

# Medical Expenses and Saving in Retirement: The Case of U.S. and Sweden\*

Makoto Nakajima<sup>†</sup>

Federal Reserve Bank of Philadelphia

Irina A. Telyukova<sup>‡</sup>

University of California, San Diego

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## Abstract

The “retirement saving puzzle” in the literature is the phenomenon that many households in the U.S. have significant wealth late in life, contrary to the predictions of a simple life-cycle model. In this paper, we use cross-country variation in out-of-pocket (OOP) medical and long-term-care expenses late in life to investigate the role of such spending in encouraging the elderly to save. The comparison of U.S. and Sweden provides a stark setting, with Sweden having, on average, low OOP medical and long-term-care expenses, and having all but eliminated the risk of such spending due to generous social programs, while in the U.S. OOP medical expenses and uncertainty around them are much larger late in life. Using a model of saving in retirement, where retirees face a number of uninsurable idiosyncratic shocks, and can save in housing and financial assets, we find that medical expenses motivate saving in retirement in financial assets, but does not impact homeownership or housing wealth. Specifically, medical expenses account for one-fifth of net worth decumulation, and most of financial asset decumulation, after retirement.

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<sup>†</sup>Research Department, Federal Reserve Bank of Philadelphia. Ten Independence Mall, Philadelphia, PA 19106-1574. E-mail: [makoto.nakajima@phil.frb.org](mailto:makoto.nakajima@phil.frb.org).

<sup>‡</sup>Department of Economics, University of California, San Diego. 9500 Gilman Drive, San Diego, CA 92093-0508. E-mail: [itelyukova@ucsd.edu](mailto:itelyukova@ucsd.edu).

## 1. Introduction

In the United States, households have, on average, significant positive wealth late in life. In the Health and Retirement Study, median net worth of a household at age 90 was about \$75,000 in 2006. The large literature on the subject, sometimes referred to as the “retirement saving puzzle” (RSP), has offered a number of possible explanations for why retirees do not spend down wealth quickly, which have included, among others, longevity risk, bequest motives, precautionary motives and medical expense risk, public care aversion and public policy such as Medicaid and Social Security.

Most authors in the literature study net worth of retirees. Instead, in previous work (Nakajima and Telyukova (2013)) we have shown that housing plays a major role in saving of retirees, and that once illiquidity of housing, relative to financial assets, is taken into account in a structural model of life-cycle saving, it changes previous conclusions about the relative roles of risk, bequests and other factors in explaining saving behavior late in life.<sup>1</sup> Nakajima and Telyukova (2013) also show, as other authors have done, that in the class of models often used in the literature, it is difficult to identify relative strengths of bequest and precautionary motives based on data from a single country.

In this paper, continuing on this line of work, we study the importance of out-of-pocket (OOP) medical expenses in accounting for the retirement saving puzzle in the U.S. We focus on medical expenses because the costs of medical care, particularly late in life, are a major current policy issue in the U.S. and elsewhere, and because they have been identified as a major reason for saving in retirement (e.g. De Nardi et al. (2010)). Our approach to the question builds on our previous work because we maintain the crucial differentiation between financial assets and housing assets when considering saving patterns of retirees. At the same time, we delve deeper into the question by using empirical *cross-country* variation in the extent of OOP medical expenses, which we measure directly in the data, and thus use as valuable identification information. Specifically, in addition to the U.S., we focus on the case of Sweden, whose public policy approach to both medical care and long-term care provides for universal public insurance, and thus for a low OOP medical spending level and minimal OOP spending risk. A comparison of these two very different environments allows for a laboratory in which we can test the impact of medical expenses on saving in retirement.

For empirical analysis, we use the U.S. Health and Retirement Study (HRS) and the Survey of Health, Ageing and Retirement in Europe (SHARE). SHARE was modeled after, and is harmonized with, the HRS, to characterize the saving behavior of retirees in the U.S. and a number of continental European countries. Using the two data sets, we measure OOP medical and long-term-care expenses of retirees in Sweden to be about one-tenth of those in the U.S. In Sweden, these expenses do not increase dramatically with age or income, unlike in the U.S. In terms of saving, Swedish retirees spend down financial assets more quickly

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<sup>1</sup> The role of housing had previously been studied empirically, e.g. by Venti and Wise (2004).

than in the U.S., while the age profiles of homeownership and housing assets are much more similar in the two countries. Together, these facts suggest the possibility that level and risk of medical and long-term expenses late in life affect saving in financial assets, while homeownership and saving in housing may be primarily affected by other factors, for example having to do with housing and mortgage markets, as well as preference factors such as bequest motives and others.<sup>2</sup>

To evaluate this possibility quantitatively, and investigate the possible differences in how OOP spending impacts housing and financial wealth differently, we pose a model of life-cycle saving in retirement, in the spirit of Nakajima and Telyukova (2014a), where retirees can choose whether to own or rent a house, how much to save in a financial asset, and how much to borrow against their house if they are a homeowner. Model households face health and mortality risk, as well as OOP medical and long-term-care expense risk. They have a warm-glow bequest motive. The government provides a consumption floor, which captures Medicaid in the U.S. (see De Nardi et al. (2013)).

We calibrate the benchmark model to match cross-sectional age profiles of net worth, housing and financial assets, homeownership rates, as well as indebtedness rates in the U.S. HRS data. Observable features, such as income, wealth and health distribution at age 65, health, mortality and medical expense risk, and housing markets are calibrated exogenously from our U.S. household data. We then change the observable features of the environment, particularly having to do with medical and long-term-care expenses, from the U.S. to Sweden, and compare the resulting optimal age profiles of saving to Swedish SHARE data, to measure how much of the difference in the saving behavior of retirees in the two countries is accounted for by differences in medical and long-term-care expenses.

The model predicts that OOP medical and long-term care spending accounts, on average, for one-fifth of the difference in median net worth age profiles between U.S. and Sweden, with the number ranging between 8% and 43%, depending on age. In contrast, OOP expenses account for almost all (on average, 110%) of the difference between age profiles of median financial assets. While spending level and risk impact financial asset savings visibly, housing assets do not appear to respond to it. This suggests that housing is not a precautionary asset and that retirees stay in their homes late in life for reasons other than OOP medical spending. Since housing constitutes the vast majority of net worth for a median household in both countries, this also implies that OOP medical spending can only account for a limited fraction of saving of a median retired household. Additional experiments suggest that factors associated with a lower utility of homeownership in Sweden could account for the remaining differences in dissaving rates in the two countries. What are these factors? We leave that important question for future research, though offer some thoughts in discussion.

Our research makes several contributions. First, we document and explore a new set of empirical facts

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<sup>2</sup> In Nakajima and Telyukova (2014b), we describe cross-country facts about housing and financial assets in retirement across 12 countries, which consists of the U.S., U.K., and 10 continental European countries.

about saving in retirement outside of the U.S. Second, we shed new light on saving motives of retirees using cross-country variation in policy pertaining to retirees. Our findings in this paper continue to point to the importance of separating housing from financial assets in order to understand the motives for saving behavior late in life, because risk, social insurance, bequests and other motives impact different assets differently. Thus, our findings contrast with those in previous literature that establish a link between the level and risk of OOP medical expenses and (dis)saving behavior in retirement, while treating all retiree savings as one asset (e.g. De Nardi et al. (2010)). From a policy perspective, understanding how households finance their retirement is crucial at a time when policymakers in many countries face aging populations and challenges to sustainability of social security policies. Since housing plays a key role in household portfolios of retirees, our work implies that housing market policies are important to consider in terms of their effect on financial security in retirement.

Our work is related to several strands of literature. The first is the aforementioned literature that provides explanations for the retirement saving puzzle using data on net worth in retirement. For example, Hurd (1989) studies the role of bequest motives and finds them to be small, Hubbard et al. (1995) find that government-provided social insurance should create a motive to dissave in retirement, Ameriks et al. (2011) study the relative importance of bequest motives and public care aversion for the related annuity puzzle, and De Nardi et al. (2010) emphasize the role of out-of-pocket medical expense risk in motivating the elderly to save. Lockwood (2012) considers the low demand for long-term care insurance as evidence of the relative importance of bequest motives versus precautionary motives.

In addition, we contribute to the emerging body of work that considers cross-country evidence on household portfolios, particularly among older households. Examples are Nakajima and Telyukova (2014b), a companion paper in which we describe cross-country differences in housing in retirement across 12 countries, Angelini et al. (2011), who characterize homeownership throughout the life cycle using the retrospective SHARELife survey, and Christelis et al. (forthcoming), who characterize differences in the composition of entire household portfolios in a previous wave of the data that we use, and decompose the reasons for these differences into influences of institutions versus household characteristics.

In Section 2, we discuss the data and document empirical facts about saving in retirement in the U.S. and Sweden, as well as an overview of institutions and data on out-of-pocket medical and long-term-care spending. In Section 3 we present the model, and calibrate it in Section 4. Main results are in Section 5. Section 6 explores other elements that could account for U.S.-Swedish differences in asset decumulation. Section 7 explores robustness of the main results. Finally, Section 8 concludes.

## 2. Data Facts on Saving and Out-of-Pocket Medical Spending

### 2.1. Data Sources

We use two household surveys in our analysis. The first is the U.S. Health and Retirement Study (HRS), which incorporates a large sample from the Asset and Health Dynamics among the Oldest Old (AHEAD). The second survey is the Survey of Health, Aging and Retirement in Europe (SHARE), which covers thirteen developed European countries, including Sweden. Both surveys are biennial and longitudinal: the HRS covers the period 1992-2010, while SHARE is much newer, and at the time of analysis had two waves, 2004 and 2006.<sup>3</sup> Because the panel dimension of SHARE is very short, at this point we cannot usefully construct life-cycle analyses of individuals or cohorts from it. Therefore, for easy comparison across countries, and unlike our previous work with the HRS in Nakajima and Telyukova (2013), we will study the 2006 *cross-sectional* age profiles of the desired variables, keeping in mind that inference can be affected by important composition and cohort effects.

We use the RAND versions of the surveys. RAND's version of SHARE is far less extensive than for the HRS. To augment the RAND data, we added a significant amount of raw information from SHARE, incorporating it into a comparable data set. For the most part, a direct comparison of the data is possible, upon conversion of currencies into 2000 dollars using real exchange rates and PPP adjustment. Compared to the HRS, SHARE at this stage has sparse coverage of respondents who are in nursing homes, but in the case of Sweden, this limitation is likely not crucial, because as we will show, Swedish policy provides for near-universal coverage of long-term-care expenses. This is one of the most important reasons why we chose Sweden for comparison.

We limit the sample only to those who report being mostly or fully retired in the two surveys, in order to remove variation in labor supply and labor income. In constructing the age profiles, we stop at age 90. The reason is that the SHARE data set has fairly small country sample sizes, and unlike HRS, it does not oversample the oldest old. As a result, the sample sizes of the oldest retirees get too small to construct reliable moments. To smooth noise in the data for other ages, in both surveys we put households into 5-year centered age bins, so that age 65 is actually a bin of ages 63-67. Thus, each household is categorized into five different age groups, of its actual age, as well as minus/plus two years.

### 2.2. Assets in Retirement: U.S. and Sweden

For this analysis, in order to control for cross-country income differences, we normalize all wealth variables by median income of the age-65 group. Figure 1 shows median net worth, housing and financial assets normalized by income, as well as the homeownership rate for the U.S. (labeled in the figures as US) and

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<sup>3</sup> The third wave of SHARE, known as SHARELife, came out in 2008 and constructs life-cycle data from retrospective surveys; we do not use this wave, as it is quite different from the other two. The 2010 wave has now become available, but was released after we completed our analysis.



**Figure 1: Age Profiles, U.S. vs Sweden. Thousands PPP-Adj. 2000 US\$.**

Sweden (SE). First, normalized net worth and financial age profiles are at the same levels of about 5.5 times annual income at age 65 in the two countries – this striking similarity aids the comparison for the purposes of the model exercise. Second, it is clear that decumulation of net worth is much more rapid in Sweden than it is in the U.S., and that the difference in spend-down behavior is mainly observable in financial assets. For example, in the U.S., the ratio of median net worth at age 90 to that at age 65 is 52%; that ratio is only 21% in Sweden. For financial assets, these ratios are 42% and 24%, respectively. Third, homeownership rates are close in the two countries but are slightly lower in Sweden for all ages. Fourth, homeownership rates decline at similar rates with age, resulting in parallel age profiles, and normalized median housing profiles among homeowners are similar in the two countries and show only a moderate decline for most of the age span that we consider. In sum, the differences in wealth spend-down rates are observed mainly in financial wealth, not in housing wealth or homeownership in the U.S. and Sweden.

To show that the differences in wealth spend-down transcend the median, we examine the wealth distribution among retirees of all ages in the two countries in Figure 2. We construct this dispersion by

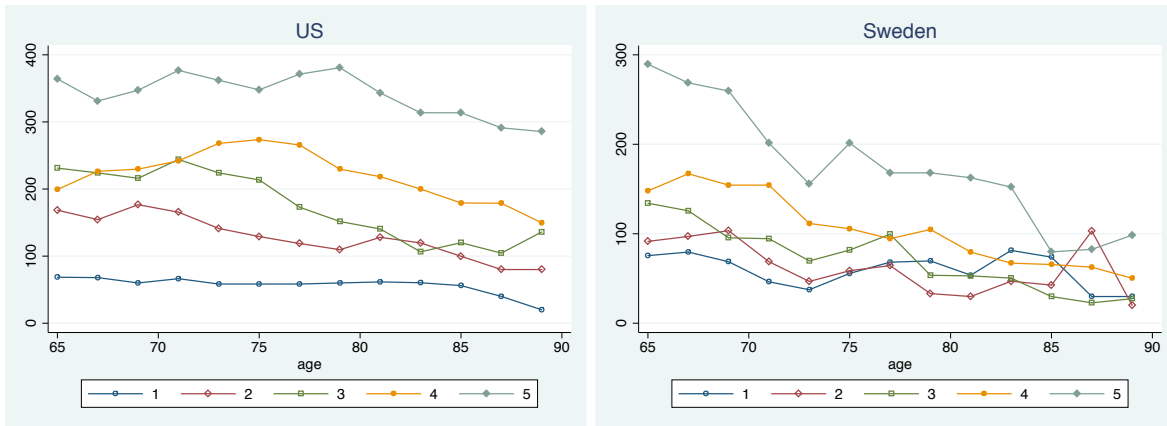


Figure 2: Net Worth by Income Bin, U.S. vs Sweden. Thousands PPP-Adj. 2000 US\$.

