of the Medicaid and SSI programs, but little is known about its costs, benefits and redistributive implications. This paper shows that the homestead exemption 1) explains important patterns of Medicaid recipiency, 2) is highly valued across the pension-income distribution, 3) incentivizes savings, which reduce

[41] This is particularly the case given the progressivity of the tax structure financing Medicaid documented, for instance, in De Nardi *et al.* (2016).

its cost for Medicaid, and 4) redistributes mostly to those with lower incomes. The analysis also shows that estate recovery programs have uncertain payouts but would likely have the largest absolute negative effect on the expected bequests of low-income retirees. The analysis also reevaluates other aspects of the Medicaid program in the presence of the homestead exemption. Importantly, it shows that most of the heterogeneity in out-of-pocket medical spending by income in the HRS can be explained by differences in Medicaid recipiency rates. Future work is needed to evaluate the welfare benefits of the homestead exemption considering the full life cycle and potential equilibirum effects. Evaluating whether some of the conclusions reached here would differ for couples is also of interest. This would likely require modeling informal care between spouses and care-setting decisions as retirees in a couple are less likely to be in nursing homes when facing difficulties with activities of daily living.

References

Achou, B. (2018) Housing Liquidity and Long-Term Care Insurance Demand: a Quantitative Evaluation, *Working Paper*, pp. 1–56.

Almenberg, J., Lusardi, A., Säve-Söderbergh, J. and Vestman, R. (2018) Attitudes Towards Debt and Debt Behavior, *NBER Working Paper 24935*.

Ameriks, J., Briggs, J., Caplin, A., Tonetti, C. and Shapiro, M. D. (2019) Long-Term Care Utility and Late in Life Saving, *Journal of Political Economy (forthcoming)*.

Ameriks, J., Caplin, A., Laufer, S. and Van Nieuwerburgh, S. (2011) The Joy of Giving or Assisted Living? Using Strategic Surveys to Separate Public Care Aversion from Bequest Motives, *Journal of Finance*, **66**, 519–561.

Barczyk, D. and Kredler, M. (2018) Evaluating Long-Term Care Policy Options, Taking the Family Seriously, *Review of Economic Studies*, **85**, 766–809.

Braun, R. A., Kopecky, K. A. and Koreshkova, T. (2017) Old, Sick, Alone, and Poor: A Welfare Analysis of Old-Age Social Insurance Programmes, *The Review of Economic Studies*, **84**, 580–612.

Braun, R. A., Kopecky, K. A. and Koreshkova, T. (2019) Old, Frail, and Uninsured: Accounting for Puzzles in the U.S. Long-Term Care Insurance Market, *Econometrica*, **87**, 981–1019.

Brown, J. R. and Finkelstein, A. (2007) Why is the Market for Long-Term Care Insurance so Small?, *Journal of Public Economics*, **91**, 1967–1991.

Brown, J. R. and Finkelstein, A. (2008) The Interaction of Public and Private Insurance: Medicaid and the Long-Term Care Insurance Market, *American Economic Review*, **98**, 1083–1102.

Chernof, B. A. and Warshawsky, M. J. (2014) Recommendations from the Federal Commission on Long-Term Care: Blueprint for a Bipartisan Path Forward, *Public Policy & Aging Report*, **24**, 37–39.

Comission on Long-Term Care (2013) Report to Congress, Tech. rep.

Davidoff, T. (2009) Housing, Health, and Annuities, *The Journal of Risk and Insurance*, **76**, 31–52.

Davidoff, T. (2010) Home Equity Commitment and Long-Term Care Insurance Demand, *Journal of Public Economics*, **94**, 44–49.

De Donder, P. and Leroux, M.-L. (2020) Long Term Care Insurance with State-Dependent Preferences, *Working Paper CREEI*.

De Nardi, M., French, E. and Jones, J. (2010) Why Do the Elderly Save? The Role of Medical Expenses, *Journal of Political Economy*, **118**, 39–75.

De Nardi, M., French, E. and Jones, J. B. (2016) Medicaid Insurance in Old Age, *American Economic Review*, **106**, 3480–3520.

De Nardi, M., French, E., Jones, J. B. and Gooptu, A. (2012) Medicaid and the Elderly, *NBER Working Paper 17689*.

Fonseca, R., Michaud, P.-C., Galama, T. and Kapteyn, A. (2020) Accounting for the Rise of Health Spending and Longevity, *Journal of the European Economic Association (forthcoming)*.

French, E. and Jones, J. B. (2011) The Effects of Health Insurance and Self-Insurance on Retirement Behavior, *Econometrica*, **79**, 693–732.

French, E., Jones, J. B. and McCauley, J. (2017) The Accuracy of Economic Measurement in the Health and Retirement Study, *Forum for Health Economics and Policy*, **20**, 1–31.

Greenhalgh-Stanley, N. (2012) Medicaid and the housing and asset decisions of the elderly: Evidence from estate recovery programs, *Journal of Urban Economics*, **72**, 210–224.

Hendren, N. (2013) Private Information and Insurance Rejections, *Econometrica*, **81**, 1713–1762.

Hubbard, R. G., Skinner, J. and Zeldes, S. P. (1995) Precautionary Saving and Social Insurance, *Journal of Political Economy*, **103**, 360.

Kaul, K. and Goodman, L. (2017) Seniors' Access to Home Equity, *Urban Institute Reseach Report*.

Kopczuk, W. and Lupton, J. P. (2007) To Leave or not to Leave: the Distribution of Bequest Motives, *Review of Economic Studies*, **74**, 207–235.

Kopecky, K. A. and Koreshkova, T. (2014) The Impact of Medical and Nursing Home Expenses on Savings and Inequality, *American Economic Journal: Macroeconomics*, **6**, 29–72.

Lockwood, L. M. (2018) Incidental Bequests: Bequest Motives and the Choice to Self-Insure Late-Life Risks, *American Economic Review*, **108**, 2513–2550.

McGee, R. (2019) Old Age Savings and House Price Shocks, *Working Paper*.

Nakajima, M. and Telyukova, I. A. (2017) Reverse Mortgage Loans: A Quantitative Analysis, *Journal of Finance*, **72**, 911–949.

Nakajima, M. and Telyukova, I. A. (2019) Home Equity in Retirement, *International Economic Review (forthcoming)*.

Palumbo, M. G. (1999) Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle, *The Review of Economic Studies*, **66**, 395–421.

Thaler, R. H. (1990) Anomalies Saving, Fungibility, and Mental Accounts, *Journal of Economic Perspectives*, **4**, 193–205.

Venti, S. and Wise, D. (1990) But they don't want to reduce housing equity, in *Issues in the Economics of Aging* (Ed.) D. A. Wise, University of Chicago Press, January, pp. 13–32.

Venti, S. F. and Wise, D. A. (1989) Aging, Moving, and Housing Wealth, in *The Economics of Aging* (Ed.) D. A. Wise, University of Chicago Press, pp. 9–54.

Venti, S. F. and Wise, D. A. (2004) Aging and Housing Equity: Another Look, in *Perspectives on the Economics of Aging*, June, pp. 127–180.

Warshawsky, M. J. and Marchand, R. A. (2017) Improving the System of Financing Long-Term Services and Supports for Older Americans, *Mercatus Working Paper*.

Yao, R. and Zhang, H. H. (2005) Optimal Consumption and Portfolio Choices with Risky Housing and Borrowing Constraints, *Review of Financial Studies*, **18**, 197–239.

For Online Publication

Appendix to "Housing in Medicaid: Should it Really Change?"

