

## Old, Sick, Alone, and Poor: A Welfare Analysis of Old-Age Social Insurance Programs

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**Abstract:** All individuals face some risk of ending up old, sick, alone, and poor. Is there a role for social insurance for these risks, and if so what is a good program? A large literature has analyzed the costs and benefits of pay-as-you-go public pensions and found that the costs exceed the benefits. This paper, instead, considers means-tested social insurance programs for retirees such as Medicaid and food stamp programs. We find that the welfare gains from these programs are large. Moreover, the current scale of means-tested social insurance in the United States is too small in the following sense: If we condition on the current Social Security program, increasing the scale of means-tested social insurance by one-third benefits both the poor and the affluent when a payroll tax is used to fund the increase.

JEL classification: E62, H31, H52, H55

Key words: means-tested social insurance, Medicaid, welfare, elderly, medical expenses

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# 1 Introduction

All individuals face some risk of ending up old, sick, alone and poor. These risks are significant. Poverty rates of the elderly are large and increase with age. They rise from a level of 17% for those aged 75–79 to 19% for those aged 80 and over.<sup>1</sup> Important determinants of these poverty outcomes are lifetime earnings risk, longevity, sickness/disability and marital status risk. Some individuals enter retirement with low assets due to bad luck in the labor market. Medical and long-term care expenses are tightly connected with longevity because they increase with age and are highest in the final periods of life. Spousal death events are costly because large nursing home or hospital expenses often precede the death of a spouse.

Poverty among the aged is a particularly troubling problem for society. In contrast to younger individuals, the aged are often unable to self-insure against a medical or spousal death event by re-entering the labor force. Is there a role for social insurance for the aged and, if so, what is a good program?

The largest U.S. social insurance program for retirees is Social Security (SS).<sup>2</sup> SS outlays were 4.1% of GDP in 2013 and are predicted to increase to 4.9% of GDP by 2036.<sup>3</sup> A large macroeconomics literature has analyzed the role of SS and found that a pay-as-you-go SS program is a bad public policy. This result has been documented in models with dynastic households as in [Fuster, İmrohoroğlu and İmrohoroğlu \(2007\)](#) and also lifecycle OLG models starting with the research of [Auerbach and Kotlikoff \(1987\)](#). [İmrohoroglu, Imrohoroglu and Joines \(1999\)](#) show that this result holds in dynamically efficient economies. [Conesa and Krueger \(1999\)](#) find that this result holds when agents face life-time earnings risk. [Hong and Ríos-Rull \(2007\)](#) show that this result holds when the economy is open and the pre-tax real interest rate is fixed. They also show that the result does not depend on the availability of private market substitutes such as private annuities and private life insurance. [İmrohoroglu, Imrohoroglu and Joines \(1995\)](#) reach the same conclusion in a model with catastrophic health risk but no Medicaid or any other means-tested transfers. Perhaps the strongest argument in favor of continuing SS is that it would be even more costly to remove. [Nishiyama and Smetters \(2007\)](#) find that the transition costs of privatizing SS can exceed the long-term benefits associated with a smaller SS program in a setting with uninsured labor market risk.

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<sup>1</sup>For purposes of comparison poverty rates for the general population are 16%. These numbers are based on the Bureau of Census Supplemental Poverty Measure which is designed to give a more comprehensive picture of the situation of the poor by including tax and other government benefits and accounting for out-of-pocket medical expenses. For more details see: <http://www.ssa.gov/policy/docs/ssb/v73n4/v73n4p49.html>

<sup>2</sup>In the United States this program is referred to as the Old-Age, and Survivors Insurance Program.

<sup>3</sup>These figures are from “The 2014 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds.” The GDP projections are from the Congressional Budget Office.

It would be a mistake to conclude from this literature that there is no role for society to provide insurance to retirees. We assess the welfare effects of means-tested social insurance (MTSI) programs for the aged and find that these programs are highly valued. MTSI programs that benefit the aged include Medicaid, Supplemental Social Security Income (SSI), food stamps and housing and energy assistance programs. MTSI provides good insurance against longevity risk and is a particularly effective way to insure against large medical expenses, spousal death events and poor lifetime earnings outcomes. MTSI works well because the transfers induced by the means-test line up well with states where demand for the insurance is high. For example, large shocks are particularly costly at the end of life because agents cannot easily self-insure by reentering the labor market and, absent a bequest motive, would like to keep their savings low. At the same time the disutility of low consumption is very high. Thus, insurance for retirees that pays off when wealth is very low is highly valued.

We use a large quantitative model of the U.S. economy to demonstrate that removing MTSI for the elderly has a large negative effect on welfare. This occurs even when SS is maintained at its current U.S. level. Our finding raises the question as to whether there is an opportunity to increase the scale of current MTSI programs. Indeed we document broad based welfare gains if the scale of these programs is increased by 1/3 and financed with a proportionate payroll tax.

Perhaps the most striking feature of MTSI is that its state-contingent nature allows it to deliver valuable insurance with programs that are much smaller than SS. Medicaid, which subsidizes medical costs, is the largest MTSI program for retirees. Yet, Medicaid expenditures for 65+ only constitute 0.6% of GDP. Only about 5% of 65+ receive assistance from SSI, the second largest program, and expenditures on this program are only about 0.3% of GDP.<sup>4</sup>

Our findings are surprising given that previous literature has found that MTSI has large distortionary effects on incentives. [Hubbard, Skinner and Zeldes \(1995\)](#) find that means-testing is a 100% tax on wealth in some states of nature. [Feldstein \(1987\)](#) shows that old-age MTSI programs can severely distort saving incentives, inducing some individuals to consume all of their income while working so that they can immediately qualify for MTSI when they retire and estimates in [Neumark and Powers \(1998\)](#) suggest that these effects are quantitatively significant. Funding these programs requires taxes which create further distortions. We first use a two-period model to illustrate the tradeoffs between the insurance

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<sup>4</sup>The Medicaid figure is taken from: U.S. Centers for Medicare and Medicaid Services, Office of the Actuary, “National Health Expenditure Accounts” and is an average from 2000 to 2010. The SSI numbers are from CBO “Growth in Means-tested Programs and Tax Credits for Low-Income Households” (2013).

and incentive effects of MTSI in a transparent way. The model shows that the value of the insurance provided by MTSI against medical expense, longevity and life-time earnings risks can outweigh the costs due to the negative incentive effects.<sup>5</sup>

Our main objective is to assess U.S. MTSI programs for retirees and this requires a quantitative model that captures the main risks faced by retirees. A large literature has already documented that individuals in the U.S. face significant lifetime earnings risk.<sup>6</sup> Individuals also face significant risks after retirement. For example, [De Nardi, French and Jones \(2010\)](#) show that medical expenses are an important driver of precautionary saving by the elderly and [Kopecky and Koreshkova \(2014\)](#) find that nursing home expense risks are particularly significant. Old-age risks are also a significant driver of impoverishment. We demonstrate this fact by providing new evidence that widowhood, poor health, and hospital and nursing home stays are all associated with higher transitions into the bottom wealth quintile and higher persistence of stays in that quintile. According to our results even wealthy households can become impoverished by these events.

We capture these risks in a general equilibrium, lifecycle model. Individuals enter the economy with a given level of educational attainment and a spouse, and stay married throughout their working life. Labor productivity of working-age households evolves stochastically over the lifecycle and a borrowing constraint limits their ability to self-insure. Prime-age male labor supply is inelastic, but female participation and hours worked is optimally chosen by the household. To capture the decline in male participation at older ages, we assume that males make a participation decision in each period between ages 55 and 65.