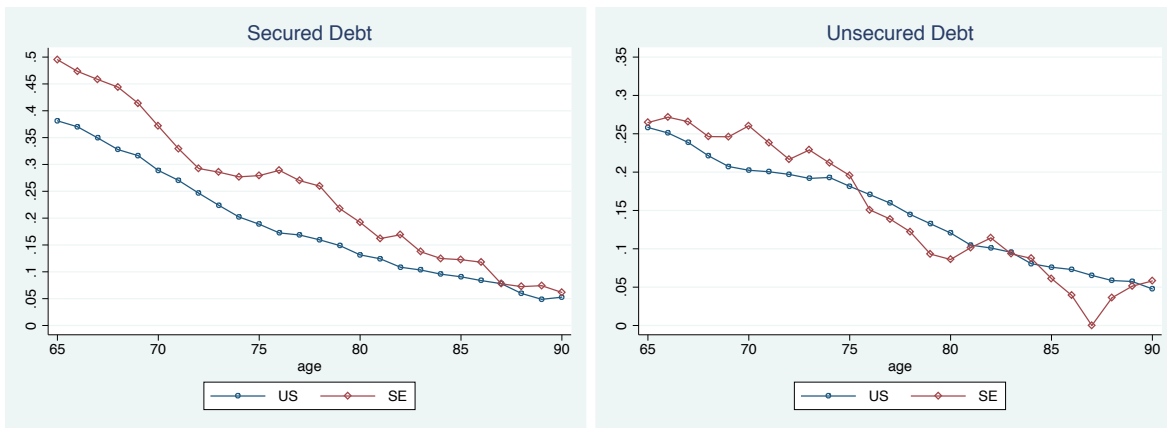


Figure 3: Age Profiles of Debt Rates, U.S. vs Sweden.

grouping retirees into income quintiles at each age, then plotting the median net worth of each income bin.<sup>4</sup> First, wealth dispersion is higher in the U.S. throughout the retirement life cycle. Second, in all quintiles of the distribution, net worth in the U.S. is nearly flat, not showing significant decumulation with age. Instead, in Sweden wealth dispersion is smaller at age 65, and net worth declines noticeably throughout the wealth distribution by age 90, though the decline is most dramatic in the top quintile.

Finally, Figure 3 shows the age profiles of secured and unsecured debt rates in the two countries. The age profiles of unsecured debt are essentially the same: 35% of age-65 retirees have unsecured debt, and by age 90, the rate of unsecured indebtedness is near or below 5%. In terms of secured debt, at age 65 50% of retirees in Sweden have some secured debt, compared to 40% in the U.S., but the rates decline steadily and quickly with age, reaching just 5% for both countries at age 90.

<sup>4</sup> Grouping households by *wealth* quintiles and showing wealth dispersion produces the same results.

### 2.3. Out-of-Pocket Medical and Long-Term Care Expenses

Unlike in the U.S., medical care across Europe tends to be insured by some combination of government-provided and mandatory private insurance (WHO, Allin et al. (2005)) to the effect of very low out-of-pocket spending on healthcare for households of any age. In Sweden, there is a compulsory tax-based system for the entire population. Participation in additional private insurance is voluntary, and very limited on the part of households. In the U.S., public insurance is most prevalent in retirement and is provided by Medicare, with Medicaid available as a supplement for the poorest households. Medicare benefits are extensive but also rationed, and as we will show below, result in significant OOP expenses.

As has been pointed out before by, e.g., Brown and Finkelstein (2011), there is a lot more variation in Europe in *long-term care* coverage. Sweden is among countries that has most comprehensive public coverage of long-term care (e.g. OECD (2005)). Coverage is universal, i.e. not means-tested, and provides in-kind benefits for both home and institutional care, with users paying only moderate fees that are set by the government. In contrast, in the U.S. long-term care is covered by Medicare and private plans, and by Medicaid for the poorest, but access to benefits leaves room for significant OOP spending for many households. For example, under Medicare home nursing care is free of charge, but skilled nursing care is only covered up to 20 days for no out-of-pocket charge; for nursing home stays or skilled nursing care between 20 and 100 days, a patient is charged \$105 per day, and above 100 days, the user pays 100% of the cost. Medicaid is means-tested, and requires co-pay based on financial status of recipient. As one expression of differences in the system, in 2000 in Sweden, about 7% of the elderly were using nursing home care, and an additional 9% employed in-home nursing care. Compare this to 4.3% of the elderly using institutional care, and 2.8% using home care in the U.S. at the same point in time.

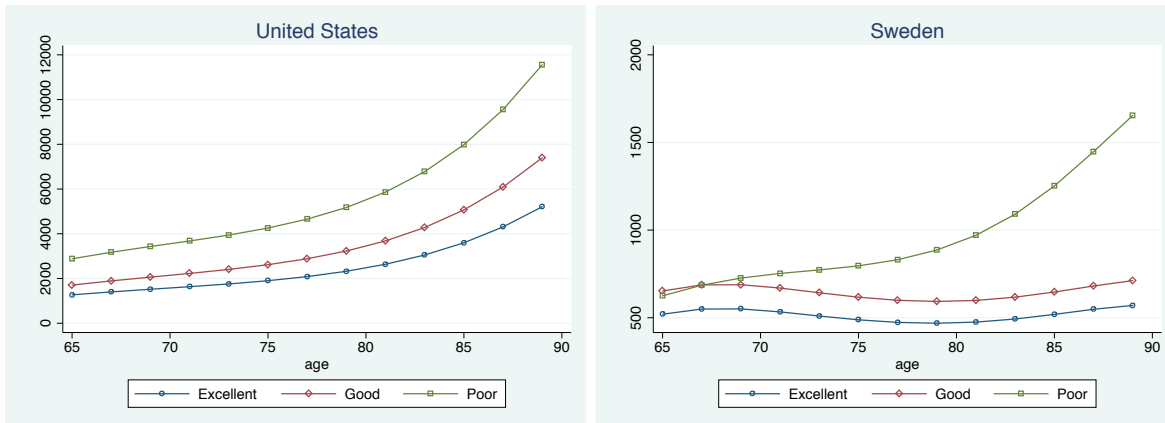
Both in the HRS and SHARE, we observe OOP medical and long-term care expenses directly. These include OOP expenses on prescription drugs, doctor visits, hospital stays and nursing homes. The HRS is more thorough in measuring these expenses as it has a more detailed set of questions for residents of nursing homes; as we discussed above, while SHARE does not provide the same coverage of this population, for Sweden this is not a significant handicap. It is a more significant issue to consider if one wants to measure OOP long-term-care expenses in countries where coverage of such expenses is not universal.

We estimate the mean and standard deviation of OOP medical expenses in our data, conditional on age, income, household size and health; more on this procedure in the calibration section. We show two possible cuts of the data here. Figure 4 shows expected mean medical and long-term-care expenses for a single person of median income by health status, for the U.S. and Sweden.<sup>5</sup> Note the vastly different scales in the graphs. As we would expect, people in both countries who are in worst health pay the most.

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<sup>5</sup> Health status is self-reported but the choices given to respondents to describe health status are harmonized between the HRS and the SHARE; more details are discussed in Section 4.1.





**Figure 4: Expected Mean Medical Expenses by Health, Median-Income Singles, 2000 US\$**

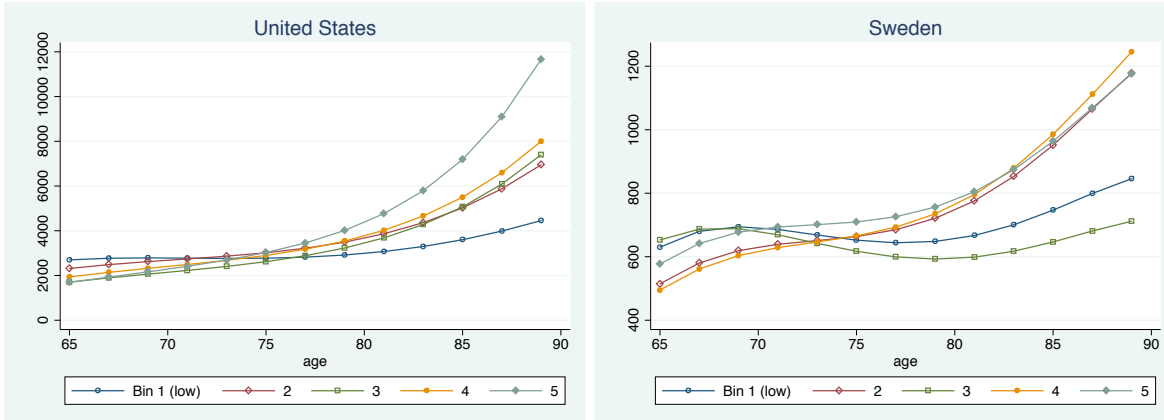
However, the orders of magnitude of the expenses are markedly different at all ages. For example, at age 90, a person of median income in poor health might expect to spend about \$12,500 in the U.S. in OOP medical expenses, measured in 2000 US \$. A similar person in Sweden would spend, on average, just over one-tenth of that.<sup>6</sup>

Figure 5 presents mean expected medical expenses for singles of *good* health by income quintile. First, the degree of inequality in medical OOP spending is markedly different in the two countries. In Sweden, with universal non-means-tested public coverage of both health care and long-term care, everyone pays roughly similar amounts out of pocket, regardless of income. Even at age 90, the distribution ranges between \$700 and \$1,200, and is not monotone in income. In the U.S., inequality in spending is much higher: medical expenses are strongly monotonic in income, with the highest quintile at age 90 spending on average about \$5,000 more than the next quintile down, at about \$15,000, and that difference is exacerbated further later in life. Second, again, the total mean spending in Sweden is about one-tenth of what it is in the U.S.

#### 2.4. Summary and Interpretation of Empirical Facts

In sum, in the U.S. and Sweden, the significant difference in the rate of decumulation of net worth is driven mainly by retirees spending down their financial wealth, while homeownership profiles and median housing profiles are similar in the two countries and show similar rates of decumulation. From institutional analysis, we find that Swedish retirees, unlike those in the U.S., have extensive public coverage of out-of-pocket medical and long-term-care expenses. In our data, we find that at age 90 Swedish retirees may spend, on average, about one-tenth of what U.S. retirees spend on medical and long-term care out of

<sup>6</sup> We cannot reliably measure expenses for persons above age 90 in Sweden because of small sample sizes, and this may raise concerns that we are underestimating expenses for the oldest old. While this is a concern, universal coverage of both health care and long-term care in Sweden is a strong form of insurance and we rely on that information to assume that there is no hidden spike in expenses past age 90. In our data, in fact, past age 90 we find a *reduction* in OOP medical expenses.



**Figure 5: Expected Mean Medical Expenses by Income, Good Health Singles, 2000 US\$**

pocket.

These facts put together suggest the hypothesis that the expected level and risk of OOP medical and long-term-care spending affects saving in financial assets through a precautionary motive, while saving in housing and homeownership are impacted by factors other than medical spending, such as bequest motives, housing market policy and the like. This implies that in order to address the retirement saving puzzle, it is misleading to study household wealth as just net worth, as it conceals important differences in the data in asset types and motivations for holding them.

In the remainder of the paper, we test our hypothesis. We quantify the impact of OOP spending on saving in retirement by testing to what extent the differences in expected OOP spending, and differing uncertainty as to the possible magnitude of this spending in Sweden and the U.S. are responsible for differences in the rate of decumulation of financial and housing assets, and net worth. In order to conduct the experiment, we pose a life-cycle model of saving in retirement, where retired households face a number of uninsurable idiosyncratic risks and can choose between homeownership and renting. We then calibrate the model to get at the answers to the central questions.

We should note that in order to conduct this experiment, we will focus on the differences in OOP spending and hold all other features of the environment constant. This is not to say that there are no other important policy differences between the two countries; see Nakajima and Telyukova (2014b) for a survey of some of these differences across these two and many other countries. Rather, our aim here is to isolate the role of medical spending only, holding all else equal. We also implicitly assume that preference parameters take the same values between the U.S. and Sweden for the same reason.

### 3. Model

The model is based on our previous work in Nakajima and Telyukova (2014a). In the model as in the data, we focus on retired households, so that we can avoid dealing with the labor supply decision of the

elderly. (For a study on this issue using SHARE, see Erosa et al. (2012)). Thus, a household in the model starts out at age 65. Model households live until maximum age 99, but face age- and health-dependent probability of death each period.

A retiree household starts out as a homeowner or a renter. In each period, the household chooses consumption and financial saving, and makes a decision regarding housing. For a homeowner, the housing decision is whether to move out of the house or to stay in it. Homeownership provides utility benefits, in addition to consumption services from the house; these capture factors such as attachment to one's house and neighborhood, the ability to modify one's house to individual taste, but also some financial benefits of ownership that are not explicitly in the model, such as house price appreciation, tax exemption of imputed rents of owner-occupied housing, mortgage interest payment deduction, or insurance against rental rate fluctuation. The strength of the utility benefit of being a homeowner is represented by one parameter and is estimated. In addition, homeowners are able to borrow against their home equity; the collateral constraint can change with age. This is a reduced-form way of modeling the cost of borrowing against home equity that increases with age, which we study in detail in Nakajima and Telyukova (2013), Nakajima and Telyukova (2014a); this parsimonious approach is most appropriate for our cross-country comparison where we are not focused on differences in housing policies. The age-dependent collateral constraint is parameterized and is also estimated to match empirical life-cycle profiles, together with other parameters, as shown below.

For a renter, the housing choice is only the size of the rental property. We abstract from the decision of a homeowner to move to a different, most likely smaller, house, or the decision of a renter to buy a house. These abstractions are motivated by the observation in the data that the proportion of homeowners making downsizing moves is small, as is the proportion of renters who purchase a home late in life. Finally, renters are not able to borrow; this is motivated by the observation in our data that the median amount of unsecured debt among retirees is small, regardless of the country.