Bertrand Achou

Section A describes how a reverse-mortgage-type loan is introduced in the model and how it is calibrated. Section B describes a similar model to the one in the main text but with exogenous medical expenditures. Section C provides additional details about the estimation. Section D describes the estimates for the model with exogenous medical spending. Section E describes counterfactual results for specifications not in the main text. Section F shows the moments for specifications 1 and 2 in the main text. Section G describes the computational method. Section H describes the solution to the intratemporal problem of allocating spending between consumption, medical consumption and housing. Section I highlights that the low elasticity of medical consumption that I find is globally in line with the estimation results from the strategic survey questions in Ameriks et al. (2019).

A Reverse Mortgages

A.1 In the model

Reverse Mortgages enter as an additional state variable RM_{t-1} indicating whether the retiree has a reverse mortgage. The constraints for those not using reverse mortgages are unchanged.

A.1.1 Homeowners getting a reverse mortgage

First, we consider the case of a homeowner who did not have a reverse mortgage ($RM_{t-1} = 0$) and decides to get one ($RM_t = 1$). To do so, she must not sell her home and needs to have $hs_t \neq nh$. She also has to pay a fixed transaction cost $\phi^{RM}p^h(ty)h_t$ which enters as an additional term on the right-hand side of (6) in the main text. In exchange, she faces the borrowing constraint:

$$b_t \geq -d_t^o \lambda_t^{RM} p^h\left(ty\right)h_t$$

instead of (7) in the main text. The interest of getting a reverse mortgage is that λ_t^{RM} is growing over time while λ_t is declining. However, in addition to the fixed cost, the extra interest rate on reverse mortgages μ^{RM} is larger than the one on standard forward mortgages μ. Hence, a reverse mortgage gives access to a looser borrowing constraint but this comes at a cost.

A.1.2 Homeowners with a reverse mortgage

For a homeowner who already had a reverse mortgage in the previous period ($RM_{t-1} = 1$), the budget constraint is:

$$\begin{aligned} b_t \;& = (1 - d_t^s)\left(R + \mu^{RM}\mathbf{1}\left\{b_{t-1} < 0\right\}\right)b_{t-1} \\ & + d_t^s \max\left\{\left(R + \mu^{RM}\mathbf{1}\left\{b_{t-1} < 0\right\}\right)b_{t-1} + p^h(ty)h_{t-1}\left(1 - \phi_p\right); 0\right\} \\ & + y_t - \tau_t + Medicaid_t - x_t^{c,h,m} \end{aligned}$$

Compared to the equations in the main text, the first line simply indicates that a non-selling homeowner inherits her past debt or liquid assets. The second line makes explicit that reverse mortgages are non-recourse loans, i.e. the maximum repayment is bounded by the resale value of the home. Finally, if the homeowner does not sell her home the borrowing constraint is:

$$b_t \geq \min\left\{-p^h\left(ty\right)h_t\lambda_t^{RM}; \left(R + \mu^{RM}\right)b_{t-1}\right\}$$

It indicates that a reverse mortgage does not have to be repaid even if the previous loan balance plus interests gets larger than $p^h\left(ty\right)h_t\lambda_t^{RM}$. At this point, the line of credit just grows at the interest rate and, although the retiree cannot use the reverse mortgage to finance additional consumption anymore, she does not have to make payments on the loan.

A.1.3 Reverse mortgages and nursing home stays

A homeowner with a reverse mortgage and who moves to nh is constrained to repay her reverse mortgage, up to the limit of the resale value of her home. In most cases, this is done by selling the home but I also allow it to occur by paying the loan balance with pension income.

A.1.4 Medicaid

For Medicaid, introducing reverse mortgages changes only the formula for assets $\tilde{A}_t^{med}$ considered in Medicaid's asset-test:

$$\tilde{A}_t^{med} = \begin{cases} \mathbf{1}\left\{b_{t-1} \geq 0\right\} Rb_{t-1} + \overline{ph}_t^{med} & \text{if } d_{t-1}^o = 0 \text{ or } d_t^o = 1 \\ \max\Big\{ \left(R + \mu \times \mathbf{1}\left\{b_{t-1} < 0\right\}\right) b_{t-1} & \text{if } d_t^s = 1 \text{ and } RM_{t-1} = 0 \\ +p^h(ty)h_{t-1}\left(1 - \phi_p\right); 0\Big\} & \\ \max\Big\{ \left(R + \mu^{RM} \times \mathbf{1}\left\{b_{t-1} < 0\right\}\right) b_{t-1} & \text{if } d_t^s = 1 \text{ and } RM_{t-1} = 1 \\ +p^h(ty)h_{t-1}\left(1 - \phi_p\right); 0\Big\} & \end{cases}$$

A.2 Bequests

With reverse mortgages, the formula for bequests is:

$$\begin{aligned} Beq_{t+1} = \max\Big\{ & \left(R + \left(\mu\left(1 - RM_t\right) + \mu^{RM} RM_t\right) \mathbf{1}\left\{b_t < 0\right\}\right) b_t \\ & + p^h(ty+1)h_t\left(1 - \phi_p\right); 0\Big\} \end{aligned}$$

A.3 Parametrization of reverse mortgages

For reverse mortgages, I set the fixed cost ϕ_{RM} and the extra interest μ_{RM} to 5% and 1.7%. These numbers are from Nakajima and Telyukova (2017) but do not include the cost of the reverse mortgage loan insurance. Including it would result in a fixed cost and an interest rate 2 and 1.3 percentage points higher, which would make reverse mortgages worse substitutes for the homestead exemption. The constraint is based figures from the brochure "Reverse Mortgage Loans: Borrowing Against your Home" by the AARP and imposing $\lambda_t^{RM} \leq 0.8$. Figure A.1 plots the collateral constraint for the reverse mortgage along the one for the constraint used for standard mortgages in specification 1. The latter is shown for a house value of \$85,000 (the mid-point on the housing grid). Apart from those in the top income category, the income-to-repayment constraint is the binding requirement and not the downpayment one, reflecting the fact that many retirees may have difficulty borrowing out of housing equity because of income requirements (Caplin, 2002). The reverse

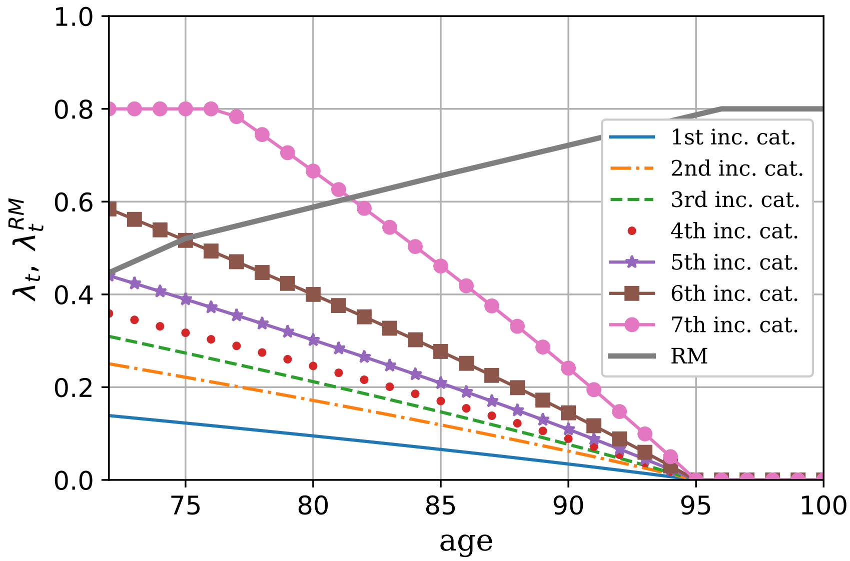


Figure A.1: Collateral constraint for Standard and Reverse Mortgages

mortgage collateral constraint loosens with age and is significantly looser than the standard mortgage one at older ages.