In our model retired individuals, age 65 and over, are subject to survival, spousal death, health and out-of-pocket (OOP) medical expense risk, including the risk of a lengthy nursing home stay. These risks vary with age, gender and marital status of the retiree and are correlated with the retiree's education type. Thus retired households are heterogeneous not only in the size of their accumulated wealth (private savings and pensions), but also in the life expectancies of their members, household OOP medical expenses and household composition. We assume that there are no markets to insure against productivity, health, or survival risk. Partial insurance, however, is available to retirees through a progressive pay-as-you-go SS program that includes spousal and survivor benefits, and a MTSI program that includes both categorically and medically needy paths to Medicaid. We also model Medicare in that medical expenses are net of Medicare transfers and the payroll tax includes

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<sup>5</sup>We wish to emphasize that following Feldstein we focus on MTSI for retirees. The costs and benefits of offering MTSI to workers are not the same since social insurance programs for workers have been shown, for example, to have much larger effects on labor supply ([Krueger and Meyer, 2002](#)).

<sup>6</sup>See for example [Heathcote, Storesletten and Violante \(2008\)](#), [Guvenen \(2009\)](#), [Heathcote, Perri and Violante \(2010a\)](#) and [Huggett, Ventura and Yaron \(2011\)](#).

Medicare contributions.

We calibrate the model to match a set of aggregate and distributional moments for the U.S. economy, including demographics, earnings, medical and nursing home expenses, as well as features of the U.S. means-tested social welfare, SS and income tax systems. We then assess the model's ability to reproduce key facts observed in the data but not targeted in the calibration. In particular, we show that the model generates patterns consistent with the data with regards to Medicaid reciprocity rates, flows into Medicaid and OOP medical expenses by age and marital status. Moreover, we show that the model delivers an increased likelihood of impoverishment for individuals who experience: large acute and long-term care OOP expenses; shocks to health status; or a spousal death event. These patterns of impoverishment in the model are in line with impoverishment statistics in our dataset obtained from the Health and Retirement Survey (HRS).

This economy is then used to investigate the welfare effects of MTSI. Removing MTSI from our baseline model of the U.S. results in large welfare *losses* for all types of households. Indeed, there is general support for increasing the scale of MTSI for retirees provided that it is financed by increasing the payroll tax. Both poor households and affluent households, as indexed by either educational attainment or lifetime earnings quintile of the male, prefer a larger scale of MTSI. In contrast, welfare of all types of households *increases* when SS is removed even though the fraction of retirees consuming at the MTSI consumption floor more than doubles. Interestingly, the welfare benefits of MTSI are even larger when SS is not available. When MTSI is available, SS is redundant in the following sense. MTSI provides meaningful insurance against longevity risk and other risks but at a lower social cost. Finally, we find important interaction effects between the two programs. One benefit of offering SS in a world where MTSI is available is that it alters saving patterns of poorer households and this in turn lowers the fraction of households that roll-in to MTSI at retirement.

To our knowledge our paper is the first to demonstrate that MTSI programs for U.S. retirees are welfare enhancing. [De Nardi, French and Jones \(2013\)](#) in a complementarity paper propose a detailed partial equilibrium model of Medicaid transfers to single retirees. Medical expenses are endogenous in their model and they are able to estimate their model's parameters. They find that retirees value Medicaid transfers at more than their actuarial cost. Agents only become active at retirement so their model is not able to capture the distortionary effects that MTSI has on working-age individuals. In addition, they are not able to assess the overall welfare effects of MTSI because they do not model the financing of this program.

Other recent research analyzes means-tests in the context of public pension reform in OLG models where lifetime earnings risk and longevity are the only risks faced by retirees.

[Tran and Woodland \(2012\)](#) compare Australia’s current means-tested public pension system with an alternative economy with no means-tested public pension. They find that means-tested public pensions may be preferred to a universal public pension plan if means-tested benefits are tapered off in a suitable way. [Sefton, van de Ven and Weale \(2008\)](#) find that the Pension Credit program that was instituted in the UK in 2003 and that relaxed the public pension means-test is preferred to both the previous program and a universal SS system.

In addition to transfers from MTSI programs, which are the subject of our analysis, U.S. retirees also receive entitlement transfers to cover acute medical expenses from the Medicare program. We model the Medicare program but do not alter its scale. [Attanasio, Kitao and Violante \(2011\)](#) consider Medicare reforms and explore how to fund Medicare as the babyboom generation retirees. The main objective of [Kopecky and Koreshkova \(2014\)](#) is to demonstrate that nursing home expenses are important drivers of wealth accumulation in the U.S., but they also consider the welfare effects of replacing Medicaid coverage of nursing home expenses with Medicare coverage.

The remainder of the paper is organized as follows. In Section 2, we provide new evidence on sources of impoverishment for the elderly. Section 3 describes the two-period model. Section 4 develops our quantitative model of the U.S. economy. Section 5 reports how we estimate and calibrate the various parameters and profiles that are needed to solve the model. In Section 6, we assess the ability of the model to reproduce statistics not targeted in the calibration, including flows into Medicaid by age and marital status, as well as a variety of wealth mobility statistics for retirees. Section 7 reports results from our welfare analysis. Finally, Section 8 contains our concluding remarks.

## 2 Sources of Impoverishment Among the Elderly

A large literature has analyzed earnings risk but much less is known about shocks that occur during retirement. Previous work by [De Nardi et al. \(2010\)](#) and [Kopecky and Koreshkova \(2014\)](#) on saving and wealth suggests that medical expenses might be an important source of impoverishment among the elderly. This section provides new empirical evidence that medical expenses as well as a range of other shocks are sources of impoverishment for retirees. In particular, we find that longevity, widowhood, self-reported health status, hospital stays and nursing home stays are all associated with higher probabilities of transitions into the first (lowest) wealth quintile and longer durations in this quintile.

Table 1 reports probabilities of 2-year transitions from the five wealth quintiles to quintile 1 using a sample of 65+ retired individuals from the 1995–2010 waves of the HRS/AHEAD

Table 1: Percentage of retirees moving from each quintile of the wealth distribution to quintile 1 two years later by marital (women only), health and nursing home status

Quintile	Marital Status		Health Status		Nursing Home Status	
	Married	Widowed	Healthy	Unhealthy	None	NH Stay
1	72.4	77.9	72.4	77.9	74.3	87.4
2	18.7	22.7	18.7	22.7	17.4	39.4
3	4.4	7.4	4.4	7.4	4.1	25.0
4	1.4	2.5	1.4	2.5	1.4	15.3
5	0.7	1.1	0.7	1.1	0.6	3.9

The percentage of individuals moving down to quintile 1 from quintiles 2–5 in a 2-year period conditional on marital or health status in the initial period, or spending at least 90 days in a nursing home during the 2-year period. Marital status numbers are for women only. The first row is the percentage of individuals who stay in quintile 1. Source: Authors’ computations using our HRS sample.

survey.<sup>7</sup> We will subsequently refer this data as ‘our HRS sample.’ The transitions are conditional on marital status, health status and nursing home status. For example, the first panel shows the probabilities of transiting to quintile 1 for married women and widowed women. To control for age, we computed the transitions separately for 65–74, 75–84 and 85+ year-old individuals and took a weighted average of the results to construct the table. Wealth consists of total wealth excluding the primary residence. More details on the construction of the wealth transitions can be found in Section 1.1 of the Online Appendix.