Households get pension income, as well as interest income from their financial assets if any. Pension income is different across households, but does not change with age except for the time when household size changes (capturing death of a spouse). This assumption is consistent with data. We also assume that households have access to a government-provided consumption floor, which captures social insurance programs for the impoverished elderly such as Medicaid in the U.S.<sup>7</sup> We assume that households have a warm-glow bequest motive. In the literature investigating various motives for saving in retirement, the bequest motive is considered one of the key elements, although the magnitude of the bequest motive is a subject of debate and depends on the underlying model. We estimate the strength of the bequest motive together with other parameters.

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<sup>7</sup> De Nardi et al. (2013) model Medicaid for retirees in a similar way and investigate how benefits of Medicaid are distributed across heterogeneous households.

In addition to the mortality shocks that we discussed above, all households are subject to three other types of idiosyncratic shocks: a shock to household size, a health status shock, which is conditioned on age and current health, and out-of-pocket medical expenditures, conditioned on age, household size, health status and income.

Households are either a couple (2-adult) or single (1-adult). A 2-adult household becomes a 1-adult one with a probability that depends on age of the household. This transition is intended to capture death of a spouse. A 1-adult household remains 1-adult for the rest of its life. This simplifies the computation, and is supported by the fact that few retired single households remarry in our data. The household size affects household pension income, per-adult consumption, and the distribution of medical expense shocks. We introduce household size in the model, because death of a spouse often triggers changes in homeownership status (Venti and Wise (2004)).

From the perspective of country comparison, the features of the model that can be changed to examine cross-country variation are household size shocks, health status shocks, medical expense shocks, details of the mortgage and housing markets, expressed via transaction costs and collateral constraints, and the consumption floor. We will also vary the initial type distribution of households to match each country's type distribution at age 65 in the data. We discuss this further in Section 4.

Formally, the state variables of a household are  $(i, b, s, m, x, h, a)$ : its age, income, household size, health status, medical expenses, amount of housing, and its financial assets. In order to save notation, we use  $h = 0$  to represent a renter.  $h > 0$  means that a household is a homeowner with a house size of  $h$ .

The simplest problem is the problem of the renter. We describe it in recursive form, using primes to denote the next period:

$$V(i, b, s, m, x, h = 0, a) = \max_{\tilde{h}, a' \geq 0} \left\{ u(c, \tilde{h}, s, 0) + \beta \sum_{s', m' > 0, x'} \pi_{i+1, s, s'}^s \pi_{i+1, m, m'}^m \pi_{i+1, b, s', m', x'}^x V(i+1, b, s', m', x', 0, a') + \beta \pi_{i+1, m, 0}^m v(a') \right\} \quad (1)$$

subject to:

$$\tilde{c} + a' + r_h \tilde{h} + x = (1 + r)a + \psi_s b \quad (2)$$

$$c = \begin{cases} \max\{\psi_s \underline{c} - r_h \tilde{h}, \tilde{c}\} & \text{if } a' = 0 \\ \tilde{c} & \text{otherwise} \end{cases} \quad (3)$$

The renter of state  $(i, b, s, m, x, h = 0, a)$  chooses the level of financial assets to carry over to the next period ( $a'$ ) and the property that he rents in the current period ( $\tilde{h}$ ) to maximize the sum of three components. The first component is the period utility, which is a function of nonhousing ( $c$ ) and housing ( $\tilde{h}$ ) consumption,

the tenure status of the renter,  $o = 0$ , and household size  $s$ . Household size affects the period utility in order to capture the economy of scale within a household. The second component is the discounted expected future value conditional on surviving to the next period ( $m' > 0$ ). Notice that  $b$  does not change, and the renter remains a renter ( $h' = h = 0$ ). The expectation is formed with respect to three shocks: (i) the household size shock, whose transition probability  $\pi^s$  depends on the current household size ( $s$ ) as well as age  $i + 1$ ; (ii) the health status shock, whose transition probability  $\pi^m$  depends on age  $i + 1$  and current health  $m$ ; (iii) the medical expense shock, whose transition probability  $\pi^x$  depends on next period's age, income, household size, and health status. The third component of the maximand in the Bellman equation (1) is the utility from bequests, where  $m' = 0$  indicates death. Notice that, for a renter, the only assets left as estate are financial assets ( $a'$ ). Equation (2) is the budget constraint of the renter. The parameter  $\psi_s$  multiplying income is a scaling parameter that adjusts the pension income depending on the current household size. The term  $x$  captures the current realization of the medical expense shock. Equation (3) represents the lower bound of consumption guaranteed to the household through the social insurance program, which is also dependent on the household size. The consumption floor is available only when the renter exhausts savings ( $a' = 0$ ) and the cost of the rent is figured in as part of the benefit.

The recursive problem of a homeowner is a choice between staying in his current house ( $V_1$ ), or selling the house and becoming a renter ( $V_0$ ).

$$V(i, b, s, m, x, h, a) = \max\{V_0(i, b, s, m, x, h, a), V_1(i, b, s, m, x, h, a)\} \quad (4)$$

The problem of the owner who decides to sell and become a renter is:

$$V_0(i, b, s, m, x, h, a) = \max_{a' \geq 0} \{u(c, h, s, 1) + \beta \sum_{s', m' > 0, x'} \pi_{i+1, s, s'}^s \pi_{i+1, m, m'}^m \pi_{i+1, b, s', m', x'}^x V(i+1, b, s', m', x', 0, a') + \beta \pi_{i+1, m, 0}^m v(a')\} \quad (5)$$

subject to:

$$\tilde{c} + a' + x + (\kappa + \delta)h = h + (1 + \tilde{r})a + \psi_s b \quad (6)$$

$$\tilde{r} = \begin{cases} r & \text{if } a \geq 0 \\ r + \iota_m & \text{if } a < 0 \end{cases} \quad (7)$$

$$c = \begin{cases} \max\{\psi_s \underline{c}, \tilde{c}\} & \text{if } a' = 0 \\ \tilde{c} & \text{otherwise} \end{cases} \quad (8)$$

Relative to the renter problem above, first, the current tenure status is a homeowner ( $o = 1$ ) with the

house size of  $h$ , in the period utility function. Second, the budget constraint (6) does not include rent, but includes income from selling the house  $h$ , net of the current maintenance cost ( $\delta$ ) and the selling cost ( $\kappa$ ). Third, the interest rate is different depending on whether the homeowner is a net saver (in this case the interest rate is  $r$ ), or a net borrower (the interest rate is  $r + \iota_m$ ). Fourth, the household is eligible for the consumption floor if  $a' = 0$ . Also notice that the household begins the next period as a renter ( $h' = 0$ ).

The problem of the homeowner who decides to stay in his house is characterized by:

$$V_1(i, b, s, m, x, h, a) = \max_{a' \geq -h(1-\lambda_i)} \{u(c, h, s, 1) + \beta \sum_{s', m' > 0, x} \pi_{i+1, s, s'}^s \pi_{i+1, m, m'}^m \pi_{i+1, b, s', m', x'}^x V(i+1, b, s', m', x', h, a') + \beta \pi_{i+1, m, 0}^m v((1-\kappa)h + a')\} \quad (9)$$

subject to (7) and:

$$\tilde{c} + a' + x + \delta h = (1 + \tilde{r})a + \psi_s b \quad (10)$$

First, a stayer homeowner can borrow against the house up to a fraction  $1 - \lambda_i$  of equity. Second, in the case of death, the estate is the consolidated asset position, which now includes the value of housing after paying selling cost  $((1 - \kappa)h)$ . Third, the budget constraint includes the maintenance cost ( $\delta h$ ).

#### 4. Calibration

The goal of the computational experiment is to use the model presented above to evaluate the extent to which differences in OOP medical and long-term care expense level and risk can account for differences in saving in retirement across the U.S. and Sweden. We also want to test whether these factors impact housing and financial assets differently. Since the differences in OOP expense risk are directly observable in our data, we can use the model for a quantitative experiment based on these measurements.

We conduct the quantitative experiment as follows. First, we calibrate our model to the U.S. data. Our calibration proceeds in two steps, as in Gourinchas and Parker (2002): in the first step, we calibrate the parameters that are directly observable in the data, while in the second, we estimate the remaining parameters to match the empirical normalized age profiles that we presented above for the U.S., using the simulated method of moments. Then, keeping preference and policy parameters fixed, we change the parameters that describe the initial distribution, household size, health, mortality and OOP spending risk from the U.S. to Sweden. In other words, we assume that preferences and the borrowing constraint are the same for retirees in the U.S. and Sweden, but the initial distribution of household types at age 65, as well as the shocks that they face, in particular regarding OOP medical expenses, are different.<sup>8</sup> For this

<sup>8</sup> Ideally, we would want to recalibrate the borrowing constraint for Sweden using some external empirical evidence that can be translated into the borrowing constraint in the model, but we do not have sufficient such evidence.

changed Swedish calibration, we compute the optimal saving decisions of retirees, to see how closely the model can replicate saving decisions of retirees in Sweden, in terms of net worth, housing and financial assets. This will allow us to answer our central question, by taking the difference between the model’s U.S. and Swedish outcomes, and comparing this difference to the data’s.

#### **4.1. First-Stage Calibration**

##### **4.1.1. Health Status and Mortality Risk**

Since both HRS and SHARE are biennial surveys, most variables are measured at that frequency, so we choose the model period to be 2 years. We allow the model retirees to live stochastically up to age 99; if they survive up to age 99, they die with certainty after the end of the period.

In both the HRS and SHARE, households are asked to self-report their health status, and we group it into three categories: excellent (1), good/average (2) and poor (3). We also add death (0), so the transition matrix incorporates both health and mortality probabilities. We estimate the transition probabilities by age and current health status. In the HRS, we take any pair of consecutive survey waves (1996-1998, 1998-2000, 2000-2002, etc.) and assuming stationarity, pool them together to create two pooled consecutive waves. In SHARE, we only have two consecutive waves, and hence compute the probabilities based on 2004-2006 waves. Table 1 presents the resulting probabilities for the U.S. and Sweden, for four selected age groups, though we estimate separate probabilities for each model age (i.e. age 65, 67, 69, etc.)

The measured transition probabilities in Sweden are slightly noisier than in the U.S. because of much smaller sample sizes for older ages. Some resulting irregularities and nonmonotonicity aside (e.g. occasional zero probabilities for Sweden), arising partly from our inability to attribute some attrition cases to death, the numbers in Sweden and the U.S. are comparable in magnitude, and have the logical tendency: probability of death increases in age and is higher the worse is the respondent’s health. In addition, health deteriorates with age, and is less persistent with age, owing to a higher probability of death.

##### **4.1.2. Medical Expense Risk**

We estimate the distribution of log-OOP medical expenditures by age, health, income quintile and household size (single or couple). The mean, standard deviation and probability of zero expenses are estimated as quartics in age, and include interaction terms between age and the other three variables. Under the assumption of log-normality of medical expenses, we can compute the expected mean of OOP medical expenses. Figure 6 presents the expected mean as before, as well as the log-standard deviation of medical expenses for the U.S. (left panels) and Sweden (right panels), for single households in the middle income bin by health. We now use the same scale in the graphs, to make clear the differences in magnitude. As we discussed, people in worse health pay higher expenses on average, in both countries. However, in Sweden, the differences in expenses by health are small compared to the U.S., and the level of expenses is an order

**Table 1: Health Status Transition, Selected Age Groups (Percent)**

U.S.									
Age 65					Age 75				
	Dead	Excellent	Good	Poor		Dead	Excellent	Good	Poor
Excellent	1.3	72.8	21.5	4.4	Excellent	3.9	60.1	26.9	9.2
Good	2.2	25.8	53.3	18.7	Good	6.6	21.1	46.9	25.4
Poor	9.6	6.1	20.7	63.7	Poor	16.3	3.8	17.6	62.3
Age 85					Age 95				
	Dead	Excellent	Good	Poor		Dead	Excellent	Good	Poor
Excellent	10.5	46.8	27.1	15.6	Excellent	28.5	29.5	19.8	22.3
Good	14.7	17.0	37.8	30.5	Good	32.9	12.9	26.8	27.5
Poor	28.8	5.1	13.2	52.9	Poor	56.9	4.2	13.6	25.3
Sweden									
Age 65					Age 75				
	Dead	Excellent	Good	Poor		Dead	Excellent	Good	Poor
Excellent	0.4	67.6	23.7	8.3	Excellent	3.8	54.3	20.8	21.0
Good	2.7	17.6	44.8	34.8	Good	0.8	16.4	40.0	42.8
Poor	0.0	3.7	23.4	72.9	Poor	18.4	12.1	10.7	58.9
Age 85					Age 89-93				
	Dead	Excellent	Good	Poor		Dead	Excellent	Good	Poor
Excellent	8.2	45.2	22.3	24.3	Excellent	25.5	32.7	24.5	17.4
Good	6.1	5.2	42.6	46.2	Good	16.8	11.8	33.5	38.0
Poor	20.2	0.0	17.0	62.8	Poor	13.9	0.0	7.4	78.8

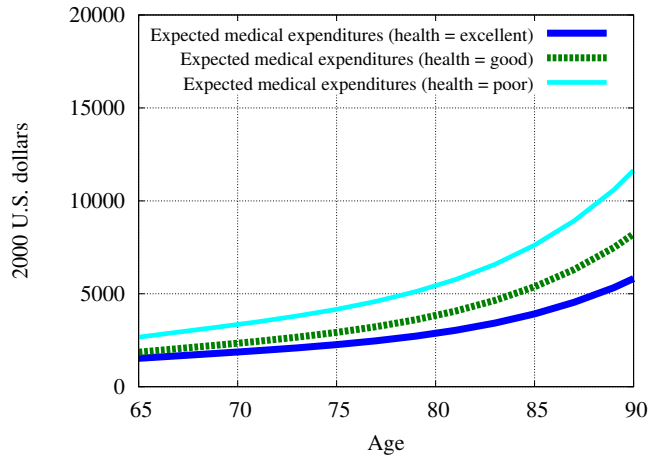
Sources: HRS 1996-2006, SHARE 2004-2006.

of magnitude lower. Conditional standard deviations of medical expenses, which show the magnitude of uncertainty that retirees face in the two countries, are lower in Sweden than in the U.S. for all health categories, although the standard deviation for households with poor health increases more with age in Sweden than in the U.S. In sum, these measurements imply that both average medical expenses and the medical expense risks are lower in Sweden, especially in the later part of life. For the use in the model, we discretize medical expense shocks according to the log-normal distribution that we estimated.