B The model with exogenous medical spending

In the model with exogenous medical spending the term $\mu(t, hs_t, \varepsilon_t) \times m_t^{1-\sigma} / (1-\sigma)$ does not appear in the utility function and medical spending are given by:

$$\ln m_t = \overline{\mu}(t, hs_t) + \overline{\sigma}(t, hs_t)\,\epsilon_t;\ \varepsilon_t \sim \mathcal{N}(0, 1)$$

With $\overline{\mu}(t, hs_t)$ and $\log \overline{\sigma}(t, hs_t)$ being a function of the same variables as in the model with endogenous medical spending. Importantly, they do not depend on permanent-income, wealth or education. Hence, in the model with exogenous medical spending, richer or poorer retirees face the same m_t. Budget constraints are similar apart from the fact that all $q(hs_t)\, p_t^m m_t$ is replaced by just m_t.

Categorically-needy retirees receive Medicaid transfers of:

$$Medicaid_t = \begin{cases} \max\Big\{0; \underline{Y} + m_t - \\ \max\left(y_t + rb_{t-1} - y_d; 0\right)\Big\} & \text{if } y_t + rb_{t-1} - y_d \leq \underline{Y} \text{ and } A_t^{med} = 0 \\ 0 & \text{otherwise} \end{cases}$$

For medically-needy retirees receive:

$$Medicaid_t = \max\left\{0; \underline{x}_{mn}^{c,h} + m_t - \left(A_t^{med} + y_t - \tau_t\right)\right\}$$

Finally, for the categorically-needy:

$$Medicaid_t = 0 \text{ if } x_t^{c,h} > \underline{Y} + y^d + \min\left\{A_d, \max\left\{0, \tilde{A}_t^{med}\right\}\right\}$$

and for the medically-needy:

$$Medicaid_t = 0 \text{ if } x_t^{c,h} > \underline{x}_{mn}^{c,h} + \min\left\{A_d, \max\left\{0, \tilde{A}_t^{med}\right\}\right\}$$

C Estimation

C.1 Variables Definitions

First of all, we need to determine the model's counterparts of the variables we are targeting. Notice that the time of the interview in the data will never align perfectly with the timing in the model. The convention I use is that for a state variable observed in t, its model's counterpart is the average of the corresponding state variable indexed by $t-1$ and t (that is the one inherited from the previous period and the one chosen today). For a control variable observed in t, its model's counterpart is the corresponding control variable indexed by t.

With this in mine, liquid_wealth_t is defined in the model as:

$$\text{liquid\_wealth}_t = \left(b_{t-1} + b_t\right)/2$$

debt_t is defined:

$$\text{debt}_t = \left(1\{b_{t-1} < 0\} + 1\{b_t < 0\}\right)/2$$

home_ownership_t is:

$$\text{home\_ownership}_t = \left(d^o_{t-1} + d^o_t\right)/2$$

Whether the individual is receiving Medicaid is defined by:

$$\text{receives\_medicaid}_t = 1\{Medicaid_t > 0\}$$

Medical expenditures before Medicaid payments are:

$$\text{med\_exp}_t = \begin{cases} q\left(hs_t\right) p^m_t m_t & \text{if } hs_t \neq nh \\ x^{c,h}_t + q\left(hs_t\right) p^m_t m_t & \text{if } hs_t = nh \end{cases}$$

Notice that medical expenditures in nursing homes include the shelter component of the nursing home as it is normally included in the out-of-pocket medical expenditures for nursing home residents in the data.[1] Finally, out-of-pocket medical expenditures are defined as:

$$\text{oop\_med\_exp}_t = \max\left\{0; \text{med\_exp}_t - Medicaid_t\right\}$$

C.2 Estimation procedure

The methodology for the second stage similar to the one in the online appendix of De Nardi et al. (2016). I summarize briefly the minimization procedure here. For more details, the interested reader can refer to their online appendix.

Let $\mathbf{\Delta}$ be the vector of second stage parameters and $\boldsymbol{\chi}$ the vector of first stage parameters. For each simulated individual, we compute liquid_wealth_t, debt_t, home_ownership_t, $\text{receives\_medicaid}_t$ and oop_med_exp_t which are functions of $(\mathbf{\Delta}, \boldsymbol{\chi})$. From the simulated data, we can then compute:

- $\text{liquid\_wealth}^{med}_{cht,t,I}\left(\mathbf{\Delta}, \boldsymbol{\chi}\right)$: the median liquid wealth of individuals in year t in cohort cht and income group I;

- $\text{liquid\_wealth}^{75th}_{cht,t,I}\left(\mathbf{\Delta}, \boldsymbol{\chi}\right)$: the 75^{th} percentile of liquid wealth of individuals in year t in cohort cht and income group I;

- $\overline{home\_ownership}_{cht,t,I}\left(\mathbf{\Delta}, \boldsymbol{\chi}\right)$: the homeownership rate of individuals in year t in cohort cht and income group I;

- $\overline{home\_ownership}_{cht,hs}\left(\mathbf{\Delta}, \boldsymbol{\chi}\right)$: the homeownership rate of individuals of cohort cht and health hs_t;

[1]However, for homeowners who would remain in their homes, the maintenance cost on the homes they own is not in $x^{c,h}_t$.

- $\overline{receives\_medicaid}_{cht,t,I}(\boldsymbol{\Delta}, \boldsymbol{\chi})$: the medicaid rate of individuals in year t in cohort cht and income group I;

- $\text{oop\_med\_exp}^{med}_{cht,t,I}(\boldsymbol{\Delta}, \boldsymbol{\chi})$: the median out-of-pocket medical expenditures of individuals in year t in cohort cht and income group I;

- $\text{oop\_med\_exp}^{90th}_{cht,t,I}(\boldsymbol{\Delta}, \boldsymbol{\chi})$: the median out-of-pocket medical expenditures of individuals in year t in cohort cht and income group I.

- $\overline{\text{oop\_mex\_exp}}_t(\boldsymbol{\Delta}, \boldsymbol{\chi})$: the mean out-of-pocket medical expenditures in year t.

Let's denote $\text{liquid\_wealth}^{hrs}_{i,t}$, debt_t, $\text{home\_ownership}^{hrs}_{i,t}$, $\text{receives\_medicaid}^{hrs}_{i,t}$ and $\text{oop\_med\_exp}^{hrs}_{i,t}$ be the observed values for liquid_wealth_t, debt_t, home_ownership_t, $\text{receives\_medicaid}_t$ and oop_med_exp_t in the data for an individual i aged t (or in year ty). The different moment conditions at the true value $\boldsymbol{\Delta}_0$ and $\boldsymbol{\chi}_0$ for $\boldsymbol{\Delta}$ and $\boldsymbol{\chi}$ are of the form:

$$E\Bigg(\Bigg(\mathbf{1}\left\{\text{liquid\_wealth}^{hrs}_{i,t} \leq liquid\_wealth^{med}_{cht,t,I}(\boldsymbol{\Delta}_0, \boldsymbol{\chi}_0)\right\} - \frac{1}{2}\Bigg) \times \mathbf{1}\{cht_i = cht\}$$
$$\times \mathbf{1}\{I_i = I\} \times \mathbf{1}\{i \text{ observed in } t\} | t\Bigg) = 0$$

$$E\Bigg(\Bigg(\mathbf{1}\left\{\text{liquid\_wealth}^{hrs}_{i,t} \leq liquid\_wealth^{75th}_{cht,t,I}(\boldsymbol{\Delta}_0, \boldsymbol{\chi}_0)\right\} - \frac{3}{4}\Bigg) \times \mathbf{1}\{cht_i = cht\}$$
$$\times \mathbf{1}\{I_i = I\} \times \mathbf{1}\{i \text{ observed in } t\} | t\Bigg) = 0$$