The table shows, first, that a higher percentage of widowed women, unhealthy individuals, and individuals who experience a nursing home stay transit to quintile 1 from each other wealth quintile as compared to their counterparts. And second, that low wealth is more persistent for these three groups than their counterparts. These patterns arise for each of the three age groups separately and impoverishment increases with age.<sup>8</sup> In Section 1.2 of the Online Appendix we show that patterns by marital status for men look very similar to those by marital status for women.

Another feature of the table is that nursing home stays have the largest impact on impoverishment. The cost of a one-year stay in a nursing home can easily exceed \$60,000 and, while the average duration is only approximately two years, [Brown and Finkelstein \(2008\)](#) estimate that approximately 9% of entrants will spend more than five years in a nursing home. Given the cost and, for some, long duration of nursing home stays, it is not surprising that the percentage of individuals who transit to or stay in quintile 1 is significantly larger if a nursing home stay has occurred. Hospital stays are also associated with a higher

<sup>7</sup>More information on this sample is available in Section 1 of the Online Appendix.

<sup>8</sup>See Table 7.

risk of impoverishment but the differences are less pronounced.<sup>9</sup>

The pattern of correlations that emerges in these transitions yields a surprisingly consistent picture. Impoverishment is positively associated with age, widowhood, poor health and both acute and long-term medical events.

### 3 A Two-Period Model

We start by describing the insurance and incentive effects of MTSI in a simple two-period model. We show that MTSI can be welfare improving in the presence of medical expense, longevity and permanent earnings risk and that it is particularly valuable when multiple risks are present. This is accomplished by analyzing how welfare changes as we vary the scale of MTSI in the model.

#### 3.1 Economy

Consider a small open economy such that the interest rate  $r$  is fixed and exogenous. Assume that the economy consists of a unit measure of individuals. A fraction  $\theta$  receive a high endowment  $y_h$  and the remaining  $1 - \theta$  receive  $y_l \leq y_h$  in period 1. A fraction,  $\gamma$ , survive to period 2 and the remaining agents die after they consume in period 1. Individuals who survive to the second period face high expenses  $m$  with probability  $\phi$ . We omit private insurance markets for longevity and medical expenses in this model and also our baseline model. Our reasons for this modeling decision are discussed in Section 7.5.

##### 3.1.1 Individuals

The individual chooses consumption  $c^y$  when young, consumption  $c^b$  when old if he experiences positive medical expenses, consumption  $c^g$  when old if he does not incur a medical expense shock and savings  $a$  that solve

$$V(y) = \max \left\{ \log(c^y) + \gamma\beta [\phi \log(c^b) + (1 - \phi) \log(c^g)] \right\},$$

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<sup>9</sup>To conserve on space, we report transitions conditional on hospital stays in Section 1.2 of the Online Appendix.

subject to

$$\begin{aligned}
c^y &= y(1 - \tau) - a, \\
c^b &= (1 + r)a - m + TR^b, \\
c^g &= (1 + r)a + TR^g, \\
TR^j &= \max \{0, \underline{c} + mI(j = b) - a(1 + r)\}, \quad j \in \{b, g\}, \quad \text{and} \\
a &\geq 0.
\end{aligned}$$

Note that the subscripts denoting type have been omitted. Transfers to the old,  $TR^j$ , are subject to a means-test. They are zero for those whose wealth net of medical expenses exceeds  $\underline{c}$ . Otherwise, they are large enough to provide the agent with  $\underline{c}$  units of consumption. These transfers are funded by a tax  $\tau$  on the endowment.

### 3.1.2 Government and Feasibility

The government can save at the same rate as individuals,  $r$ . It saves the revenues from taxing agents' endowments when young and uses them to finance means-tested transfers to them when old. Accidental bequests are taxed and consumed by the government. The government budget constraints and aggregate resource constraint are displayed in the Appendix.

## 3.2 The Welfare-Enhancing Effects of Means-tested Social Insurance

MTSI provides an insurance benefit to those who have long lives, high medical expenses and/or a low endowment. Notice that, for example, when medical expenses are large an individual is more likely to receive a transfer. In short, MTSI is a state-contingent transfer program. However, it is not obvious that MTSI is welfare enhancing as it distorts saving incentives in two ways. First, it is well known from [Hubbard et al. \(1995\)](#) that means-testing creates non-convexities in agents' budget sets. These non-convexities are due to the fact that in certain states of nature the means-test is a 100% tax on wealth. This results in a savings distortion and a small reduction in disposable income or a small increase in the consumption floor can produce a discrete fall in savings. Second, observe that this program is funded with a distortionary tax. In equilibrium, jumps in the saving policies due to a marginal increase in the consumption floor generate jumps in aggregate transfers which in turn produce a discrete increase in the equilibrium tax rate. We now show that the insurance benefit of MTSI can be so large as to offset the negative savings and tax distortions it creates.

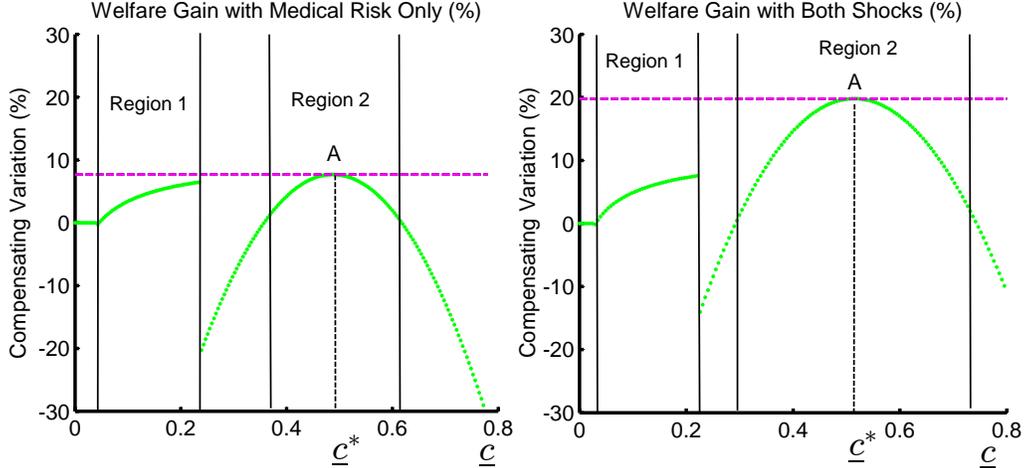


Figure 1: Welfare effects of MTSI for various levels of the consumption floor,  $\underline{c}$ , in two versions of the two-period model.

**Medical Expense Risk Only** Consider first a situation where  $y_l = y_h = 1$  and  $\gamma = 1$  so that there is no longevity risk. Under this assumption introducing MTSI into a Laissez-Faire (LF) economy with no social insurance program is welfare improving if medical risks are sufficiently large. However, as Figure 1 illustrates, welfare is not monotonically increasing in the scale of the MTSI program due a jump in the individual savings policy and the tax rate. The left panel of the figure plots compensating variations for different scales of MTSI as compared to LF.<sup>10</sup> Notice that MTSI is welfare improving over LF in two distinct ranges of the consumption floor. In region 1 private savings are positive and individuals receive a transfer only when they have medical expenses. In region 2 all individuals receive transfers and private savings are zero. Underlying the result that MTSI is Pareto improving in the two regions is a positive welfare effect provided by the state-contingent nature of the program and a negative effect due to the savings distortions. The positive insurance effect is clearest in region 1 where welfare rises monotonically with the scale of the program. In this region, MTSI reduces ex-post consumption inequality. At a consumption floor of about 0.22 the savings policy discretely falls to zero, taxes jump up and welfare discretely falls. In region 2 the program fully insures against medical expense risk and the only reason why welfare varies is because the size of the consumption floor affects the time profile of consumption. The allocation at point A provides the optimal amount of insurance and time profile of consumption and is thus Pareto Optimal (PO).