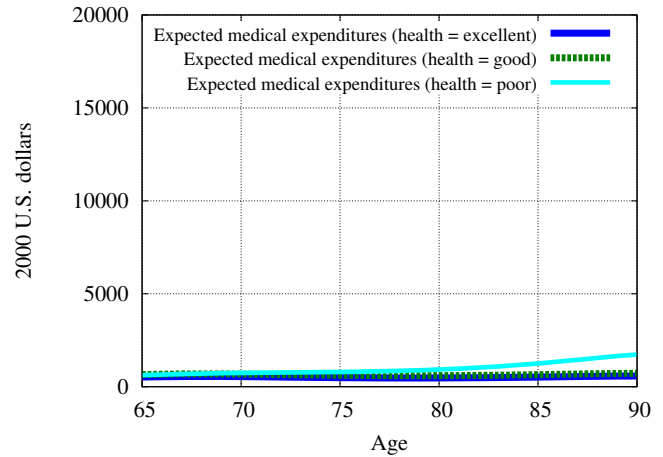
#### 4.1.3. Household Size Transition

Table 2 compares the transition probabilities of household size between the U.S. and Sweden. Only the transition probabilities conditional on being a 2-adult household are shown, because we assume that there is no transition from 1-adult to 2-adult households (which is rare in data in both countries). In both countries, the probability of becoming a 1-adult household increases with age, although the probabilities are generally higher in Sweden conditional on age.

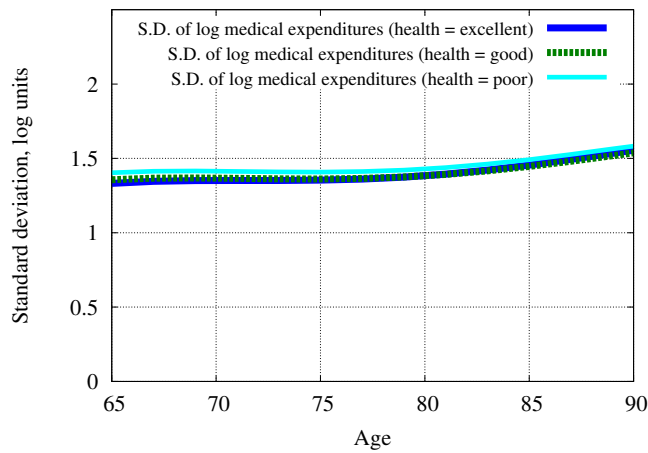




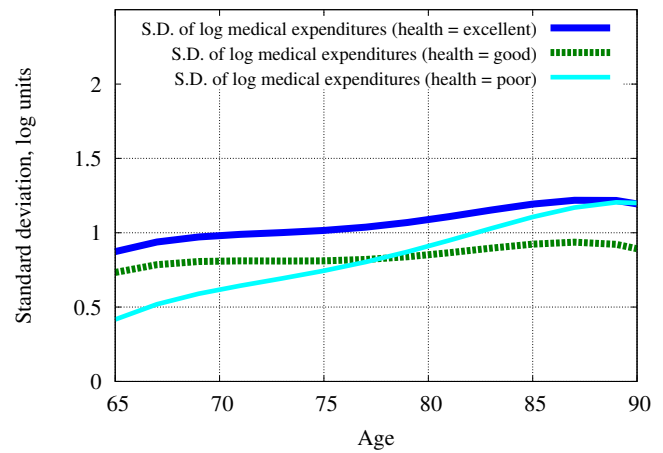
(a) U.S.: Expected Medical Expenses



(b) Sweden: Expected Medical Expenses



(c) U.S.: S.D. of Log Medical Expenses



(d) Sweden: S.D. of Log Medical Expenses

**Figure 6: Expected Mean and Standard Deviation of OOP Medical Expenses, Mid-Income Singles by Health, 2000 US\$. Sources: HRS 1996-2006, SHARE 2004-2006.**

**Table 2: Household Size Transition (Percent)**

Age	U.S.		Sweden	
	2-adult → 1-adult	2-adult → 2-adult	2-adult → 1-adult	2-adult → 2-adult
65	3.38	96.62	9.98	90.02
75	8.00	92.00	18.51	81.49
85	13.41	86.59	20.58	79.42
95	21.85	78.15	100.00	0.00

Sources: HRS 1996-2006, SHARE 2004-2006.

#### 4.1.4. Initial Distribution at Age 65

As another input into the model, we construct the initial distribution of households across all the state variables at age 65. The dimensions of the distribution are as in the model: income, household size, health

**Table 3: Initial Distribution at Age 65**

	U.S.	Sweden
<b>Household Size</b>		
1-adult	0.391	0.503
2-adult	0.609	0.497
<b>Health status</b>		
1 (excellent)	0.445	0.377
2 (good)	0.323	0.331
3 (poor)	0.231	0.292
<b>Tenure</b>		
Homeowner	0.885	0.812
Renter	0.115	0.188
<b>Net financial asset position</b>		
Saver	0.792	0.731
Borrower	0.208	0.269

Sources: HRS 2006, SHARE 2006.

**Table 4: Initial Distribution at 65 – Income Bins**

	1	2	3	4	5
<b>U.S.</b>	6,858	12,404	17,948	25,918	42,722
<b>Sweden</b>	8,027	11,214	13,352	17,425	27,352

Note: Annualized after-tax income. 2000 PPP-adjusted U.S. dollars. Sources: HRS 2006 and SHARE 2006.

status, homeownership status, amount of housing owned, and the financial asset position. We treat income as fixed with age, as it incorporates pension and social security income and does not vary with the life cycle of a given cohort in our data, and classify households into income quintiles.<sup>9</sup> Tables 3 and 4 summarize the dimensions of the initial distribution not already discussed. There are more single (1-adult) households in Sweden at age 65. The distribution of health states is similar in the U.S. and Sweden, although more respondents classify themselves in excellent health in the U.S. than in Sweden. As shown above, the homeownership rate is higher in the U.S. than in Sweden at age 65, and more retirees are net borrowers in Sweden at age 65.<sup>10</sup> The after-tax income distribution displays significantly more dispersion in the U.S. than in Sweden.

<sup>9</sup> We normalize income by household size to take into account that couples' income is larger than singles' income by a factor of 1.48, on average, in our data.

<sup>10</sup> In order to make the data consistent with the model, we define debt as the consolidated net negative financial assets. In other words, debt here is defined as net worth minus the value of the house, if any. Proportion of borrowers is the proportion of households with net negative financial asset position. As can be seen in panel (e) of Figure 7, the proportion is monotonically decreasing in age, like proportion of households with either secured or unsecured debt, shown in Figure 3.

**Table 5: First-Stage Housing Cost Parameters**

Parameter	Description	Value
$\delta$	Maintenance cost of housing <sup>1</sup>	0.017
$\kappa$	House selling cost	0.066
$r$	Saving interest rate <sup>1</sup>	0.040
$\xi$	Mortgage interest premium <sup>1</sup>	0.016

<sup>1</sup> Annualized value.

#### 4.1.5. Remaining First-Stage Parameters: Housing Costs

Table 5 shows the calibration for parameters related to housing costs that we use. We take these numbers directly from the data or the literature for the U.S. The saving interest rate is 4% per year, since the financial asset in the model captures all of the financial assets that retirees hold.<sup>11</sup> The mortgage interest premium is 1.6% above that rate, that is, the mortgage interest rate is 5.6%. The maintenance cost of a house is 1.7% per year of the house’s value. The selling cost of a house is 6.6% of the house’s value, and captures all the financial and time costs associated with the process of selling a house. See Nakajima and Telyukova (2013) for further discussion of these parameter choices.

In the experiment we will assume these parameters to be the same in Sweden, in order to hold the influence of housing market differences on saving choices constant.

#### 4.2. Second-Stage Calibration: United States

We estimate the remaining parameters for the baseline model to match moments of U.S. data. The parameters include preference parameters, the borrowing constraint for homeowners, and the size of the consumption floor. The moments used for the estimation are the U.S. cross-sectional age profiles that we described in the data section, which we match to their model counterparts by a minimum-distance estimator.

With respect to preferences, households discount the next period using discount factor  $\beta$ . We use the following period utility function with constant relative risk aversion:

$$u(c, h, s, o) = \frac{\left( \left( \frac{c}{\xi_s} \right)^\eta \left( \frac{\omega_o h}{\xi_s} \right)^{1-\eta} \right)^{1-\sigma}}{1 - \sigma} \quad (11)$$

$\eta$  is the Cobb-Douglas aggregation parameter between nonhousing consumption goods ( $c$ ) and housing services ( $h$ ).  $\sigma$  is the risk aversion parameter.  $\omega_o$  represents the extra utility of housing. For renters ( $o = 0$ ),  $\omega_0$  is normalized to unity. For homeowners ( $o = 1$ ),  $\omega_1$  represents benefits of homeownership,

<sup>11</sup>We abstract from portfolio choice problem of retirees, especially between risky assets such as stocks and risk-free assets such as bonds.

**Table 6: Second-Stage Estimated Parameters, U.S. Benchmark**

Parameter	Description	Value
$\beta$	Discount factor <sup>1</sup>	0.957
$\eta$	Consumption aggregator	0.739
$\sigma$	Coefficient of RRA	1.792
$\omega_1$	Utility from ownership	2.484
$\gamma$	Strength of bequest motive	0.539
$\zeta$	Curvature of utility from bequests	28,177
$\underline{c}$	Consumption floor per adult <sup>1</sup>	6,398
$\lambda_{65}$	Collateral constraint for age-65	0.444
$\lambda_{73}$	Collateral constraint for age-73	0.773
$\lambda_{81}$	Collateral constraint for age-81	0.989
$\lambda_{89}$	Collateral constraint for age-89	0.998
$\lambda_{99}$	Collateral constraint for age-99	0.996

<sup>1</sup> Biennial value.

both financial that we do not explicitly model, and nonfinancial.  $\xi_s$  is the adjustment for household size. Following Fernández-Villaverde and Krueger (2007), we set  $\xi_1 = 1$  and  $\xi_2 = 1.34$ .<sup>12</sup>

A household gains utility from leaving bequests in the standard warm-glow fashion. When a household dies with the consolidated wealth of  $a$ , its utility function takes the form:

$$v(a) = \gamma \frac{(a + \zeta)^{1-\sigma}}{1-\sigma}. \quad (12)$$

Here,  $\gamma$  captures the strength of the bequest motive, and  $\zeta$  affects the marginal utility of bequests, i.e. the threshold of wealth at which retirees find it valuable to leave a bequest. In effect,  $\zeta$  determines whether bequests are a luxury good. We assume that the curvature of the bequest utility function is the same as the period utility function.<sup>13</sup>

In the second stage of the estimation, we estimate the parameters to maximize the fit of the model according to the cross-sectional age profiles of median net worth, housing and financial wealth, homeownership rate and the net debt rate, i.e., the proportion in each age group with negative financial assets net of equity debt. The estimation procedure minimizes the (squared, weighted) distance between these age profiles in the model and the data. Table 6 summarizes the parameters estimated in the second stage.

The coefficient of risk aversion  $\sigma$  is estimated to be 1.79, right in the middle of the standard range in the macro literature. The estimates imply that living in an owned home gives retirees 3.5 times the utility benefit of being a renter. As we mentioned before, this parameter captures both utility benefits, such as

<sup>12</sup>See Table 1 of their paper. We use the average value across available estimates, shown in the last column of the table.

<sup>13</sup>De Nardi et al. (2010) assume the same functional form for utility from bequest, and also assume that the curvature of the bequest utility function is the same as curvature of the period utility function.

attachment to the house, the neighborhood, the custom features of the house, as well as financial benefits, such as house price appreciation, insurance against rental rate fluctuation or tax exemption of mortgage interest, which we do not model explicitly. The consumption floor per adult is estimated at \$6,398 per adult per two years. This is close to the estimate obtained by De Nardi et al. (2010) (\$5,627 for two years, in 2000 dollars), but significantly smaller than non-Social-Security social insurance benefit computed by Hubbard et al. (1994), adjusted for inflation.<sup>14</sup> Finally, we estimate the strength of the bequest motive at 0.54, and the curvature parameter of the bequest function at \$28,177. In order to get the sense of the properties of the bequest motive, we use the transformation proposed by Lockwood (2012), and also used by De Nardi et al. (2010). We compute the level of wealth in the last period of life at which a household starts leaving positive bequests, and the marginal propensity to bequeath.<sup>15</sup> In our estimated model, the threshold wealth level of wealth at which a household starts leaving bequests is \$39,057, while the marginal propensity to bequeath is 0.40. For comparison, parameters estimated by De Nardi et al. (2010) imply the threshold wealth level of \$36,000, very similar to ours, while the marginal propensity to bequeath is 0.88.