$$E\Bigg(\left(\text{home\_ownership}^{hrs}_{i,t} - \overline{home\_ownership}_{cht,t,I}(\boldsymbol{\Delta}_0, \boldsymbol{\chi}_0)\right) \times \mathbf{1}\{cht_i = cht\}$$
$$\times \mathbf{1}\{I_i = I\} \times \mathbf{1}\{i \text{ observed in } t\} | t\Bigg) = 0$$

$$E\Bigg(\left(\text{receives\_medicaid}^{hrs}_{i,t} - \overline{receives\_medicaid}_{cht,t,I}(\boldsymbol{\Delta}_0, \boldsymbol{\chi}_0)\right) \times \mathbf{1}\{cht_i = cht\}$$
$$\times \mathbf{1}\{I_i = I\} \times \mathbf{1}\{i \text{ observed in } t\} | t\Bigg) = 0$$

$$E\Bigg(\left(\mathbf{1}\left\{\text{oop\_med\_exp}_{i,t}^{hrs} \leq \text{oop\_med\_exp}_{cht,t,I}^{med}\left(\boldsymbol{\Delta}_0, \boldsymbol{\chi}_0\right)\right\} - \frac{1}{2}\right) \times \mathbf{1}\left\{cht_i = cht\right\} \times \mathbf{1}\left\{I_i = I\right\} \times \mathbf{1}\left\{i \text{ observed in } t\right\} | t\Bigg) = 0$$

$$E\Bigg(\left(\mathbf{1}\left\{\text{oop\_med\_exp}_{i,t}^{hrs} \leq \text{oop\_med\_exp}_{cht,t,I}^{75th}\left(\boldsymbol{\Delta}_0, \boldsymbol{\chi}_0\right)\right\} - \frac{3}{4}\right) \times \mathbf{1}\left\{cht_i = cht\right\} \times \mathbf{1}\left\{I_i = I\right\} \times \mathbf{1}\left\{i \text{ observed in } t\right\} | t\Bigg) = 0$$

$$E\Bigg(\left(\text{oop\_med\_exp}_{i,t}^{hrs} - \overline{\text{oop\_mex\_exp}}_t\left(\boldsymbol{\Delta}_0, \boldsymbol{\chi}_0\right)\right) \times \mathbf{1}\left\{i \text{ observed in } t\right\} | t\Bigg) = 0$$

Assuming that the first-stage parameters are set to their true values, the J moment conditions above are stored in a $J \times 1$ vector $\boldsymbol{\varphi}_N\left(\boldsymbol{\Delta}, \boldsymbol{\chi}_0\right)$ where N is the number of individuals in the data. The estimated value for $\boldsymbol{\Delta}$ is given by:

$$\hat{\boldsymbol{\Delta}} = \text{argmin}_{\boldsymbol{\Delta}} \frac{N}{1 + \frac{N}{N_S}} \hat{\boldsymbol{\varphi}}_N\left(\boldsymbol{\Delta}, \boldsymbol{\chi}_0\right)' \hat{\boldsymbol{W}}_N \hat{\boldsymbol{\varphi}}_N\left(\boldsymbol{\Delta}, \boldsymbol{\chi}_0\right)$$

$\hat{\boldsymbol{W}}_N$ is the weighting matrix which is diagonal with each element being the inverse of the variance of the corresponding moment,[2] and is estimated from the data. $N_S = 20 \times N$ is the number of simulated individuals. The variance-covariance matrix of the estimated parameters and χ^2 statistics are computed in the usual way:

$$\boldsymbol{V} = \left(1 + \frac{N}{N_S}\right)\left(\boldsymbol{D}'\boldsymbol{W}\boldsymbol{D}\right)^{-1}\boldsymbol{D}'\boldsymbol{W}\boldsymbol{S}\boldsymbol{W}\boldsymbol{D}\left(\boldsymbol{D}'\boldsymbol{W}\boldsymbol{D}\right)^{-1} \tag{C.1}$$

with $\boldsymbol{D}$ is the gradient matrix and $\boldsymbol{S}$ is the variance-covariance matrix of the different moments. To find $\hat{\boldsymbol{\Delta}}$, I use a the a variant of the Tik-Tak algorithm described in Arnoud et al. (2019). I first conduct a grid search based on a sobol sequence.[3] In this step, I evaluate the model at 3,000 different vectors. I then run the BOBYQA algorithm developed by Powell (2009) from 18 different starting vectors.[4]

[2] Debt rates tend to be given a lot of weight as they are low. To avoid giving them too much importance relative to other moments, I divide the weights given to these moments by 5.

[3] The library sobol_seq0.1.2 was used: https://pypi.org/project/sobol_seq/.

[4] I use the Py-BOBYQA package (Cartis et al., 2019). Previous estimations of the model were done using the Nelder-Mead simplex algorithm from the Scipy library. At the time I was going to run the final

D Estimates of medical needs/spending parameters and of the model with exogenous medical expenditures

Table D.1 displays the estimated values of the parameters for similar specifications than those in the main text but with exogenous medical spending. Both specifications rely on relatively high values of β of 1.08 and 1.02. The curvature parameters γ is in between those obtained in the main text at 4.62 and 5.29. Both β and γ are larger than values estimated in De Nardi et al. (2010). The model needs such high values to generate the slow dissaving in the data as Medicaid's floors are much larger than the consumption floor estimated in De Nardi et al. (2010). In addition, the two specifications rely on bequest motives which kick in at relatively high levels of consumption and which are not particularly strong.

Table D.2 shows the estimates for the medical needs or spending parameters. One noticeable feature is that $0 < \mu^{md} < \mu^{hd} < \mu^{nh}$ reflecting the fact that medical expenditures tend to rise with the level of disability. The parameters for the models with exogenous medical spending are very close to each other. For the model with endogenous medical spending, the estimates are quite different simply because μ needs to adjust with changes in γ and σ to generate a similar level of medical expenditures.

Despite the fact that medical spending m_t does not depend on permanent-income, the exogenous model generates significant heterogeneity by permanent income in out-of-pocket medical spending (after Medicaid transfers). This can be seen from the left panel of figure D.1. This is thanks to the fact that the model generates heterogeneity in Medicaid rates close to the one in the data (see the right panel of the same figure). The model fits a little less well some dimensions of out-of-pocket expenditures than the model with endogenous medical expenditures (notably out-of-pocket spending of low-income retirees). It is not totally surprising as in the model with endogenous medical expenditures the elasticity of medical consumption with respect to consumption is low but not zero (around 20% all else equal).[5] Nonetheless, the model

estimations for the paper, I found out about the paper by McGee (2019) who claim that the BOBYQA algorithm is usually faster than the Nelder-Mead simplex one. I thus did run both algorithms starting from the same (limited number of) vectors and I indeed found that in my case the BOBYQA algorithm converged significantly faster while giving as good results as the Nelder-Mead one. I am thankful to McGee (2019) for the hint as this has helped reduce estimation time.