The results illustrated in the left panel of Figure 1 presume a particular scale of expected

<sup>10</sup>We set the endowment  $y = 1$ ,  $m = 0.5$  and  $\phi = 0.05$ . These choices imply that average medical expenses are 2.5% of the endowment and that there is a welfare enhancing role for MTSI. We also assume that  $r = 1/\beta - 1 = 0$ .

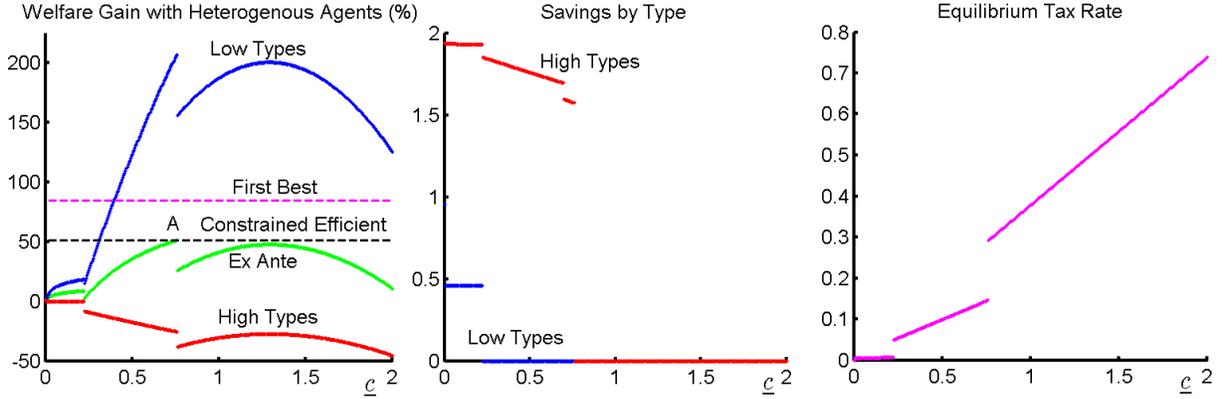


Figure 2: The left panel shows how the welfare effects of MTSI vary with the size of the consumption floor,  $\underline{c}$ , for the two-period model with endowment, longevity and medical expense risk. The middle graph shows the levels of savings of the two income types for each value of the floor and the right panel shows the tax rate at each value.

medical expenses. As expected medical expenses are increased the sizes of regions 1 and 2 also increase and at some point all consumption floors less than  $\underline{c}^*$  are Pareto preferred to LF.

**Longevity and Medical Expense Risk** The right panel of Figure 1 reports compensating variations for alternative scales of MTSI in comparison with LF for the case where both longevity risk and medical expense risk are present. The general shape of the welfare function in this panel is similar to that of the left panel. MTSI improves over LF in two regions, one with positive private savings and the second with zero private savings, and MTSI can implement the PO allocation. The most significant new feature of the right panel of Figure 1 is that the welfare benefit of MTSI is now higher in both regions 1 and 2. The reason for this result is that the two risks are positively correlated. In other words, it is more costly to save for period 2 medical expenses when the probability of surviving to that period is less than one. Thus, a higher value is placed on insurance that reduces the need for savings.

**Endowment, Longevity and Medical Expense Risk** We now consider a parameterization where agents face the risk of a low endowment when young which we interpret as permanent earnings risk. MTSI can help insure against this risk as well but the distortions we described above may also be larger. Figure 2 shows results for an economy with endowments of  $y_l = 1$  and  $y_h = 4$ , an equal fraction of each type ( $\theta = 1/2$ ),  $m = 0.95$ ,  $\gamma = 0.9$  and  $\phi = 0.05$ . The left panel of Figure 2 shows compensating variations relative to LF of newborn individuals before they know their endowment (ex-ante) and after.

Observe that the equilibrium with the optimal ex-ante consumption floor (point A) illustrates the claim of [Feldstein \(1987\)](#) that when MTSI is available to retirees, poorer households choose not to save. Instead they consume all of their earnings while working and rely on MTSI during retirement. In this equilibrium, high endowment types save and only receive transfers when they experience the medical expense event. The welfare of the poor is particularly high and the welfare of the rich is particularly low at this point. The rich are paying taxes for insurance that they value but also financing old-age consumption of the poor. In fact, the rich prefer LF over having to fund transfers to poor individuals who have no medical expenses.

In spite of these large distortions, the insurance benefits of MTSI are even larger and ex-ante welfare at point A is positive. In fact, ex-ante welfare is positive for the entire range of consumption floors.

Taken together our results show that, while the distortionary effects of MTSI are significant, it can still provide valuable insurance against a variety of risks faced by retirees. However, this framework is inadequate for assessing the welfare effects of MTSI currently offered to retirees in the U.S. We now turn to develop a quantitative model of the U.S. that we will use to assess this substantive question.

## 4 The Model

Our quantitative model is an overlapping generations model with two-member households that face earnings, health, medical expense and survival risk. Factor markets are competitive and there are no private insurance markets. Households' ability to self-insure is further limited by a no-borrowing constraint.

### 4.1 Demographics

Time is discrete. The economy is populated by overlapping generations of individuals. New-born individuals are sorted into two-member households. The number of households is normalized to one in each period and the population grows at a constant rate  $n$ . Each household consists of a male and female individual and each individual is endowed with an education type. We use  $x_s^i$  to denote the fraction of individuals of gender  $i \in \{m, f\}$  with either high school or college educational attainment  $s \in \{hs, col\}$ . The distribution of households across education types  $\mathbf{s} \equiv (s^m, s^f)$  is  $\Gamma_{\mathbf{s}}$ .

During the first  $R$  periods of life, households make labor supply decisions and we thus refer to them as working-age households. All working-age households are married couples.

Each member of a working-age household retires at age  $R+1$  and becomes subject to survival risk. Thus retired households consist of either married couples, widows or widowers. Marital status of a household is described by the variable  $d$ :  $d = 0$  for married,  $d = 1$  for a widow and  $d = 2$  for a widower. Individuals die no later than age  $J$ .

## 4.2 The Structure of Uncertainty

The sources of uncertainty vary by age. Each member of a working-age household is exposed to earnings risk. During retirement, each household member faces individual-specific survival, spousal death and health risk and households face household-specific medical expense risk. We describe each of these risks in detail.

Individual productivity evolves over the working period according to functions  $\Omega^i(j, \boldsymbol{\varepsilon}_e, s^i)$ ,  $i \in \{m, f\}$ , that map individual age  $j$ , household earning shocks  $\boldsymbol{\varepsilon}_e \equiv (\varepsilon_e^m, \varepsilon_e^f)$  and education type  $s^i$  into efficiency units of labor. The vector of household earning shocks  $\boldsymbol{\varepsilon}_e$  follows an age-invariant Markov process with transition probabilities given by  $\Lambda_{ee'}$ . Efficiency units of newborn households are distributed according to  $\Gamma_e$ .

At age  $R + 1$ , the marital status of a household starts to evolve. At the beginning of age  $R + 1$  some individuals become widows (widowers) in that they lose their spouse and the fraction  $\zeta^m$  ( $\zeta^f$ ) of their spouse's lifetime earnings  $\bar{e}^m$  ( $\bar{e}^f$ ) which determines their social security benefits. This shock only occurs at age  $R + 1$  and is assumed to vary with male lifetime earnings. It is used to pin-down the age-65, marital status distribution  $\Gamma_d(\bar{e}^m)$  and is discussed in more detail in Section 5.1.3.