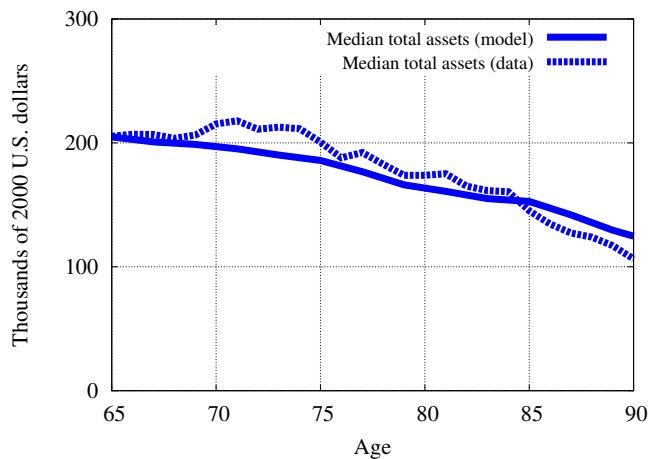
The age-specific borrowing constraint  $\lambda_i$  is estimated by piecewise-linear approximation, with intervals of 8 years, and bounded between 0 and 1. Thus, the borrowing constraint of a 67-year-old is not the same as that of a 65-year-old, but is obtained by linear interpolation between the estimated  $\lambda_i$  for age-65 and age-73 households. These parameters are pinned down mainly by the percentage of retirees who are in debt, which is one of our estimation targets. The parameters imply that retirees at age 65 are able to borrow up to 56% of their home equity, but as they age, they become increasingly constrained, so that by age 81, they can essentially no longer borrow. This is a parsimonious way to capture the fact that borrowing becomes very costly for the elderly. Some, possibly a lot, of this cost comes from the supply side: elderly borrowers do not have easy access to traditional equity borrowing instruments because they fail the inherent income requirement for mortgage repayment (Caplin (2002)). The market that exists for reverse mortgages – instruments targeted at elderly borrowers – appears thin, which is both demand- and supply-side driven (Nakajima and Telyukova (2014a)). Here, we capture all these factors in reduced form via  $\lambda_i$ .<sup>16</sup>

To assess the fit of the model with these parameters, Figure 7 shows the five targeted age profiles in the U.S. data (dotted lines) and in the model (solid lines): median net worth, homeownership rate, median housing assets conditional on ownership, median financial assets net of equity debt, and proportion of retirees in debt. Generally the model can replicate the target age profiles well. In particular, median net

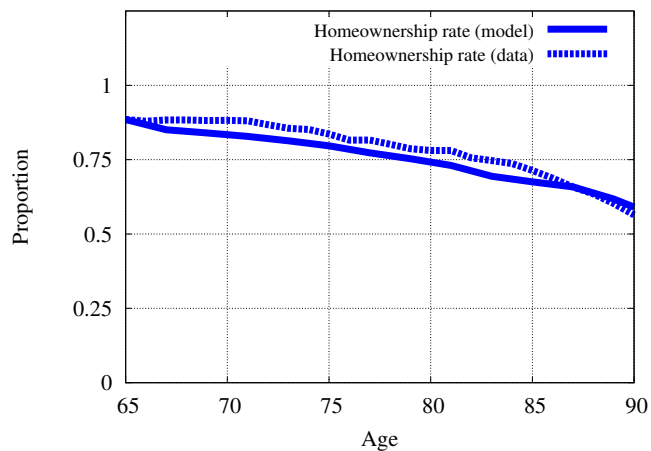
<sup>14</sup>The estimate of Hubbard et al. (1994) is \$6,893 per year in 1984 dollars. In 2000 dollars and for two years, it is \$22,848. We use Consumer Price Index for conversion.

<sup>15</sup>See Appendix A for details.

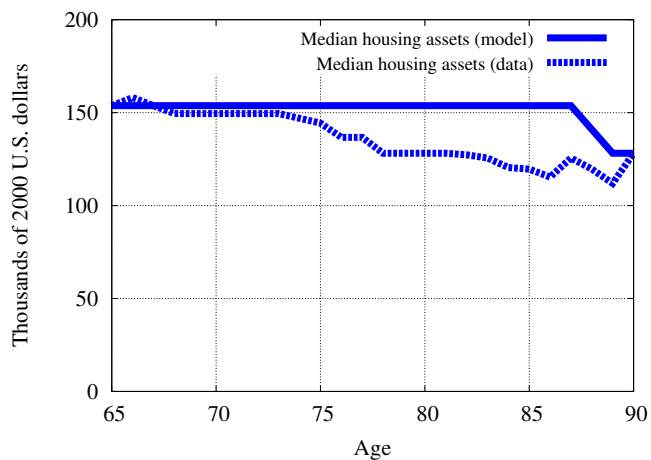
<sup>16</sup>In Nakajima and Telyukova (2014a), we model the debt-to-income requirement of standard mortgage contracts explicitly, and find that it results in similar quantitative results to the reduced-form formulation of  $\lambda$  in this model, by restricting the low-income retirees from borrowing, while high-income retirees do not find it beneficial to borrow, even though they can borrow substantially if they choose to.



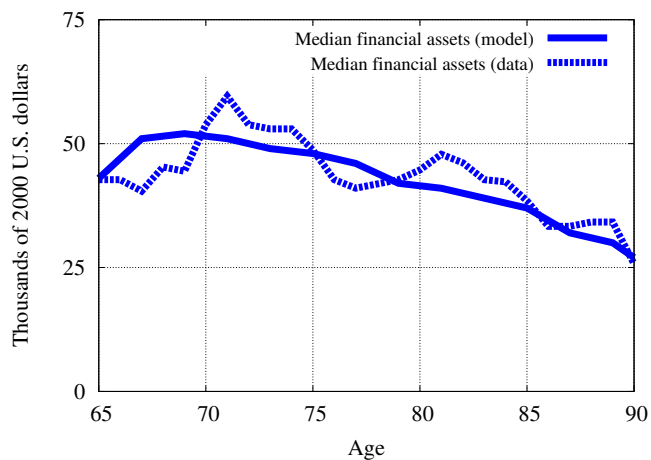
(a) Median Net Worth



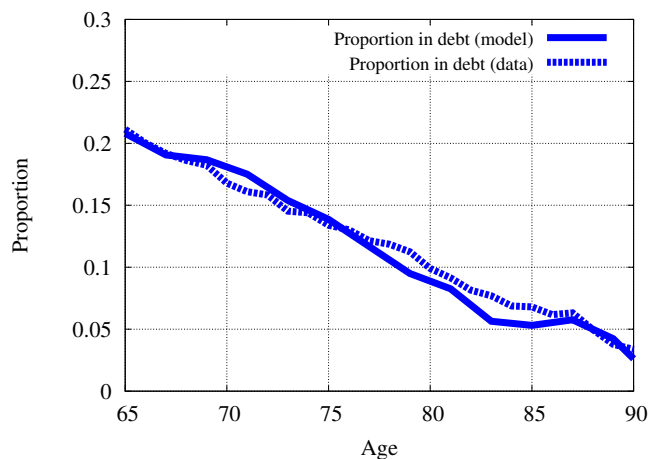
(b) Homeownership Rate



(c) Median Conditional Housing Assets



(d) Median Financial Assets



(e) Proportion in Net Debt

**Figure 7: Benchmark Model Fit – Age Profiles in Model vs. U.S. Data**

worth (panel (a)), homeownership rate (panel (b)), median financial assets (panel (c)), and proportion of households in debt (panel (e)) are quite well matched as a result of our estimation procedure. Meanwhile, the model overstates the flatness of the median housing profile among homeowners, though not the amount of decumulation over the entire life cycle (panel (d)). This happens partly because in the model, there are only 11 house values possible, due to discretization, unlike in the data, where housing is a continuous variable, and households can let the house value depreciate, possibly by adjusting intensity of maintenance.

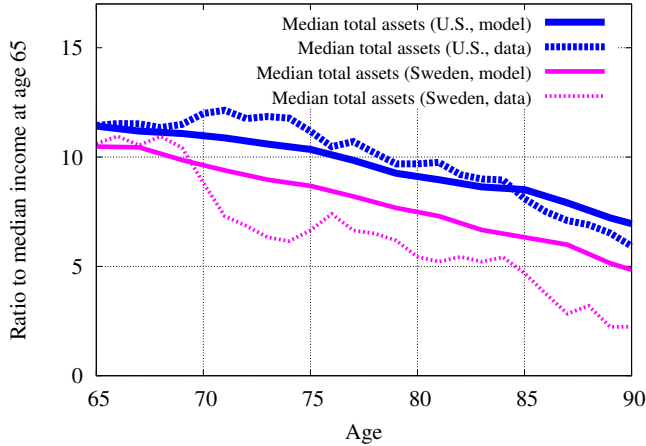
## 5. Investigation of the Effect of Medical Expenses on Saving in Retirement

### 5.1. Main Experiment: Sweden

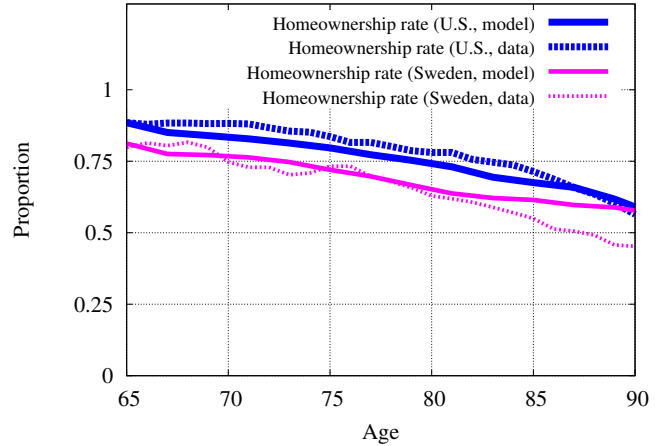
As the main experiment, we use the parameters that we estimated in the model for the U.S., and under the assumption of preferences, housing and mortgage markets, and the consumption floor being identical in Sweden, change only the observable inputs for (i) the initial distribution at age 65, and (ii) the shocks that households face (household size shocks, health status shocks, and medical and long-term-care expense shocks), as described in Section 4.1. We refer to the benchmark model as the "U.S. Model," and to the model with Swedish inputs as the "Swedish Model."

Figure 8 visually presents the predictions of the experiment. In order to make the comparison easier, we again normalize the asset holdings of each country by the respective median nonfinancial income at age 65. As we noted in the data section, the median retired households in both countries start their retirement period with similar amount of wealth relative to their nonfinancial income. Looking at the differences in the median net worth profiles (panel (a)), the Swedish model appears to generate under one-half of the difference between U.S. and Sweden as a result of the changes in risk characteristics and the initial type distribution, on average across age. Moving on to homeownership rate (panel (b)), the Swedish model replicates Sweden's age profile of homeownership, which is about 10 percentage points below the U.S. profile in data, up to age 80. After age 80, the Swedish age profile converges to the U.S. age profile gradually in the model, while the difference between the two profiles remains stable in data. As for median housing assets of homeowners (panel (c)), the Swedish model tracks the data well. The model does not generate the observed sudden decline after age 85, but the noticeable drop in the empirical profile is probably due to the small sample size. Finally, the profile of median financial asset holdings in Sweden (panel (d)) in data is remarkably well replicated by the Swedish model, especially the initial decline of median financial asset holdings.

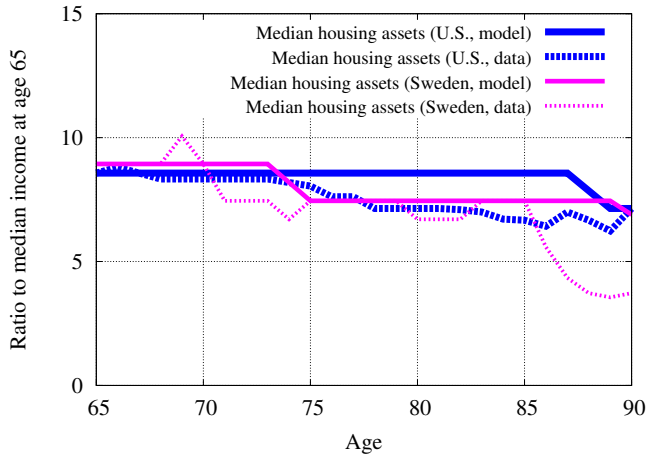
In sum, the Swedish model accounts for less than one-half of the observed differences between the U.S. and Sweden in terms of the median net worth profiles, but replicates well the Swedish age profiles of median financial assets. The model with Swedish initial distribution and Swedish shocks performs moderately well in replicating the age profiles of homeownership rates and housing assets of homeowners in



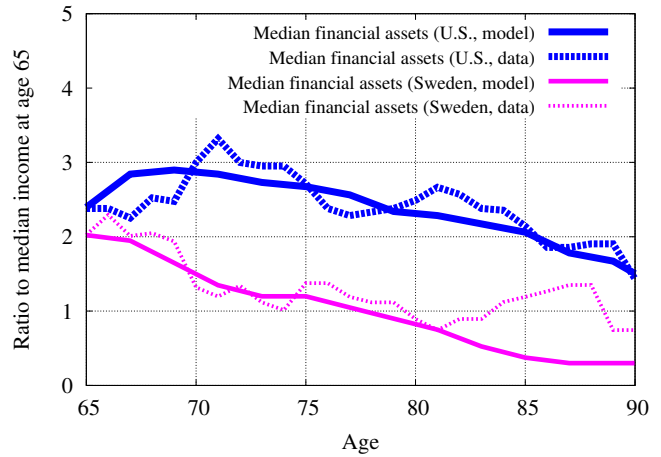
(a) Median Net Worth



(b) Homeownership Rate



(c) Median Conditional Housing Assets



(d) Median Financial Assets

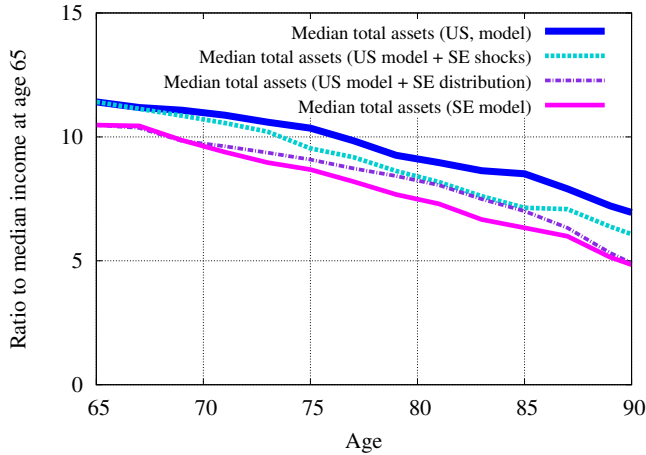
**Figure 8: U.S. vs Sweden, Model and Data**

Sweden. However, remember that because we changed both the initial age-65 type distribution and three types of shocks (household size, health and OOP medical expenses), all of these forces are at play. In the next section, we quantify the contribution of the initial distribution and the shocks separately.