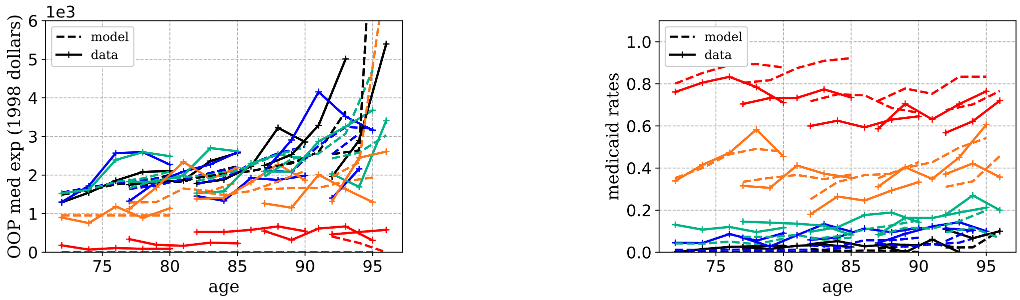
[5] For specification 1, the distance between the model and the data is 2202 with endogenous medical spending and 2709 with exogenous medical spending. For specification 2, these figures are 2191 and 2563 respectively, showing that the model with endogenous medical spending does a better job at matching the

Table D.1: Parameters' estimates (exogenous medical expenditures)

		(1)		(2)	
		estimate	s.e.	estimate	s.e.
Preference					
β	time preference	1.08	0.01	1.02	0.01
γ	curvature (non-medical spending)	4.62	0.05	5.29	0.07
ϕ_0	homeownership preference	0.18	0.01	0.20	0.00
ϕ_W	bequest strength	0.56	0.06	0.70	0.09
c_W	bequest curvature	17,132	1,240	20,408	2,270
κ_0^{debt}	disutility of debt (intercept)	3.91E-06	1.94E-06	na	
κ_1^{debt}	disutility of debt (slope)	1.34e-2	4.87e-3	na	
Medicaid					
$\underline{Y} = \underline{x}^{c,h}_{en,\cancel{nh}}$	SSI income threshold	5,612	8	4,700	12
$\underline{x}^{c,h}_{mn,\cancel{nh}}$	medically needy floor community	6,389	30	6,378	36
$\underline{x}^{c,h}_{en,nh}$, $\underline{x}^{c,h}_{mn,nh}$	floor in nursing home	10,682	437	15,983	1,033
Borrowing constraint					
λ_{72}	at age 72	na		0.234	0.031
λ_{82}	at age 82	na		0.070	0.001
λ_{92}	at age 92	na		0.021	0.001

Table D.2: Medical needs/spending parameters

	(1)		(2)		(3)		(4)	
	estimate	s.e.	estimate	s.e.	estimate	s.e.	estimate	s.e.
μ_0	14.431	0.171	34.265	0.383	7.315	0.020	7.329	0.019
μ_1	0.306	0.008	0.764	0.017	0.014	0.001	0.013	0.001
μ_2	-0.005	0.001	-0.015	0.002	0.000	0.000	0.000	0.000
μ^{md}	3.766	0.156	9.905	0.407	0.221	0.014	0.260	0.015
μ^{hd}	5.998	0.467	16.670	0.722	0.498	0.022	0.477	0.047
μ_0^{nh}	7.638	0.987	16.568	1.232	2.426	0.051	2.489	0.047
μ_1^{nh}	-0.152	0.028	-0.408	0.033	-0.013	0.002	-0.012	0.003
μ_2^{nh}	0.010	0.003	0.041	0.004	0.001	0.000	0.001	0.000
σ_0	2.660	0.019	3.505	0.017	-0.216	0.008	-0.201	0.005
σ_1	0.004	0.001	0.003	0.001	-0.003	0.002	-0.004	0.001
σ_2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
σ^{md}	0.067	0.013	0.057	0.008	0.087	0.008	0.105	0.013
σ^{hd}	0.194	0.028	0.243	0.014	0.269	0.020	0.300	0.027
σ_0^{nh}	0.472	0.029	0.510	0.019	-0.195	0.009	-0.199	0.015
σ_1^{nh}	0.006	0.002	0.006	0.001	0.025	0.002	0.023	0.002
σ_2^{nh}	0.000	0.000	0.000	0.000	-0.001	0.000	-0.001	0.000
endogenous med. exp.	Yes		Yes		No		No	
utility cost of debt	Yes		No		Yes		No	



(a) Median out-of-pocket expenditures

(b) Medicaid rates

Figure D.1: Specification 1 with exogenous medical expenditures

Notes: Panel a and b: out-of-pocket medical spending and medicaid moments. Solid lines: data. Dotted lines: model. Each line corresponds to retirees in a given permanent-income (PI) quintile and cohort followed over time. Red, orange, green, blue, and black lines correspond to retirees in the bottom (first) to top (fifth) PI quintile.

with exogenous medical spending does a good job at reproducing most of the heterogeneity in out-of-pocket spending by permanent income.

E Counterfactual results for other specifications than those in the main text

Tables E.1 to E.3 show the counterfactual results for specification 2 but imposing $\gamma = 3$, $\phi_W = .95$ and $c_W = 15,000$. The results end up close to those in specification 1 in the main text. This specification also generates similar changes to Medicaid and homeownership rates than in specification 1 when the homestead exemption is removed. For this specification, when estate recovery is introduced, recuperated amounts through estate recovery are estimated larger on average than compensated variations. However, Medicaid spending (not shown) increase by about \$750 on average after the change, which makes overall Medicaid savings lower than compensated variations on average.

Tables E.4 to E.6 show the counterfactual results for the specifications with exogenous medical spending. The results for the changes in Medicaid generosity and the removal of the homestead exemption are quite similar to those for specification 2 in the main text. However, the removal of the homestead exemption has very little effect on welfare for these specifications as bequests become only operative at high levels of consumption.

targeted moments.

Table E.1: Costs and benefits of changing in Medicaid generosity (specification 2 with $\gamma = 3$, $\phi_W = .95$ and $c_W = 15,000$)

		floors down 10%		floors up 10%	
income quintile	PDV	ΔPDV	CV	ΔPDV	CV
1	39,511	-1,957	7,546	5,646	-3,707
2	22,750	-2,664	6,066	3,380	-3,199
3	12,459	-1,218	2,418	1,327	-2,110
4	6,211	-386	1,091	438	-993
5	2,708	-130	814	133	-645
all	14,639	-1,155	3,206	1,880	-1,949

Table E.2: Costs and benefits of removing of the homestead exemption (specification 2 with $\gamma = 3$, $\phi_W = .95$ and $c_W = 15,000$)

income quintile	PDV	ΔPDV	CV
1	39,511	-1,997	6,417
2	22,750	-1,412	3,401
3	12,459	-642	1,214
4	6,211	-209	491
5	2,708	-2	19
all	14,639	-733	1,954

Table E.3: Costs and benefits of estate recovery (specification 2 with $\gamma = 3$, $\phi_W = .95$ and $c_W = 15,000$)

	income quintile	PDV	theoretical	actual	CV
partial recovery	1	39,511	3,645	2,502	1,212
	2	22,750	2,880	1,859	1,259
	3	12,459	1,516	757	1,105
	4	6,211	669	227	914
	5	2,708	352	39	979
	all	14,639	1,664	964	1,078

Table E.4: Costs and benefits of changing in Medicaid generosity (exogenous model)

	specification 1					specification 2				
		floors down 10%		floors up 10%			floors down 10%		floors up 10%	
income quintile	PDV	ΔPDV	CV	ΔPDV	CV	PDV	ΔPDV	CV	ΔPDV	CV
1	37,474	-3,770	27,379	2,903	-5,067	37,224	-4,412	18,953	4,386	-5,055
2	16,401	-2,227	11,804	3,047	-5,822	17,191	-2,196	9,804	2,990	-5,362
3	6,834	-599	6,170	810	-5,211	7,663	-644	5,080	781	-4,651
4	3,047	-166	7,859	158	-6,153	3,553	-148	5,548	165	-4,478
5	1,305	-96	13,202	85	-10,392	1,646	-69	10,242	47	-7,809
all	11,001	-1,172	12,519	1,240	-6,814	11,486	-1,253	9,442	1,443	-5,602