During retirement, households face uncertainty about their members' health and survival, and household medical expenses. An individual's health status,  $h^i$ , takes on one of two values: good ( $h^i = g$ ) and bad ( $h^i = b$ ). The probability of having good health next period,  $\nu_j^i(h, d)$ , depends on age, gender, current health status and marital status. The initial distribution of health status,  $\Gamma_h^i(s^i)$ , depends on education. We denote a household's health status by  $\mathbf{h} \equiv (h^m, h^f)$ . The probability of an individual surviving to age  $j+1$  conditional on surviving to age  $j$  is given by  $\pi_j^i(h, d)$  and depends on age, gender, health status and marital status. Household marital status changes as individual household members die. Let  $\pi_j(d' | \mathbf{h}, d)$  denote the probability of marital status  $d'$  at age  $j+1$  for an age- $j$  household with health status  $\mathbf{h}$  and marital status  $d$ . The probabilities are given by

	$d' = 0$	$d' = 1$	$d' = 2$
$d = 0$	$\pi_j^m(h^m, 0)\pi_j^f(h^f, 0)$	$[1 - \pi_j^m(h^m, 0)]\pi_j^f(h^f, 0)$	$\pi_j^m(h^m, 0)[1 - \pi_j^f(h^f, 0)]$
$d = 1$	0	$\pi_j^f(h^f, 1)$	0
$d = 2$	0	0	$\pi_j^m(h^m, 2)$

Household-level medical and long-term care expenses evolve stochastically according to the function  $\Phi(j, \mathbf{h}, \boldsymbol{\varepsilon}_M, d)$  that depends on household age  $j$ , household health status  $\mathbf{h}$ , the vector of medical expense shocks  $\boldsymbol{\varepsilon}_M \equiv (\varepsilon_m^p, \varepsilon_m^t)$  and demographic status  $d$ .<sup>11</sup> The first medical expense shock follows an age-invariant Markov process with transition probabilities  $\Lambda_{MM'}$  and initial distribution  $\Gamma_{M_p}$ . The largest realization of this persistent medical expense shock is a nursing home event and is denoted by  $\bar{\varepsilon}_m^p$ . The second shock is a transient, *iid* shock with probability distribution  $\Gamma_{M_t}$ .

### 4.3 Government

The government uses revenues from corporate, payroll and income taxes to finance SS payments, means-tested transfers and government expenditures,  $G$ .

#### 4.3.1 Social Security

We model SS as a pay-as-you-go system. The benefit function  $S(\bar{\mathbf{e}}, d)$  depends on lifetime earnings of both household members,  $\bar{\mathbf{e}}$ , and the household's current marital status,  $d$ . The specific benefit formula is reported in Section 3.6 of the Online Appendix. We note here that it captures the following features of the U.S. Social Security system. First, married couples have the option of either receiving their own benefits or 1.5 times the benefit of the highest earner in the household. Second, widows/widowers have the choice of taking their own benefit or their dead spouses benefit. SS benefits are financed by a capped, proportional tax on earnings that we denote by  $\tau_{ss}(\cdot)$ .

#### 4.3.2 Medicaid and Other Means-Tested Programs for the Elderly

Medicaid has grown into the largest means-tested program in the U.S. It provides medical expense insurance to the elderly, the disabled, children and single women with children. General guidelines for Medicaid benefits for the elderly are determined by the federal government. However, states establish and administer their own Medicaid programs and determine the scope of coverage. Retirees may qualify for other means-tested welfare benefits including SSI, subsidized housing, food stamps and energy assistance. The federal government determines SSI eligibility and most states use the same means test to determine eligibility for Medicaid and other state-run welfare programs.

[De Nardi, French, Jones and Goopta \(2012\)](#) provide an excellent description of eligibility rules for SSI and Medicaid programs for the elderly and argue that there are two basic ways

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<sup>11</sup>The assumption that medical expense shocks are household level is made for reasons of tractability.

to qualify. We thus model MTSI transfers in the following way

$$Tr^R \equiv \begin{cases} \max\{\underline{y}^d + \varphi M - S(\bar{e}, d), \underline{c}^d + M - S(\bar{e}, d)\}, & \text{if } S(\bar{e}, d) < \underline{y}^d, a < \underline{a}^d \text{ and } \varepsilon_m^p \neq \bar{\varepsilon}_m^p, \\ \max\{0, \underline{c}^d + M - I^R\}, & \text{otherwise.} \end{cases} \quad (1)$$

Households not experiencing a nursing home event,  $\varepsilon_m^p \neq \bar{\varepsilon}_m^p$ , can qualify for MTSI by demonstrating that their SS income  $S(\bar{e}, d)$  and assets  $a$  lie below the means-test thresholds  $\underline{y}^d$  and  $\underline{a}^d$ .<sup>12</sup> This path, which is given by the first line of equation (1), is referred to as categorically needy. Most states require that these households make copayments for medical expenses. The size of copayments,  $(1 - \varphi)M$ , varies depending on the type and amount of the expense incurred and are capped. A result is that categorically needy have significant OOP medical expenses. The term in the first argument recognizes these OOP expenses and the second argument caps OOP expenses such that a household's total income is at least  $\underline{c}^d$ . Households who experience a nursing home event and households with high medical expenses can qualify for MTSI via the medically needy path which is given by the second line of the equation. This occurs when medical expenses are large relative to cash-on-hand  $I^R$  (assets plus after-tax income).

Note that equation (1) insures that total household consumption is bound below by  $\underline{c}^d$ . This transfer function also has the property that average consumption of categorically needy households exceeds average consumption of medically needy households which [De Nardi et al. \(2012\)](#) show is a property of U.S. MTSI.

Medicaid and other means-tested social welfare programs are jointly financed by states and the federal government using a variety of revenue sources. In the model, we assume that all funding for means-tested transfers comes out of general government revenues.

### 4.3.3 Medicare and Government Purchases

Medicare outlays are financed by a payroll tax  $\tau_{mc}$ . It follows that total payroll taxes are  $\tau_e(e) = \tau_{ss}(e) + \tau_{mc}(e)$ . We do not formally model the distribution of Medicare benefits. The main reason for this is a lack of data on individual or household level Medicare benefits. HRS only reports post-Medicare OOP medical expenses. In our model, medical expenses covered by Medicare are included in government purchases,  $G$ , instead.

The government budget is balanced period-by-period. It follows that revenues from the corporate tax  $\tau_c$ , income taxes  $T_y^W$  and  $T_y^R$ , and Medicare tax  $\tau_{mc}(\cdot)$  finance means-tested transfers and  $G$ .

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<sup>12</sup>Our income test follows the Medicaid and SSI programs which exclude asset income.

## 4.4 Household's Problem

We start by describing the household's preferences. For married U.S. households, most of the variation in labor supply is due to changes in labor force participation of the female and older male as well as hours worked by the female (see e.g. [Keane and Rogerson \(2012\)](#) for a survey). For this reason, we only model a participation decision for older males but model both a participation and hours decision for females.