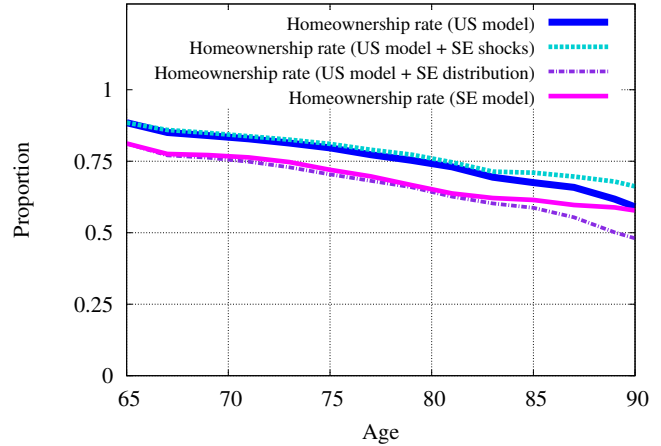
## 5.2. Decomposition: Risks vs Initial Type Distribution

In this section, we run two separate experiments: first, we study the U.S. model with only the initial distribution changed to replicate Sweden's; in the second, opposite experiment, we examine the U.S. model with only the shock processes from Swedish data. Figure 9 summarizes the effect of the decomposition models on saving profiles. Note that while we present here the results of substituting three shock processes simultaneously, in additional experiments we found that shocks to household size do not have a significant separate effect on the age-asset profiles. Therefore, we interpret the experiments of simultaneously changing

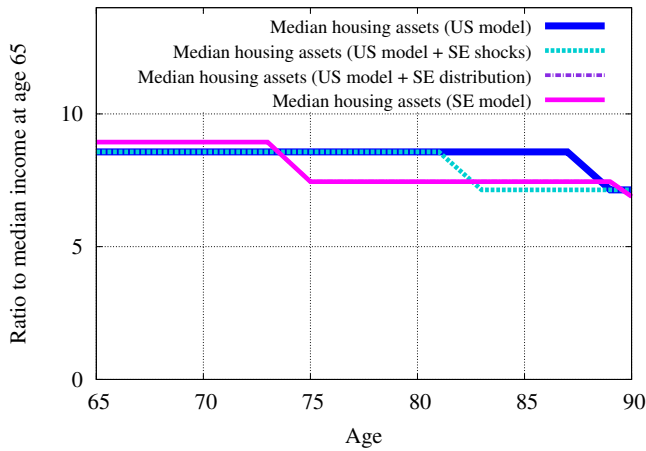




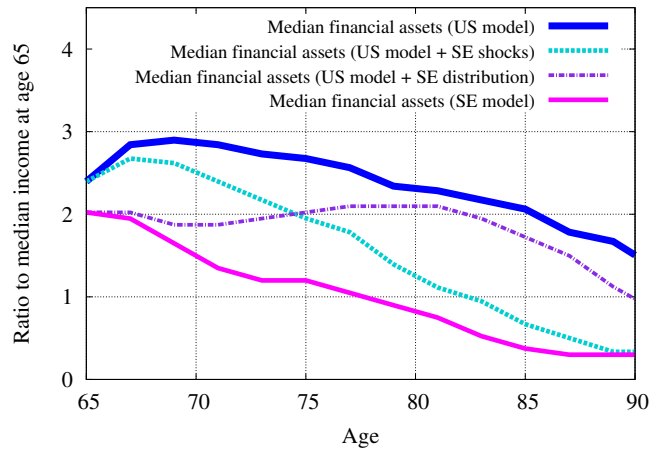
(a) Median Net Worth



(b) Homeownership Rate



(c) Median Conditional Housing Assets



(d) Median Financial Assets

**Figure 9: Decomposition: Risks vs Initial Type Distribution**

all the shocks as isolating the impact of introducing Sweden’s health and medical expense shocks into the U.S. model. Appendix B shows experiments with further decomposition, with only health or medical expense shock processes changed from U.S. to Swedish ones.

Recall that in the previous section we showed that the Swedish model replicates around one-half of the observed differences between the U.S. and Swedish median net worth profiles. Panel (a) shows that, except for the middle of the age profile (ages 75-85), most of the U.S.-Swedish net worth differences are generated by the differences in the initial distribution, rather than by the different medical expenses. On the other hand, in the middle of the age profile (ages 75-85), medical expenses account for close to half of the U.S.-Swedish differences. Overall, the contribution of medical expense level and risk in accounting for the differences in median net worth profiles between the two countries is limited.

The findings are similar for homeownership rates and median housing assets (panels (b) and (c)).

Most of the differences between the U.S. and Swedish homeownership age profiles are generated by the differences in the initial type distributions. Indeed, when Swedish shocks alone are introduced to the U.S. model, the model predicts a slower decline in the homeownership rate, so that homeowners stay in their homes counterfactually longer. This is why the model cannot match the continued decline in the homeownership rate after age 85 in Sweden. As for the median conditional housing asset holdings, the U.S. model with Swedish initial type distribution generates the same age profile as the Swedish model, implying that the contribution of health and medical shocks to saving in housing is not significant. A caveat is that the U.S. model with Swedish shocks also predicts a decline in the median conditional housing asset holdings that is faster than the U.S. model, suggesting some role for medical expense shocks after age 80. Here, the discretization of housing wealth makes the comparison somewhat difficult, however.

Finally, in the previous section, we showed that the Swedish model replicates Sweden's age profile of median financial asset holdings well. The decomposition experiment shows that it is the differences in health and medical expense shocks between the U.S. and Sweden that are responsible for the majority of the differences in financial saving between the two countries (panel (d)). By construction, the Swedish initial distribution explains much of the difference in the early part of the age profiles, but accounts for less than half of that difference after age 75. Indeed, the U.S. model with Swedish shocks can alone replicate Sweden's low levels of median financial savings at age 90, although it predicts counterfactually higher levels of financial saving at age 65, which is by construction.

To summarize, the main experiment and the decomposition experiments imply that the expected level and uncertainty of OOP medical and long-term-care spending impact financial saving decisions of retirees, but not their decisions to own homes and keep housing wealth. Put another way, retirees use financial assets to save and pay for medical expenses, making financial assets the main precautionary asset for this purpose, while housing is not used in such a precautionary fashion. Since housing makes up the majority of median net worth (about 80%) in both countries, this implies that the majority of saving by retirees cannot be accounted for by OOP medical expenses, and that other factors are at play in accounting for housing-related saving decisions. The role of medical expenses and expense risk does change with age, so that they can account for close to one-half for some ages, but much less on average, of the differences in retirees' net worth between the two countries.

One caveat to this interpretation of our results is that we find the initial distribution at age 65 to be an important driver of homeownership and housing asset differences between the two countries, which suggests that the reasons for households to own homes prior to retirement are important in explaining net worth profiles during retirement. If any of these differences in initial conditions are themselves motivated by differing risk of OOP medical spending, so that more U.S. households own homes motivated by this consideration, then there is a link between OOP spending risk and homeownership that we are not capturing

in our models, which do not deal with life-cycle considerations prior to retirement.

In the next subsection, we convert our visual results into numerical ones, by quantifying the contribution of the shocks and the initial distribution to the differences between U.S. and Sweden in dissaving rates of net worth and financial assets.

### 5.3. Quantifying the Role of Medical Expenses

One way to quantify the results in Figure 8 is shown in Table 7. Here, we compute the differences in percent decline relative to age 65 for U.S. and Sweden in median net worth (top panel) and median financial assets (bottom panel) in (i) the data (column 2), (ii) the Swedish model (column 3), and (iii) the U.S. model with only Swedish shocks (column 4), to help isolate the shocks' contribution. Columns 5 and 6 compute the ratio of model's predicted decline to that in the data. While this approach is a noisy way to quantify the model results, as noise in the data can lead to nonmonotonic and spurious discrepancies between the model and data, it is also the most transparent. To be clear, for age group  $j$  we compute, e.g. for net worth (nw):

$$\text{diff}_j^{nw} = 100 * \left( \frac{\frac{\text{nw}_j^{SE}}{\text{nw}_{65}^{SE}} - \frac{\text{nw}_j^{US}}{\text{nw}_{65}^{US}}}{\frac{\text{nw}_j^{US}}{\text{nw}_{65}^{US}}} \right)$$

Notice that, by construction, the value is zero for age 65 households. Since the numbers differ by age, we show a simple average as one possible way to summarize the results. According to the average in column 5, the Swedish model can account for about third (33.6%) of the observed differences between the U.S. and Swedish median net worth profiles. The average of column 6 implies that about 20% is accounted for by the differences in risks (household size, health, and OOP medical and long-term-care expenses). Moreover, in Appendix B, we show that differences in OOP medical and long-term-care expenses are responsible for most of the contribution of risks. Therefore, we can say that differences in the levels and risks of OOP medical and long-term-care expenses can account for about one-fifth of the U.S.-Swedish differences in the median net worth decumulation profile. If we ignore the outliers, the proportion of U.S.-Swedish differences in median net worth profiles that can be accounted for by both the initial type distribution and the shocks is between 17 and 56%, and even without the outliers, the average number is around one-third. The contribution of differences in risks between the U.S. and Sweden account for between 8 percent and 43 percent if outliers are ignored.

According to column 6, the Swedish model accounts for 135% on the observe differences in the median financial asset profiles between the U.S. and Sweden. The model overpredicts (the model's contribution is more than 100 percent) mainly because the Swedish age profile of median financial assets increases significantly between age 83 and 87 (see Figure 8). If the outliers are removed from the calculation of the

**Table 7: Quantifying Model Performances – U.S. vs Sweden**

Median Net Worth						
Age	% Difference Data	% Difference Full Model	% Difference SE Risk Model	Model/Data Full Model	Model/Data SE Risk Model	
67	-1.4	1.7	-0.5	-124.8	36.8	
69	-2.2	-3.0	-2.0	137.6	91.1	
71	-35.2	-6.0	-2.9	17.1	8.3	
73	-42.4	-7.9	-3.6	18.5	8.6	
75	-35.9	-8.7	-7.9	24.1	21.9	
77	-33.1	-9.4	-6.8	28.2	20.5	
79	-31.2	-9.7	-6.8	31.2	21.9	
81	-42.4	-11.3	-8.8	26.7	20.7	
83	-37.5	-15.9	-11.9	42.5	31.8	
85	-37.5	-19.0	-16.1	50.7	43.0	
87	-56.9	-17.5	-10.4	30.7	18.3	
89	-63.1	-22.4	-11.5	35.5	18.4	
91	-64.9	-26.0	-13.7	40.1	21.2	
93	-63.8	-15.6	-1.0	24.5	1.5	
95	-59.8	-33.5	-12.6	56.0	21.1	
Average	-40.5	-13.6	-7.8	33.6	19.2	

Median Financial Assets						
Age	% Difference Data	% Difference Full Model	% Difference SE Risk Model	Model/Data Full Model	Model/Data SE Risk Model	
67	4.9	-18.8	-5.9	-382.4	-119.6	
69	-8.1	-32.6	-9.6	402.8	118.7	
71	-57.6	-43.8	-15.7	76.0	27.2	
73	-55.5	-48.0	-20.4	86.4	36.8	
75	-40.5	-46.9	-27.1	115.9	66.9	
77	-38.7	-51.5	-30.4	133.0	78.6	
79	-44.9	-54.5	-40.5	121.5	90.2	
81	-67.2	-61.2	-51.2	91.0	76.2	
83	-55.9	-71.4	-56.4	127.8	100.9	
85	-34.6	-78.5	-67.6	226.5	195.0	
87	-14.5	-80.1	-71.9	551.4	494.8	
89	-54.0	-78.8	-80.0	145.7	148.0	
91	-51.1	-73.5	-75.0	143.8	146.8	
93	-60.4	-62.5	-70.6	103.5	116.9	
95	-31.9	-20.4	-50.0	67.8	156.6	
Average	-40.7	-54.8	-44.8	134.8	110.2	

average, the average proportion becomes 117 percent. If we also ignore the outliers at the beginning of the age profiles (ages 67 and 69), the proportion accounted for by the model ranges between 64 percent and 146

percent. If only the Swedish shocks are introduced but the U.S. initial type distribution is kept, on average, the model accounts for 110 percent of the observed differences in age profiles of the median financial assets between the U.S. and Sweden. Again, as we show in Appendix B, most of the contribution can be attributed to differences in OOP medical and long-term-care expense risks. If the outliers between ages 83 and 87 are dropped, the number goes down to 94 percent. Excluding early outliers, the proportion accounted for by Swedish medical and long-term-care expenses only varies between 27 percent and 157 percent. Generally speaking, the numbers are consistent with the finding in the previous section that the Swedish model can account for most of the U.S.-Swedish differences in the age profiles of the median financial assets, and out-of-pocket medical and long-term-care expenses account for majority of the explanatory power of the model.

To summarize, the model predicts that out-of-pocket medical and long-term-care expenses affect primarily financial assets, and not housing assets, and accounts for about one-fifth of the difference in net worth between the two countries, but for most of the difference in financial assets.

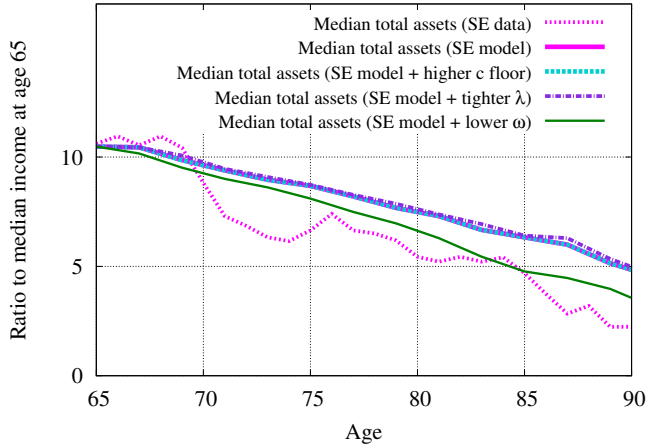
## 6. Role of Mortgage and Housing Markets, and Social Insurance

In the last section, we found that the differences in the initial distribution and medical and long-term-care expenses do not impact housing saving, and as such, do not account for a majority of differences in net worth decumulation in retirement between U.S. and Sweden. What are the factors that may fill this gap in understanding housing saving in retirement?