Table E.5: Costs and benefits of removing of the homestead exemption (exogenous model)

	specification 1			specification 2		
income quintile	PDV	ΔPDV	CV	PDV	ΔPDV	CV
1	37,474	-3,438	11,649	37,224	-2,845	8,515
2	16,401	-2,239	4,770	17,191	-1,719	4,066
3	6,834	-504	1,225	7,663	-542	1,412
4	3,047	-128	631	3,553	-139	1,028
5	1,305	-6	281	1,646	-16	996
all	11,001	-1,073	3,090	11,486	-891	2,792

Table E.6: Costs and benefits of estate recovery (exogenous model)

		specification 1				specification 2			
	income quintile	PDV	theoretical	actual	CV	PDV	theoretical	actual	CV
partial recovery	1	37,474	3,369	3,360	174	37,224	3,611	3,608	45
	2	16,401	2,088	2,073	177	17,191	1,933	1,930	62
	3	6,834	564	552	187	7,663	709	707	109
	4	3,047	157	145	237	3,553	243	231	250
	5	1,305	40	33	513	1,646	89	76	783
	all	11,001	1,095	1,084	275	11,486	1,137	1,130	289

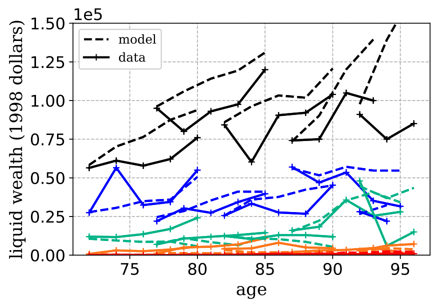
F Main moments for both specifications with endogenous medical expenditures

Figures F.1 and F.2 show some of the main moments for specifications 1 and 2 in the main text. Specification 1 generates more savings than specification 2, due in part to the more prevalent bequest motives. Albeit some differences, homeownership rate profiles look very similar for both specifications. Specification 2 generates higher debt rates than in the data for those in the second income quintile. Specification 1 matches debt rates more closely and also generates more bunching at zero liquid wealth for homeowners. The figures for bunching actually look very similar to those in the data for this specification (available upon request). Finally, both specifications match Medicaid rates and out-of-pocket medical spending quite well. The main difference is that specification 2, relative to specification 1, generates less Medicaid rates at the bottom and more at the top of the permanent-income distribution.

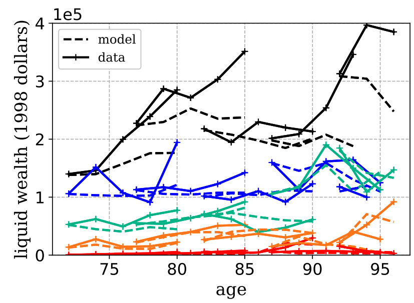
G Computational method

The computational method is standard. I discretize the grid for b_t using 60 points with more density at low values. The maximum point on the grid is \$10 million. The grid for consumption has 160 points with more density at low values and goes from \$300 to \$231,000 (or 10 times the largest value for pension income $y(I)$). The housing grid has 9 points corresponding to house values in 1998 equal to \$11k, \$35k, \$50k, \$70k, \$85K, \$123k, \$170k, \$217k and \$350k. I discretize medical expenditures ε_t using Tauchen and Hussey method with 5 grid points. I solve the model backwards separately for each gender, income and cohort to find the value function $V_t(.)$ for each t. I then use this value function to simulate the model forward. For values of b_t which lie within the grids I use linear interpolation. Given that the highest value for b_t is large compared with the wealth in my sample, I assume that for $b_t \geq b_{max}$, the value function is equal to the one at b_{max}. When allowing for estate recovery, I use bi-dimensional linear interpolation. The grid for $\Sigma_t^{Medicaid}$ has 20 points with more density at low values. The grid ranges from 0 to one million dollars.

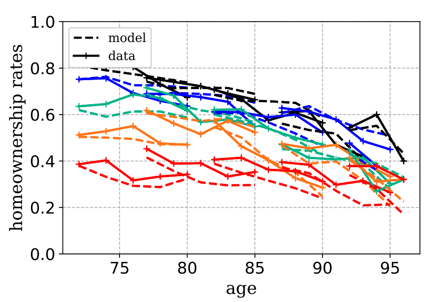
To solve for the maximization problem I use standard grid search. For renters, I limit the range of values to look for on the consumption grid by using the (intratemporal) first order condition between c_t and h_t. The codes for the model are in Python 3. I use the Anaconda distribution (2019) which can be downloaded freely from https://www.continuum.io/downloads, and includes



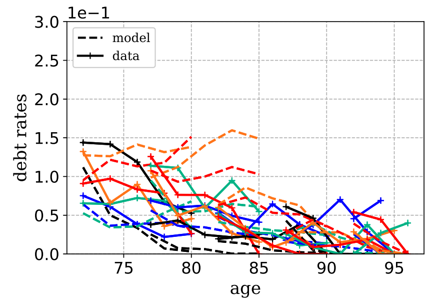
(a) Median liquid wealth



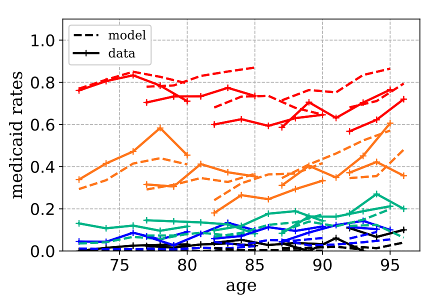
(b) 75^{th} percentile liquid wealth



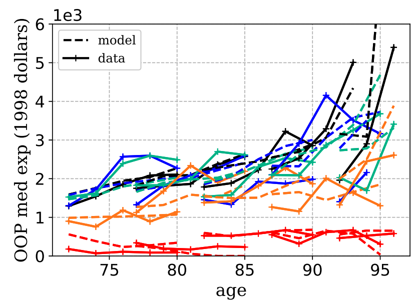
(c) Homeownership rates



(d) Debt rates

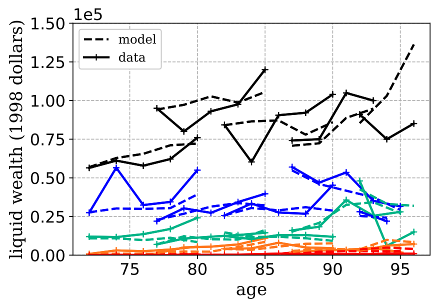


(e) Medicaid rates

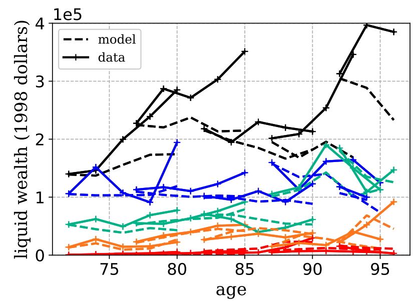


(f) Median out-of-pocket medical expenses

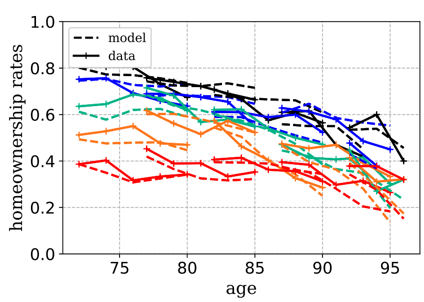
Figure F.1: Specification 1 with endogenous medical spending