Let  $c$  denote consumption and  $\{l_f, l_m\}$  denote non-market time of the female and male. Then the utility function of a working household is given by

$$U^W(c, l_f, l_m, \mathbf{s}) = 2 \frac{(c/(1 + \chi))^{1-\sigma}}{1 - \sigma} + \psi(\mathbf{s}) \frac{l_f^{1-\gamma}}{1 - \gamma} - \phi_f(\mathbf{s}) \mathbf{I}(l_f < 1) - \phi_m(\mathbf{s}) \mathbf{I}(j \geq \bar{j}) \mathbf{I}(l_m < 1), \quad (2)$$

where  $\mathbf{I}$  is the indicator function,  $\sigma > 0$ ,  $\gamma > 0$ ,  $\psi(\mathbf{s}) > 0$  for all  $\mathbf{s}$  and  $\phi_i(\mathbf{s}) > 0$  for all  $\mathbf{s}$  and  $i$ . This specification of preferences assumes a unitary household in which each member is fully altruistic towards their spouse. The parameter  $\chi \in [0, 1]$  determines the degree to which consumption is joint within the household. For instance, when  $\chi$  is 1, all consumption is individual and when  $\chi$  is 0, all consumption is joint. The third term in the utility function captures the utility cost of female participation in the labor force and the final term captures the utility cost of a male of age  $j \geq \bar{j}$  participating. Modeling the participation cost of females helps us match both the intensive and extensive margins of female labor supply. We allow the parameters  $\psi(\mathbf{s})$  and  $\phi_i(\mathbf{s})$  to vary by household type when we calibrate the model. This allows us to capture how hours and participation rates of females and participation rates of older males differ across household types in U.S. data. The utility function of a retired household with  $N$  living members (determined by  $d$ ) is given by

$$U^R(c, d) = 2^{N-1} \frac{(c/(1 + \chi)^{N-1})^{1-\sigma}}{1 - \sigma}. \quad (3)$$

The constraints and decisions of working households and retired households are quite different. We thus describe each problem separately.

### 4.4.1 Working Household's Problem

A working household of age  $j$  with education type  $\mathbf{s} \equiv (s^m, s^f)$  enters each period with assets  $a$  and average lifetime earnings of the male and female  $\bar{\mathbf{e}} \equiv (\bar{e}^m, \bar{e}^f)$ . It then receives the current labor productivity shocks  $\boldsymbol{\varepsilon}_e \equiv (\varepsilon_e^m, \varepsilon_e^f)$  and chooses consumption  $c$ , savings  $a'$ , male

non-market time  $l_m$  and female non-market time  $l_f$ . Let individual earnings be

$$e^i = w\Omega^i(j, \boldsymbol{\varepsilon}_e, s^i) \left( 1 - l_f \mathbf{I}_{i=f} - [\bar{l} \mathbf{I}_{j < \bar{j}} + l_m \mathbf{I}_{j \geq \bar{j}}] \mathbf{I}_{i=m} \right), \quad i \in \{m, f\}. \quad (4)$$

The optimal choices are given by the solution to the following problem

$$V^W(j, a, \bar{\mathbf{e}}, \boldsymbol{\varepsilon}_e, \mathbf{s}) = \max_{c, l_f, l_m, a'} \left\{ U^W(c, l_m, l_f, \mathbf{s}) + \beta \mathbf{E}[V(j+1, a', \bar{\mathbf{e}}', \boldsymbol{\varepsilon}'_e, \mathbf{s}) | \boldsymbol{\varepsilon}_e] \right\}, \quad (5)$$

subject to the law of motion for  $\boldsymbol{\varepsilon}_e$  and its initial distribution, as described in Section 4.2, and the following constraints:

$$c \geq 0, \quad 0 \leq l_f \leq 1, \quad a' \geq 0, \quad l_m \in \{\bar{l}, 1\}, \quad (6)$$

$$\bar{e}^{i'} = (e^i + j\bar{e}^i)/(j+1), \quad i \in \{m, f\}, \quad \text{and} \quad (7)$$

$$c + a' = a + y^W - T_y^W, \quad (8)$$

where

$$y^W \equiv e^m + e^f + (1 - \tau_c)ra, \quad \text{and} \quad (9)$$

$$T_y^W \equiv \tau_y(y^W - \tau_e(e^m)e^m - \tau_e(e^f)e^f) + \tau_e(e^m)e^m + \tau_e(e^f)e^f. \quad (10)$$

Equation (6) describes regularity conditions on consumption and leisure and imposes a borrowing constraint which rules out uncollateralized lending. The dynamics of average lifetime earnings, which determine social security benefits, are given in equation (7) and the household budget constraint is given by equation (8). Household income, equation (9), has two components: labor income and capital income. Capital income is subject to a corporate tax  $\tau_c$ , and equation (10) states that households face a nonlinear income tax  $\tau_y(\cdot)$  and a nonlinear payroll tax  $\tau_e(\cdot)$ . Finally, note that  $l_m$  only appears for  $j \geq \bar{j}$  or, in other words, only older males make a participation decision.

#### 4.4.2 Retired Household's Problem

During retirement the household's problem changes. Men and women spend all of their time enjoying leisure. Retirees face health, medical expense, spousal death and survival risk.

We assume that individuals observe their own and their spouses death event one period in advance. It follows that bequests are zero for households with a single member. This assumption has the following motivations. First, there is considerable evidence that bequests and inheritances are low. One reason for this is that wealth is low in the final year of life. [Poterba, Venti and Wise \(2011\)](#) report that 46.1% of individuals have less than \$10,000 in

financial assets in the last year observed before death and 50% have zero home equity using data from HRS. In a separate study of the Survey of Consumer Finances (SCF), [Hendricks \(2001\)](#) reports direct measurements of inheritances. He finds that most households receive very small or no inheritances. Fewer than 10% of households receive an inheritance larger than twice average annual earnings and the top 2% account for 70% of all inheritances.

The second reason for this assumption is that it allows us to capture the fact that both OOP and Medicaid medical expenses are large in the final year of life. In our HRS sample of retirees, OOP expenses in the last year of life are 3.43 times as large as OOP expenses in other years. Medicaid expenses are not available in our dataset. However, [Hoover, Crystal, Kumar, Sambamoorthi and Cantor \(2002\)](#) report that Medicaid expenses in the final year of life account for 25% of total Medicaid expenses for those aged 65 and older. This result is based on Medicare Beneficiary Survey data from 1992–1996.

Previous research has found that changes in the size and distribution of accidental bequests due to changes in government policy muddle analysis of the welfare effects of policy reform. For examples of this see [Hong and Ríos-Rull \(2007\)](#) and [Kopecky and Koreshkova \(2014\)](#). We avoid this problem because under our assumption accidental bequests are zero.

To maintain tractability we assume that for retirees the household’s education type is no longer a state variable. Education does enter indirectly since the initial distribution of individual health status varies with educational attainment. Health, and thus education, affect both individual survival probabilities and household medical expenses as described in [Section 4.2](#).

An age- $j$  household with assets  $a$ , average lifetime earnings  $\bar{e}$ , health  $\mathbf{h}$ , medical expense shock  $\boldsymbol{\varepsilon}_M$ , current demographic status  $d$  and next period demographic status  $d'$  chooses  $c$  and  $a'$  by solving

$$V^R(j, a, \bar{e}, \mathbf{h}, \boldsymbol{\varepsilon}_M, d, d') = \tag{11}$$

$$\max_{c, a'} \left\{ U^R(c, d) + \beta \mathbf{E} \left[ \sum_{d''=0}^2 \pi_{j+1}(d'' | \mathbf{h}', d') V(j+1, a', \bar{e}, \mathbf{h}', \boldsymbol{\varepsilon}'_M, d', d'') | \mathbf{h}, \boldsymbol{\varepsilon}_M \right] \right\}$$

subject to the laws of motion for  $\mathbf{h}$  and  $\boldsymbol{\varepsilon}_M$ , their initial distributions, as described in [Section 4.2](#), and the following constraints

$$c \geq 0, \quad a' \geq 0, \quad \text{and} \tag{12}$$

$$c + M + a' = a + y^R - T_y^R + Tr^R, \tag{13}$$

where

$$M \equiv \Phi(j, \mathbf{h}, \boldsymbol{\varepsilon}_M, d, d'), \quad (14)$$

$$y^R \equiv S(\bar{\mathbf{e}}, d) + (1 - \tau_c)ra, \quad (15)$$

$$T_y^R \equiv \tau_y^R((1 - \tau_c)ar, S(\bar{\mathbf{e}}, d), d, M), \quad (16)$$

$$I^R \equiv a + y^R - T_y^R, \quad (17)$$

and the expectations operator  $\mathbf{E}$  is taken over  $\boldsymbol{\varepsilon}'_M$  and  $\mathbf{h}'$ . The means-tested transfer  $Tr^R$  is defined in equation (1).