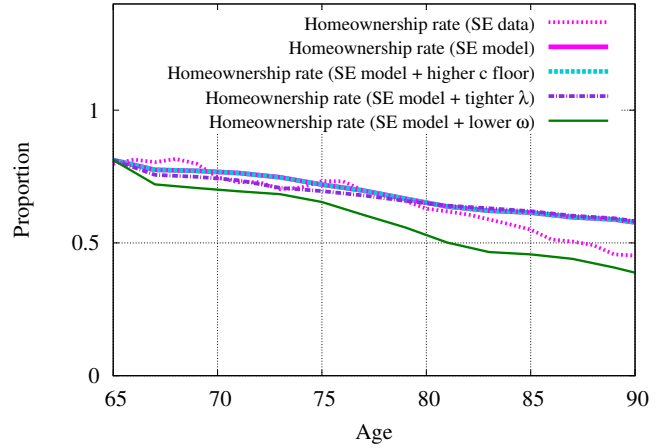
Recall that the maintained assumptions in our experiments so far were that the parameters that characterize mortgage and housing markets, and the consumption floor, which is associated with the level of social insurance, are the same between the U.S. and Sweden. In this section, we relax these assumptions by changing some of the relevant parameters, in order to get an indication of candidate explanations behind the differences in homeownership and saving in housing late in life.<sup>17</sup>

In particular, we focus on three parameters, (i)  $\underline{c}$  (consumption floor), (ii)  $\{\lambda_i\}$  (tightness of housing collateral constraint), and (iii)  $\omega$  (extra utility of homeownership). We tried changing other parameters, such as  $r$  (saving interest rate),  $\iota$  (mortgage interest premium),  $\kappa$  (house selling cost), and found that these parameters either do not have a significant effects on age profiles of asset decumulation, or generate highly counterfactual implications. In the experiment with an alternative  $\underline{c}$ , we double the level of the estimated consumption floor for the U.S. This is meant to capture the general idea that social security in Sweden may be wider-reaching than it is in the U.S., although our data do not allow the calculation of the exact

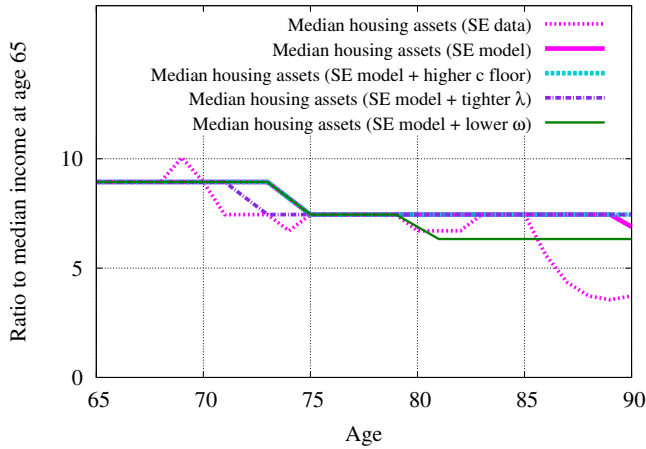
<sup>17</sup>Note that we also hold preference parameters constant between the two countries; in this paper, we do not address this assumption as it is more difficult to find empirical justification for parameter changes of this nature. Obviously, some of these parameters are important, such as those pertaining to bequest motives, and possible differences in these motives across countries. We discuss the role of these parameters and housing saving in retirement to some extent in Nakajima and Telyukova (2013).



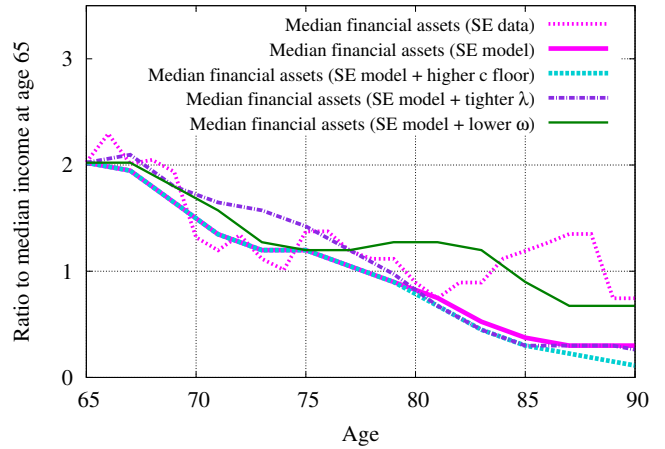
(a) Median Net Worth



(b) Homeownership Rate



(c) Median Conditional Housing Assets



(d) Median Financial Assets

**Figure 10: Role of Mortgage and Housing Markets, and Social Insurance**

benefit. One possible effect of this may be to increase further the rate of asset decumulation, as a higher consumption floor reduces precautionary motives for saving late in life. In the second experiment, we tighten the borrowing constraint  $\{\lambda_i\}$  for each age by 50%. This could accelerate the timing of selling the house and the speed of asset decumulation; the choice of the experiment is motivated by the observed lower homeownership rate in Sweden and the faster rate of net worth decumulation, while we do not have direct empirical evidence for the magnitude of the borrowing constraint in Sweden. In the third experiment, we lower  $\omega$ , which captures the extra utility of homeownership, by 75%. As we mentioned above, this preference parameter in the model also captures financial benefits of homeownership that are not explicitly in the model, such as house price appreciation, tax exemption of imputed rents, mortgage interest payment deduction, or insurance against rental rate fluctuation.

Figure 10 visually summarizes the results. The figure shows the age profiles of Swedish data, the

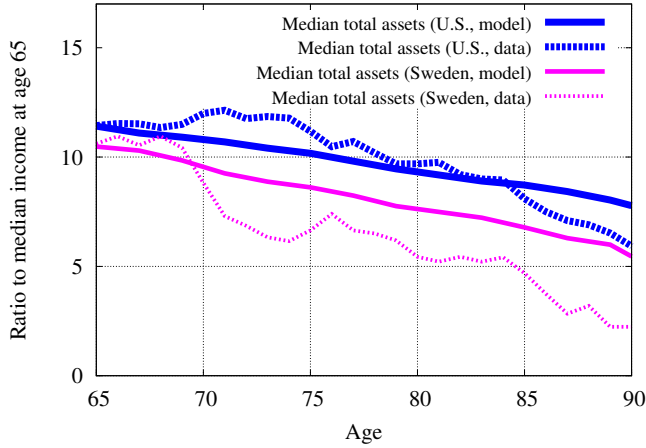
baseline Swedish model as described in the main experiments, and the additional three experiments. The level of the consumption floor does not affect median profiles of net worth or conditional housing assets, or homeownership rates. The only visible effect is to induce a further decumulation of financial assets after age 85. The reason is that the consumption floor affects only the households that exhaust assets. A more generous social security program makes the most vulnerable older retirees, above age 85, dissave more quickly in financial assets, but this does not bring the model prediction closer to the data.

The main effect of a tighter collateral constraint is to induce more households to sell houses and become renters between ages 70 and 80. Age profiles of homeownership rates and conditional median housing assets shift down slightly, and as a result, median financial assets increase, between ages 70 and 80. On the other hand, households after age 80 are virtually unaffected by the change; this is not surprising because the borrowing constraint is very tight even in the benchmark model after age 80 (see table 6). Even between ages 70 and 80, the effect on the age profile of median net worth is negligible, because households that are induced to move out of their house simply shift their asset composition from housing to financial assets, without an increase in spend-down rates.

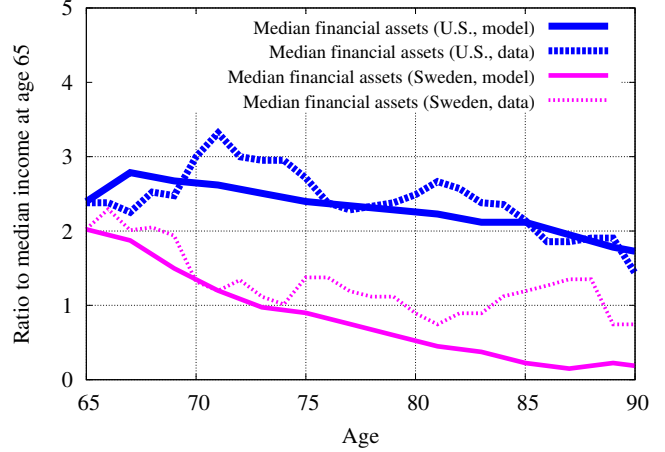
Finally, we find that lowering the extra utility of homeownership brings the model prediction closer to the Swedish data on asset decumulation. In particular, with a lower  $\omega$ , the age profile of median net worth is steeper, and thus closer to the Swedish data. As expected, homeownership profile also shifts down with a lower  $\omega$ , although the model prediction overshoots the empirical age profile. The age profile of median housing assets shifts down slightly, while median financial assets shift up. Both shifts are consistent with the Swedish data, especially after age 80, notwithstanding the noise in the measurement.

From these experiments, it is primarily the utility of homeownership that impacts homeownership behavior among retirees. We do not claim to have answered the question of what could be behind the lower  $\omega$  for Sweden. One possibility may be that U.S. housing markets demonstrate more volatility and higher rates of price appreciation, making homeownership more attractive in the U.S. However, empirically this channel does not seem to be supported. Although Sweden experienced a large decline in house prices in the early 1990s, house price appreciation rates between the mid-1990s and 2006 have been at least as high as in the U.S. during the same period. According to house price indices in the two countries, the average real house price appreciation rate between 1996 and 2006 was 6.1% in the U.S. and 7.6% in Sweden.<sup>18</sup> Moreover, Riksbank (2014) reports that total mortgage balances have been expanding since mid-1990s in Sweden. Other possibilities for differences in the utility of homeownership between the U.S. and Sweden include tax incentives for homeownership, regulation of rental markets, features of mortgage markets, and capital gains and estate tax policies. In addition, other aspects of preferences, such as bequest motives, may interact with the value of this parameter. These are important open issues for future research.

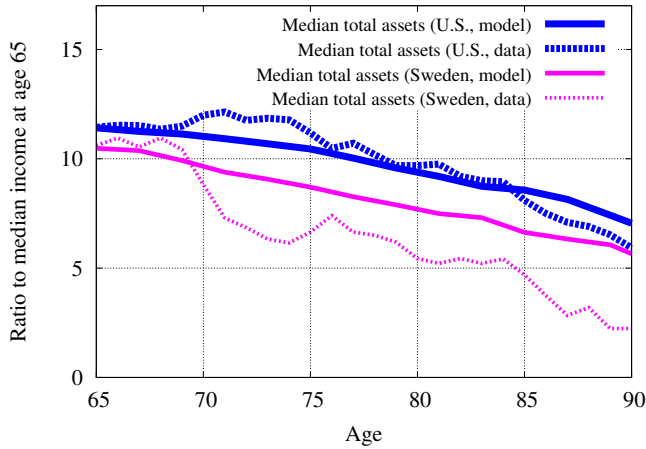
<sup>18</sup>The real house price index was 126.5 in 1996Q4 and 228.3 in 2006Q4 in the U.S., while it was 74.4 in 1996Q4 and 154.5 in 2006Q4 in Sweden.



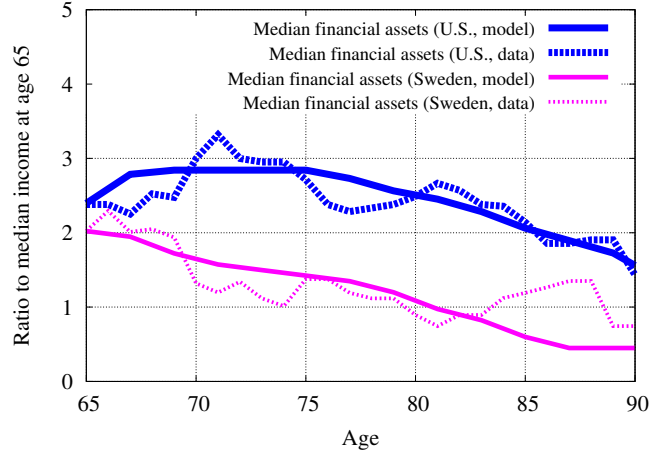
(a) Model with  $\sigma = 3.84$ : Median Net Worth



(b) Model with  $\sigma = 3.84$ : Median Financial Assets



(c) Model with Avg household size: Median Net Worth



(d) Model with Avg household size: Median Financial Assets

**Figure 11: Robustness: U.S. vs Sweden**

## 7. Robustness

In this section, we show that our results are robust to alternative assumptions. In particular, we select and show two sets of robustness results in figure 11. In the first experiment, we fix the parameter representing the coefficient of relative risk aversion,  $\sigma$ , at 3.84, instead of our estimated value of 1.8. The higher value of the risk aversion parameter is the value estimated by De Nardi et al. (2010), and translates into a stronger precautionary motive which may impact asset composition and level for retirees.<sup>19</sup> The rest of the second-stage estimation is conducted in the same way as our baseline model, i.e., the rest of the parameters in table 6 are estimated to minimize the differences in age profiles of median net worth, median financial assets, median housing assets, and homeownership rate, between the U.S. data and the model. The top

<sup>19</sup>It is the estimated value of  $\sigma$  in the model with bequests. See Table 3 of their paper.



two panels of the figure compare the age profiles of median net worth and median financial assets of the U.S. and Sweden, in the alternative model and the data. The figures are similar to those of the baseline model. Again, the Swedish model can account for about one-third of the observed differences between the U.S. and Swedish age profiles of median net worth, and for almost all of the differences in median financial assets.

In the second experiment, we omit household size transition uncertainty and assume that household size changes deterministically with age. This experiment shows how sensitive our results are to the particular assumptions about family transitions that we made in order to accommodate both couples and single households in the data. In this alternative model, age-dependent household size is computed as the average across households in each age group. The rest of the model stays the same. The bottom two panels of Figure 11 confirm that the main results are not sensitive to household size parameterization assumptions in the benchmark. In particular, the figure confirms that the main Swedish model accounts for about one-third of the observed differences in the median net worth profiles between the U.S. and Swedish data, and for all of the differences in the median financial asset profiles.

## 8. Conclusion

We use harmonized cross-country data on U.S. and Sweden to compare facts about saving in financial and housing assets in retirement, as well as about out-of-pocket medical and long-term-care expenses. With OOP medical and long-term-care expenses high in the U.S. and low in Sweden, we find that the differences in patterns of wealth decumulation in the two countries come mainly from financial assets.