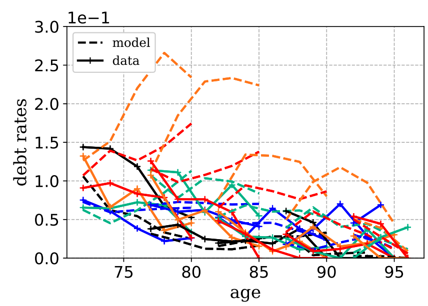
(a) Median liquid wealth



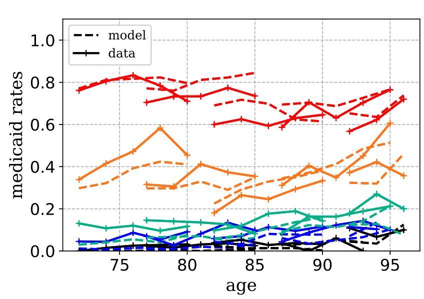
(b) 75^{th} percentile liquid wealth



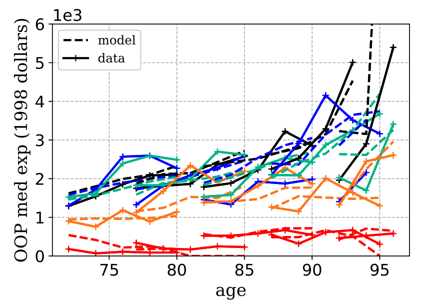
(c) Homeownership rates



(d) Debt rates



(e) Medicaid rates



(f) Median out-of-pocket medical expenses

Figure F.2: Specification 2 with endogenous medical spending the most popular libraries for numerical work or data analysis (mainly Numpy (Oliphant., 2006; van der Walt et al., 2011), Scipy (Virtanen et al., 2019), Matplotlib (Hunter, 2007), Numba (Lam et al., 2015), Pandas (McKinney, 2010)). The most computationally-intensive part of the program (which is to simulate the model for a given set of parameters) uses the just-in-time compiler capabilities of Numba. Solving one iteration of the model in the estimation step takes about 2 minutes on a iMac Pro (2017) with a 3GHz Intel Xeon W Processor (featuring 20 virtual processors) and 64Go of RAMs. For the counterfactuals, the simulation of the model without estate recovery takes about 8 minutes and the one with estate recovery takes about 20 minutes.[6]

H Solution to intratemporal problem

The Lagrangean for the intratemporal problem is:

$$\begin{aligned}\mathcal{L} =& \frac{\left(\left(1+\phi_o d_t^o\right) c_t^{\omega} \tilde{h}_t^{1-\omega}\right)^{1-\gamma}}{1-\gamma} + \mu\left(\cdot\right) \times \frac{m_t^{1-\sigma}}{1-\sigma} \\ &+\lambda\left(x_t^{c,h,m} - c_t - d_t^o \psi^h p^h\left(ty\right) h_t - \left(1-d_t^o\right) r^h\left(ty\right) h_t - q\left(hs_t\right) p_t^m m_t\right)\end{aligned}$$

We have the two first order conditions relative to c_t and m_t:

$$\omega\left(1+\phi_o d_t^o\right) c_t^{\omega-1} \tilde{h}_t^{1-\omega}\left(\left(1+\phi_o d_t^o\right) c_t^{\omega} \tilde{h}_t^{1-\omega}\right)^{-\gamma} = \lambda$$

$$\mu\left(\cdot\right) \times m_t^{-\sigma} = q\left(hs_t\right) p_t^m \lambda$$

Implying:

$$\begin{aligned} q\left(hs_t\right) p_t^m \omega\left(1+\phi_o d_t^o\right)^{1-\gamma} c_t^{\omega(1-\gamma)-1} \tilde{h}_t^{(1-\omega)(1-\gamma)} &= \mu\left(\cdot\right) \times m_t^{-\sigma} \\ \Rightarrow m_t^{\sigma} &= \frac{\mu\left(\cdot\right)}{\omega q\left(hs_t\right) p_t^m}\left(1+\phi_o d_t^o\right)^{\gamma-1} c_t^{1+\omega(\gamma-1)} \tilde{h}_t^{(1-\omega)(\gamma-1)} \\ \Rightarrow m_t &= \left[\frac{\mu\left(\cdot\right)}{\omega q\left(hs_t\right) p_t^m}\left(\left(1+\phi_o d_t^o\right) \tilde{h}_t^{1-\omega}\right)^{\gamma-1} c_t^{1+\omega(\gamma-1)}\right]^{1/\sigma}\end{aligned}$$

For a renter who could pick any housing size, we further have the first-order condition relative to :

$$\begin{aligned}\left(1-\omega\right) c_t^{\omega} \tilde{h}_t^{-\omega}\left(c_t^{\omega} \tilde{h}_t^{1-\omega}\right)^{-\gamma} &= \lambda r^h\left(ty\right) \\ \Rightarrow \frac{c_t}{\tilde{h}_t} &= \frac{\omega}{1-\omega} r^h\left(ty\right)\end{aligned}$$

[6]The model can be run without problems on a computer with a more standard processor (such as the popular Intel I7). It will just take more time.

From this we can compute c_t and $\tilde{h}_t$ in nursing home for a given x_t^{nh}:

$$c_t = \omega x_t^{nh}$$
$$\tilde{h}_t = (1-\omega)\, x_t^{nh} / r^h\,(ty)$$

From this we can compute the corresponding m_t:

$$m_t = \left[\frac{\mu(\cdot)}{\omega q\,(hs_t)\, p_t^m}\left(\frac{(1-\omega)\, x_t^{nh}}{r^h\,(ty)}\right)^{(1-\omega)(\gamma-1)} \left(\omega x_t^{nh}\right)^{1+\omega(\gamma-1)}\right]^{1/\sigma}$$
$$\Rightarrow m_t = \left[\frac{\mu(\cdot)}{\omega q\,(hs_t)\, p_t^m}\left(\frac{(1-\omega)}{r^h\,(ty)}\right)^{(1-\omega)(\gamma-1)} (\omega)^{1+\omega(\gamma-1)} \left(x_t^{nh}\right)^{(1-\omega)(\gamma-1)+1+\omega(\gamma-1)}\right]^{1/\sigma}$$
$$\Rightarrow m_t = \left[\frac{\mu(\cdot)}{q\,(hs_t)\, p_t^m}\left(\frac{(1-\omega)}{r^h\,(ty)}\right)^{(1-\omega)(\gamma-1)} \omega^{\omega(\gamma-1)} \left(x_t^{nh}\right)^{\gamma}\right]^{1/\sigma}$$
$$\Rightarrow m_t = \left[\frac{\mu(\cdot)}{q\,(hs_t)\, p_t^m}\left((1-\omega)^{(1-\omega)}\,\omega^{\omega} r^h\,(ty)^{(\omega-1)}\right)^{(\gamma-1)} \left(x_t^{nh}\right)^{\gamma}\right]^{1/\sigma}$$

I Comparison with Ameriks et al. (2019)

In this section, I show that the low estimated elasticity of medical expenditures that I estimate, on top of being key to reproduce well important dimensions of the HRS data, is also in line with the estimates, obtained using strategic survey questions (SSQs), of the utility when needing long-term care in Ameriks et al. (2019).

First, I show that their specification of the utility in long-term care can possibly be interpreted as a limit case of the type of utility I consider, when $\sigma >> \gamma$. To see this, consider the type of SSQs that they use to estimate the marginal utility of spending (including long-term care) when needing help with activities of daily living (ADLs) (see section 4.1 in their paper), but considering a utility specification similar to the one in my paper with, in addition, a marginal utility of consumption when needing help with ADLs which is allowed to vary.

Suppose than a retiree is asked to solve the following allocation problem :

$$\max \pi \frac{c_1^{1-\gamma}}{1-\gamma} + (1-\pi)\left[\delta \frac{c_2^{1-\gamma}}{1-\gamma} + \mu \frac{m_2^{1-\sigma}}{1-\sigma}\right]$$

$$s.t.\ c_1 + p_2\,(c_2 + q m_2) \leq W$$

where π is the probability to be healthy (implicitly with $\mu = 0$) and $1 - \pi$ is the probability to need help with ADLs. δ allows for the marginal utility of consumption to vary when needing help with ADLs and μ affects the marginal utility of medical or long-term care spending.