The main differences between the working household's problem and the retired household's problem are as follows: medical expenses  $M$  now enter the household's budget constraint, equation (13), and households have no labor income but instead receive social security benefits. Retired households also face a nonlinear income tax schedule. In particular, their social security benefits are subject to income taxation if these benefits exceed the exemption level specified in the U.S. tax code. We allow for a deduction of medical expenses that exceed  $\kappa$  percent of taxable income. The specific formulas used to compute income taxes are reported in the appendix.

#### 4.4.3 Problem for a Household about to Retire

The previous two cases cover all situations except that of a household in its last working period,  $R$ . Such a household enters the period with the state variables of a working household and chooses consumption, savings, female labor supply and male labor supply, recognizing that in period  $R + 1$  it will face the problem of a retired household. Consequently, when evaluating next period's value function, they form expectations using the distributions  $\Gamma_h^m$ ,  $\Gamma_h^f$ ,  $\Gamma_{M_p}$ ,  $\Gamma_{M_t}$  and  $\Gamma_d(\bar{\mathbf{e}}^m)$ .

## 4.5 Technology

Competitive firms produce a single homogeneous good by combining capital  $K$  and labor  $L$  using the constant-returns-to-scale production technology

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

Table 2: Key Structural Parameters in the Baseline Economy

Parameter	$\beta$	$\sigma$	$\chi$	$\bar{l}$	$\gamma$	$r$	$\alpha$	$\delta$
Value	0.97	2	0.67	0.55	2	5.6%	0.3	7%

Note that  $r$  is the annual pre-tax interest rate. The average post-tax rate is 4.1%.

where  $A$  is fixed. They rent capital and labor in perfectly competitive factor markets. The aggregate resource constraint, expressed in per capita terms, is

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

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

## 4.6 General Equilibrium

We consider a steady-state competitive equilibrium for a small open economy. Even though the U.S. is a large economy, capital markets are integrated and thus it is not clear how important changes in domestic savings are for determination of the real interest rate. We therefore choose to hold the real interest rate fixed. The definition of equilibrium for our economy can be found in Section 2.2 of the Online Appendix.

## 5 Calibration

The model is parameterized to match a set of aggregate and distributional moments for the U.S. economy, including demographics, earnings, medical and nursing home expenses, as well as features of U.S. social insurance programs for retirees and the U.S. tax system. Some of the parameter values can be set directly, others are formally calibrated so that moments generated by the model reproduce corresponding moments in the data.<sup>13</sup> Table 2 reports the value of some of the standard, structural parameters.<sup>14</sup> The remainder of this section discusses the most novel aspects of the calibration.

<sup>13</sup> Solving the quantitative model takes over 45 minutes on a computer with 16 cores due to the computational complexity. For this reason it is not feasible to implement a formal method-of-moments estimation strategy.

<sup>14</sup>Details on the calibration of these parameters as well as other preference parameters, income tax functions, and contribution and benefit formulas for SS can be found in Section 3 of the Online Appendix.

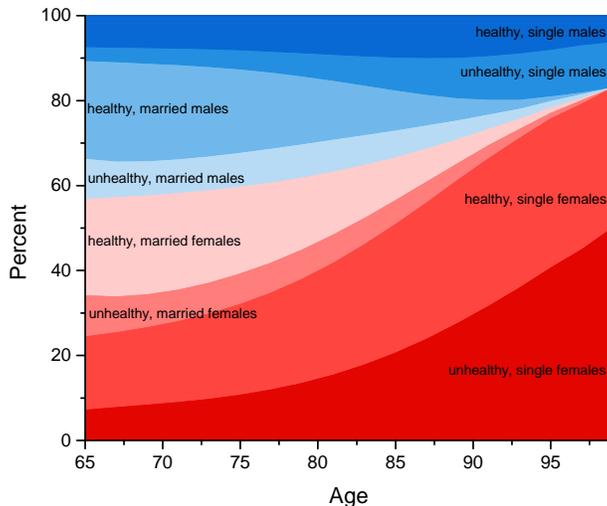


Figure 3: The population distribution of retirees by age. Individuals are classified by gender, health and marital status. The data for this figure is our HRS sample.

## 5.1 Demographics

Given that the focus of our analysis is on retirees, we want to reproduce the demographic structure of the 65+ population. Figure 3 reports the evolution of this distribution by marital status, health and gender estimated from our HRS sample. At the beginning of retirement, half of the population is healthy and married. As individuals age, three things happen: the fraction of singles increases, the fraction of unhealthy increases and males die faster than females. Below we will describe how we estimate this demographic structure and reflect it into our model.

### 5.1.1 Age Structure

Agents are born into our economy at age 21 and can live to a maximum age of 100. We set the model period to two years because the data on OOP medical expenses is only available bi-annually. Thus the maximum life span is  $J = 40$  periods. Agents work for the first 44 years of life, i.e. the first 22 periods. At the beginning of period  $R + 1 = 23$  (age 65), they retire and begin to face survival risk.

The target for the population growth rate  $n$  is the ratio of population 65 years old and over to that 21 years old and over. According to U.S. Census Bureau, this ratio was 0.18 in the year 2000.<sup>15</sup> We target this ratio rather than directly setting the population growth rate because the fraction of retirees in the total population determines the tax burden on

<sup>15</sup>We frequently use 2000 as a reference year because it is the only census year that falls in the range of our HRS sample.

Table 3: Marital status distribution of households with 65–66 year-old household heads by social security benefit quintiles

Quintile	1	2	3	4	5
Married	0.19	0.24	0.36	0.67	0.95
Single Female	0.56	0.55	0.45	0.21	0.03
Single Male	0.25	0.21	0.20	0.12	0.02

The fraction of households in each social security income quintile who are married, single female or single male households. Source: Authors’ computations using our HRS sample.

workers, which is an object of primary interest in our policy analysis. This results in an 1.8% annual growth rate of population.

### 5.1.2 Education

Newborn individuals are endowed with either high school or college educational attainment which is fixed throughout their working life. The model distribution of schooling types is set to reproduce its empirical counterpart in our HRS data sample for 65–66 year-old married households. In our data, both spouses have college degrees in 14% of households, in 14% only the male has a college degree, in 5% only the female has a college degree, and in 67% neither spouse has a college degree.