Our quantitative experiment, using a calibrated life-cycle model of saving in retirement, quantifies the extent to which differing medical spending level and risk characteristics in the two countries can account for the resulting differences in saving patterns. The model predicts that out-of-pocket medical and long-term-care expenses account for one-fifth of the difference in median net worth decumulation between the U.S. and Sweden, and nearly all of the differences in financial asset decumulation. The model predicts that risk affects primarily financial assets, and not housing assets; the differences in housing asset profiles and ownership of homes late in life must be due to other factors, which our main experiment explicitly holds constant. Additional experiments reveal that a lower extra utility of homeownership in Sweden makes the model prediction closer to the Swedish data.

There is a large variety of institutional differences between the U.S. and Sweden in addition to the differences in healthcare and long-term care insurance policies, concerning pension programs, social safety nets such as Medicaid in the U.S., housing markets, mortgage markets and the like. It is also possible that these institutional differences produce differences in preferences, especially the parameters representing the extra utility of homeownership and bequest motives. The role of these institutions is important to continue investigating. We leave these topics to ongoing and future research.

## References

- Allin, Sara, Vaida Bankauskaite, Hans Dubois, Josep Figueras, Christina Golna, Susanne Grosse-Trebbe, Nadia Jemai, David McDaid, Annette Riesberg, Jonas Schreyoegg, and Sarah Thomson**, *Snapshots of health systems*, World Health Organization on behalf of European Observatory on Health Systems and Policies, 2005.
- Ameriks, John, Andrew Caplin, Steven Paufer, and Stijn van Nieuwerburgh**, “The Joy of Giving or Assisted Living? Using Strategic Surveys to Separate Public Care Aversion from Bequest Motives.,” *Journal of Finance*, 2011, *66* (2), 519–561.
- Angelini, Viola, Agar Brugiavini, and Guglielmo Weber**, “The Dynamics of Homeownership among the 50+ in Europe,” 2011. Mimeo.
- Brown, Jeffrey R. and Amy Finkelstein**, “Insuring Long-Term Care in the United States,” *Journal of Economic Perspectives*, 2011, *25* (4), 119–142.
- Caplin, Andrew**, “Turning Assets into Cash: Problems and Prospects in the Reverse Mortgage Market,” in Olivia S. Mitchell, Zvi Bodie, Brett Hammond, and Steve Zeldes, eds., *Innovations in Retirement Financing*, Philadelphia, PA: University of Pennsylvania Press, 2002, chapter 3, pp. 234–253.
- Christelis, Dimitris, Dimitris Georgarakos, and Michael Haliassos**, “Differences in Portfolios Across Countries: Economic Environment versus Household Characteristics,” *Review of Economics and Statistics*, forthcoming.
- De Nardi, Mariacristina, Eric French, and John Bailey Jones**, “Why Do the Elderly Save? The Role of Medical Expenses,” *Journal of Political Economy*, 2010, *118* (1), 39–75.
- , – , **and** – , “Medicaid Insurance in Old Age,” 2013. Federal Reserve Bank of Chicago Working Paper No. 2012-13.
- Erosa, Andres, Luisa Fuster, and Gueorgui Kambourov**, “Labor Supply and Government Programs: A Cross-Country Analysis,” *Journal of Monetary Economics*, 2012, *59* (1), 84–107.
- Fernández-Villaverde, Jesús and Dirk Krueger**, “Consumption over the Life Cycle: Facts from Consumer Expenditure Survey Data,” *Review of Economics and Statistics*, 2007, *89* (3), 552–565.
- Gourinchas, Pierre-Olivier and Jonathan A. Parker**, “Consumption over the Life-Cycle,” *Econometrica*, 2002, *70* (1), 47–89.

- Hubbard, R. Glenn, Jonathan Skinner, and Stephen P. Zeldes**, “The Importance of Precautionary Motives in Explaining Individual and Aggregate Saving,” *Carnegie-Rochester Conference Series on Public Policy*, 1994, pp. 59–125.
- , – , **and** – , “Precautionary Saving and Social Insurance,” *Journal of Political Economy*, 1995, *103* (3), 360–399.
- Hurd, Michael D.**, “Mortality Risk and Bequests,” *Econometrica*, 1989, *57* (4), 779–813.
- Lockwood, Lee M.**, “Bequest Motives and the Annuity Puzzle,” *Review of Economic Dynamics*, 2012, *15* (2), 226–243.
- Nakajima, Makoto and Irina A. Telyukova**, “Home Equity in Retirement,” 2013. Mimeo, UCSD.
- **and** – , “Reverse Mortgage Loans: A Quantitative Analysis,” Working Paper 14-27, Federal Reserve Bank of Philadelphia 2014a.
- **and** – , “Housing in Retirement Across Countries,” 2014b. Mimeo, UCSD.
- OECD**, *Long-term Care for Older People*, OECD Publishing, 2005.
- Riksbank**, “From A to Z: the Swedish Mortgage Market and its Role in the Financial System,” Riksbank Studies 2014.
- Venti, Steven F. and David A. Wise**, “Aging and Housing Equity: Another Look,” in David A. Wise, ed., *Perspectives on the Economics of Aging*, Chicago: University of Chicago Press, 2004, chapter 3, pp. 127–175.

## Appendix

### A. Interpretation of Bequest Parameters

In this appendix, we follow De Nardi et al. (2010) and present a way to interpret bequest-related parameters.<sup>20</sup> In particular, we compute (i) the minimum level of wealth where households start leaving bequests, and (ii) the marginal propensity to bequeath, once the level of wealth goes above the minimum level.

For simplicity, let's assume a single (1-adult) household of age- $I$  (last year of life). Furthermore, let's assume there is no housing decision. Since this is the last year of life, by assumption, future value consists only with utility of bequest. The problem of such household can be represented as follows:

$$\max_{c,e} \frac{c^{1-\sigma}}{1-\sigma} + \beta\gamma \frac{(e+\zeta)^{1-\sigma}}{1-\sigma} \quad (13)$$

subject to:

$$e = (x - c)(1 + r) \quad (14)$$

where  $c$  is last period consumption,  $x$  is the wealth holding at the beginning of the last period (after paying medical expenses),  $e$  is the amount of bequests,  $r$  is the saving interest rate. By taking the first order condition with respect to consumption, we can derive the following decision rule for the optimal amount of bequests.

$$e^* = \frac{1+r}{1+r+\Lambda} (\Lambda x - \zeta) \quad (15)$$

where  $\Lambda = (\beta\gamma(1+r))^{\frac{1}{\sigma}}$ . From Equation (15), we can easily see that the optimal amount of bequests is positive if  $x \geq \frac{\zeta}{\Lambda}$ . Moreover, the marginal propensity of bequests can be calculated as:

$$\frac{\partial \frac{e^*}{1+r}}{\partial x} = \frac{\Lambda}{1+r+\Lambda} \quad (16)$$

In our baseline calibration, we have  $r = 0.08$ ,  $\beta = 0.957$ ,  $\sigma = 1.792$ ,  $\gamma = 0.539$ , and  $\zeta = 28,177$ . From these parameter values, we can obtain the threshold value of  $x$  of \$39,057 and the marginal propensity to bequeath of 0.400. For the estimated model of De Nardi et al. (2010),  $r = 0.02$ ,  $\beta = 0.970$ ,  $\sigma = 3.84$ ,  $\gamma = 2,360$ , and  $\zeta = 273,000$ . These parameters imply that the threshold value of wealth is \$36,225 and the marginal propensity of bequeath is 0.881. In both our baseline model and the estimated model of De Nardi et al. (2010), the threshold value of wealth is high, which is consistent with a small fraction of (wealth-rich) households which actively leaves bequests. On the other hand, the marginal propensity to

<sup>20</sup>To be precise, Appendix D of a working paper version of their paper.

bequeath is different between our baseline model and the estimated model of De Nardi et al. (2010).

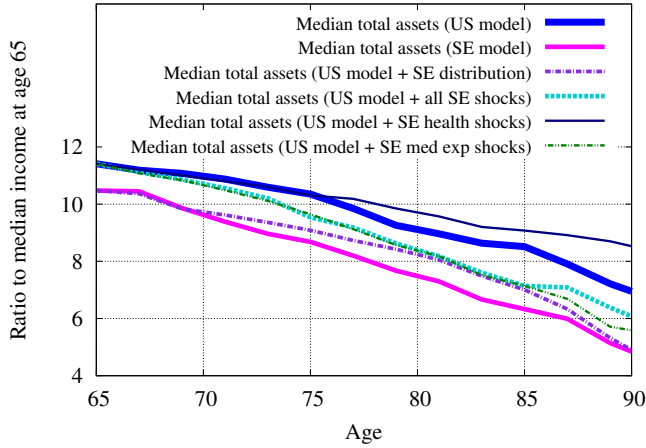
## B. Further Decomposition Experiments

Figure 12 shows the age profiles of median net worth, homeownership rate, median housing and financial assets, and proportion of households in net debt for the following 6 model economies.

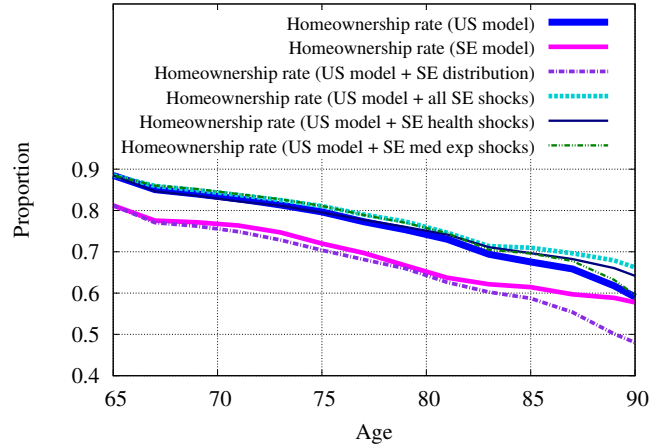
1. U.S. model (with U.S. initial type distribution and all U.S. shocks).
2. Swedish model (with Swedish initial type distribution and all Swedish shocks).
3. U.S. model with Swedish initial distribution.
4. U.S. model with all Swedish shocks.
5. U.S. model with Swedish health shocks.
6. U.S. model with Swedish medical expense shocks.

The models 1-4 are also shown in Figure 9. Notice that model 3 has not only the Swedish health and medical expense shocks, but also Swedish household size shocks. However, since we found that household size shocks do not affect the age profiles in a sizable manner, we omit the U.S. model with only Swedish household size shocks.

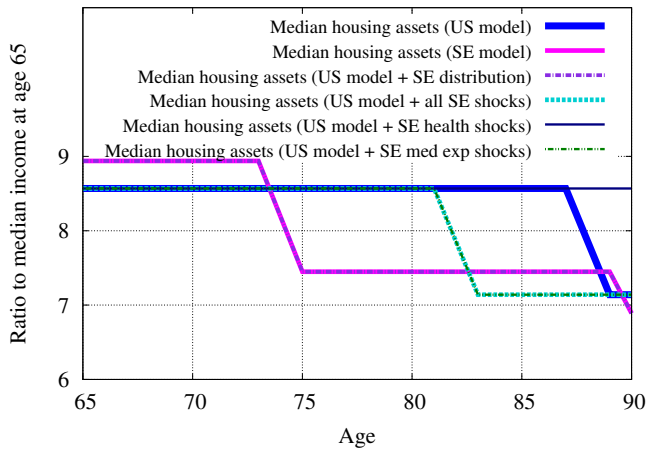
It is easy to see that medical expense shocks play the crucial role in creating the differences between the U.S. life-cycle profiles and the Swedish profiles. In other words, the U.S. model only with Swedish medical expense shocks (model 6) generates life-cycle profiles close to those of the U.S. model with all Swedish shocks (model 4) in Figure 9. The only relatively minor exception is the profile of the homeownership rate for households of age 85 and above. For those households, health shocks, in particular, slower deterioration of health status among the Swedish households, keep the homeownership rate higher. One can see by comparing the profile of the homeownership rate between the model 4 and the model 5.



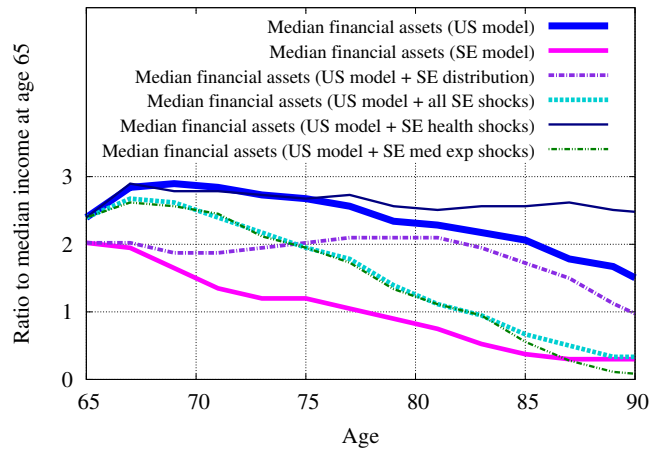
(a) Median Net Worth



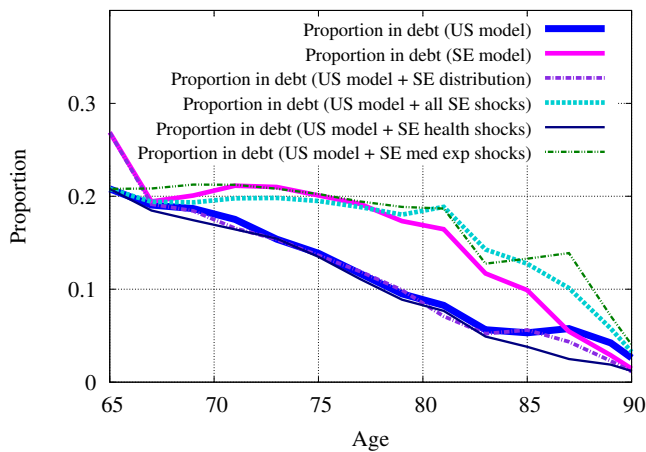
(b) Homeownership Rate



(c) Median Conditional Housing Assets



(d) Median Financial Assets



(e) Proportion of in Net Debt

**Figure 12: Decomposition: Risks vs Initial Type Distribution**