The first order conditions are:

$$\pi c_1^{-\gamma} = \lambda$$

$$(1 - \pi)\, \delta c_2^{-\gamma} = \lambda p_2$$

$$(1 - \pi)\, \mu m_2^{-\sigma} = \lambda p_2 q$$

with λ the multiplier on the constraint. With $p_2 = (1 - \pi)$ as in their SSQs, we get:

$$c_2 = (\delta/\pi)^{1/\sigma}\, c_1$$

$$m_2 = (\mu/\,(\delta q))^{1/\sigma}\, c_2^{\gamma/\sigma}$$

If $\sigma >> \gamma$:

$$m_2 = (\mu/\,(\delta q))^{1/\sigma}\, c_2^{\gamma/\sigma} \simeq (\mu/\,(\delta q))^{1/\sigma}$$

Notice that μ (which is unobservable) can be arbitrarily large (for a given large σ) in order to generate a given level of medical spending qm_2. As a consequence, the term $(\mu/\,(\delta q))^{1/\sigma}$ does not need to be close to 1 when σ is large.

From the above, we see that, when $\sigma >> \gamma$, the above allocation problem is approximately equivalent to:

$$\pi \frac{c_1^{1-\gamma}}{1-\gamma} + (1 - \pi) \left[\delta \frac{c_2^{1-\gamma}}{1-\gamma} + \mu \frac{(\mu/\,(\delta q))^{(1-\sigma)/\sigma}}{1-\sigma} \right]$$

$$s.t.\ c_1 + p_2 \left(c_2 + q\, (\mu/\delta q)^{1/\sigma} \right) \leq W$$

which can be rewritten as:

$$\pi \frac{z_1^{1-\gamma}}{1-\gamma} + (1 - \pi)\, \delta \frac{\left(z_2 - q\, (\mu/\,(\delta q))^{1/\sigma} \right)^{1-\gamma}}{1-\gamma}$$

$$s.t.\ z_1 + p_2 z_2 \leq W$$

with $z_1 \equiv c_1$ and $z_2 = c_2 + qm_2$. Doing an additional change of notation with $(\theta_{ADL})^{-\gamma} \equiv \delta$ and $\kappa_{ADL} \equiv -q\, (\mu/\,(\delta q))^{1/\sigma}$, we obtain exactly the same setting as in section 4.1 in Ameriks et al. (2019).

We can now show that the very negative κ_{ADL} they find is globally in line with the estimates I find for σ. To see this consider, the initial allocation problem but with $\sigma = \gamma$ (a case close to De Nardi et al. (2016) who find $\gamma = 2.83$ and $\sigma = 2.99$). In this case, we have:

$$c_2 = (\delta/\pi)^{1/\gamma} c_1$$

$$m_2 = (\mu/(\delta q))^{1/\gamma} c_2$$

$$W = c_1 + (1-\pi)(c_2 + qm_2)$$

implying:

$$c_1 = \frac{W}{1 + (1-\pi)(\delta/\pi)^{1/\gamma} + (1-\pi) q (\mu/(q\pi))^{1/\gamma}} \tag{I.1}$$

On the other hand, the allocation problem supposed in Ameriks et al. (2019) gives:

$$c_1 = \frac{W - (1-\pi) q (\mu/(\delta q))^{1/\sigma}}{1 + (1-\pi)(\delta/\pi)^{1/\gamma}}$$

or

$$c_1 = \frac{W + (1-\pi)\kappa_{ADL}}{1 + (1-\pi)(1/\pi)^{1/\gamma} (\theta_{ADL})^{-1}}$$

Their estimates rest on how much c_1 individuals choose. If they estimated $\kappa_{ADL} \simeq 0$, this would tend to reject a model with $\sigma >> \gamma$ and would favor estimates in which $\sigma \simeq \gamma$ as in De Nardi et al. (2016). Indeed, in this case it would suggest that the decision rules to their SSQs that they observe are close to (I.1), and that c_1 is linear in wealth W (and so c_1/W is constant). However, the fact that they estimate a largely negative $\kappa_{ADL} = -\$37,000$ is globally more in line with a model with $\sigma >> \gamma$ in which c_1/W tends to increase with wealth.

References

(2019). Anaconda Software Distribution. Computer software. Version 3.

Ameriks, J., Briggs, J., Caplin, A., Tonetti, C., and Shapiro, M. D. (2019). Long-Term Care Utility and Late in Life Saving. *Journal of Political Economy (forthcoming).*

Arnoud, A., Guvenen, F., and Kleineberg, T. (2019). Benchmarking Global Optimizers. *NBER Working Paper Series.*

Caplin, A. (2002). Turning Assets into Cash : Problems and Prospects in the Reverse Mortgage Market. In Mitchell, O. S., Bodie, Z., Hammond, B., and Zeldes, S., editors, *Innovations in Retirement Financing*, chapter 3, pages 234–253. University of Pennsylvania Press, Philadelphi PA.

Cartis, C., Fiala, J., Marteau, B., and Roberts, L. (2019). Improving the flexibility and robustness of model-based derivative-free optimization solvers. *ACM Transactions on Mathematical Software*, 45(3).

De Nardi, M., French, E., and Jones, J. (2010). Why Do the Elderly Save? The Role of Medical Expenses. *Journal of Political Economy*, 118(1):39–75.

De Nardi, M., French, E., and Jones, J. B. (2016). Medicaid Insurance in Old Age. *American Economic Review*, 106(11):3480–3520.

Hunter, J. D. (2007). Matplotlib: A 2D Graphics Environment. *Computing in Science & Engineering*, 9:90–95.

Lam, S. K., Pitrou, A., and Seibert, S. (2015). Numba: A LLVM-based python JIT compiler. *Proceedings of the Second Workshop on the LLVM Compiler Infrastructure in HPC - LLVM '15*, pages 1–6.

McGee, R. (2019). Old Age Savings and House Price Shocks. *Working Paper.*

McKinney, W. (2010). Data Structure for Statistical Computing in Python. *Proceedings of the 9yh Python in Science Conference (Scipy 2010)*, pages 51–56.

Nakajima, M. and Telyukova, I. A. (2017). Reverse Mortgage Loans: A Quantitative Analysis. *Journal of Finance*, 72(2):911–949.

Oliphant., T. E. (2006). *A guide to Numpy.*

Powell, M. (2009). The BOBYQA algorithm for bound constrained optimization without derivatives. *NA Report NA2009/06*, page 39.

van der Walt, S., Colbert, S. C., and Varoquaux, G. (2011). The NumPy Array: A Structure for Efficient Numerical Computation. *Computing in Science & Engineering*, 13:22–30.

Virtanen, P., Gommers, R., Oliphant, T. E., Haberland, M., Reddy, T., Cournapeau, D., Burovski, E., Peterson, P., Weckesser, W., Bright, J., van der Walt, S. J., Brett, M., Wilson, J., Millman, K. J., Mayorov, N., Nelson, A. R. J., Jones, E., Kern, R., Larson, E., Carey, C., Polat, Ä., Feng, Y., Moore, E. W., VanderPlas, J., Laxalde, D., Perktold, J., Cimrman, R., Henriksen, I., Quintero, E. A., Harris, C. R., Archibald, A. M., Ribeiro, A. H., Pedregosa, F., van Mulbregt, P., and Contributors, S. . . (2019). SciPy 1.0: Fundamental Algorithms for Scientific Computing in Python. *Nature Methods*.