### 5.1.3 Marital Status

Newborn individuals are matched with a spouse and remain married until at least age 65. In our HRS sample, only 48% of 65–66 year-old households are married couples, 36% are single females and 16% are single males. For the most part, these figures reflect the cumulative effects of divorce and spousal death in the ages prior to age 65. Since our primary objective is to model retirees, we summarize these effects with a spousal death event and associated loss in spousal lifetime earnings at age 65. This event, which is distinct from the health-related survival risk agents face throughout retirement, ensures that  $\Gamma_d(\bar{e})$  reproduces the marital status distribution of 65 year-olds. An important feature of our HRS data is that there are very large differences in social security benefits across the three types of households. Married households have the highest benefits and single males receive higher benefits than females. In order to reproduce the empirical magnitudes of these differences, we assume that the spousal death shock is negatively related to average lifetime earnings of the male. We then calibrate the death shock so that it reproduces the fractions of married, single male and single female households by social security benefit quintiles shown in Table 3.

Table 4: Expected additional years of life at age 65 by health, gender and marital status

	Female	Male	All
	19.5	16.6	18.2
<i>By health</i>			
good	20.5	17.6	19.2
bad	15.8	12.2	14.3
<i>By marital status</i>			
married	20.1	17.2	18.6
single	18.4	14.3	17.0

Source: Authors’ computations using our HRS sample. Note that life expectancies in our HRS sample are lower than those in the 2000 U.S. Census. We thus scaled up the survival probabilities to match Census life expectancies at age 65.

The loss of spousal earnings associated with the age 65 death event also helps the model to replicate the left tail of the SS income distribution conditional on marital status and hence Medicaid reciprocity rates in the data. We defer a discussion of this to Section 5.4.2.

#### 5.1.4 Survival Probabilities and Health Status

Survival probabilities for males and females,  $\pi_{j+1}^i(h^i, d)$ , are estimated using our HRS sample. They are assumed to be a logistic function of age, age-squared, health status, marital status, health status interacted with age and marital status interacted with age. Transition probabilities for health status are also estimated separately for males and females, using the same logistic functions. The initial distributions of individuals across health status at age 65,  $\Gamma_h^i(s^i)$ , are set to match the distribution of health status by education in the HRS sample for 65–66 year-olds. Expected years of life by gender, health and marital status generated by these objects are reported in Table 4. All three factors have large effects on longevity. Having a spouse at age 65 is particularly beneficial for males extending their longevity by 2.9 years compared to 1.7 years for females. Good health extends life by about five years for both genders. Finally, females live on average 2.9 years longer than males.

## 5.2 Earnings Process

Our strategy for calibrating the labor productivity process follows [Heathcote, Storesletten and Violante \(2010b\)](#) who also consider earnings for married households. However, their earnings process cannot account for the fact that some households in our HRS sample receive very little social security income during their retirement. To address this problem, we augment their earnings process to allow for a low earnings state for males and set the

Table 5: Social security income distribution in the data and the model.

	<i>Quintiles</i>					<i>Top Percentiles</i>			<i>Gini</i>
	Q1	Q2	Q3	Q4	Q5	10	5	1	
	<i>share of total, %</i>								
Data	7.3	14.2	18.8	24.7	35.0	13.6	10.7	2.5	0.28
Model	7.8	13.3	18.1	25.6	35.2	18.7	9.5	2.1	0.28

Source: Authors' computations using our HRS sample. Data is adjusted for cohort-effects.

value of earnings in this state to reproduce the SS income Gini coefficient. We assume that this state has the same persistence as other states. The resulting earnings process is non-Gaussian.<sup>16</sup> Table 5 reports the Gini and other moments of the SS income distribution in the model and the data. Notice that the model does a good job of reproducing the bottom tail of this distribution. This specification of the earnings process also improves the model's implications for the bottom tail of the earnings distribution.

### 5.3 Medical Expense Process

Medical expenses vary systematically with age, gender, health and marital status. We assume that medical expenses have a deterministic and stochastic component and describe each of these components in turn.

#### 5.3.1 Deterministic Medical Expense Profiles

Medical expenses are household-specific in the model. We start by estimating deterministic medical expense profiles for individuals and then sum these expenses over spouses for married couples. The shape of the medical expense profiles is determined by regressing individual medical expenses on a quartic in age and a quartic in age interacted with gender, marital status, mortality status (a dummy variable that takes on the value of one if death occurs in the next period) and health status using a fixed-effects estimator.<sup>17</sup>

Our HRS data only reports household expenses paid OOP and not those covered by Medicaid. However, when solving the model, we need to specify *pre-Medicaid* medical expenses, defined as the sum of OOP and Medicaid payments. To resolve this issue, we exploit the fact that individuals in the top lifetime earnings quintile (or who have/had spouses in the top lifetime earnings quintile) are unlikely to qualify for means-tested Medicaid transfers,

<sup>16</sup>In order to make this process consistent with the estimates of Heathcote et al. (2010b), we use a simulated method of moments strategy described in Section 3.4 of the Online Appendix.

<sup>17</sup>As pointed out by De Nardi et al. (2010), the fixed effects estimator overcomes the problem with the variation in the sample composition due to differential mortality and also accounts for cohort effects.

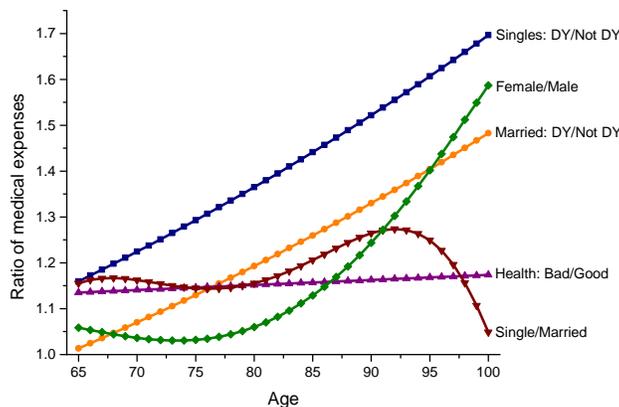


Figure 4: Estimated effects of marital status, health and death year (DY) conditional on marital status on individual medical expenses by age. The vertical axis is the ratio of estimated medical expenses for each type pair. Source: Authors’ computations using our HRS sample.

and hence their OOP medical expenses are, on average, very close to their pre-Medicaid expenses. Thus, the control variables in our medical expense regression include permanent income quintile dummies and their age-interaction terms. These latter controls reduce the estimation bias arising from the fact that Medicaid transfers increase with age. The estimated coefficients from this regression for permanent earnings quintile 5 pin down the shape of the deterministic age-profile of the pre-Medicaid medical expense process.<sup>18</sup>

The obtained medical expense profiles are similar to profiles reported in [De Nardi et al. \(2010\)](#) and [Kopecky and Koreshkova \(2014\)](#). OOP expenses increase with permanent income and age. Moreover, OOP medical expenses are higher for females relative to males and higher if self-reported health status is poor.

Our estimated medical expense profiles also provide new information about how medical expenses vary by marital status and death year. Figure 4 shows the effects of marital status and death year on medical expenses. For purposes of comparison, we also report how medical expenses vary with gender and health. The most striking feature of the figure is that death year has a very large effect on medical expenses and its importance increases with age. At age 65 medical expenses for singles in their death year are 15% higher than for singles not in their death year. By age 85 the difference has risen to 45%. The effect of death year is smaller for married individuals but still important. Notice also that the effect of marital status on medical expenses is as large as or larger than the effect of health for those under age 95.

<sup>18</sup>All of the coefficients documented here are significant at conventional significance levels. Estimated coefficients and standard errors from these regressions are available from the authors.

### 5.3.2 Stochastic Structure of Medical Expenses

The stochastic component of medical expenses has a persistent and a transitory component. The standard deviation of the transitory component is 0.816 and the persistent component is assumed to follow an AR(1) at annual frequencies with an autocorrelation coefficient of 0.922 and a standard deviation of 0.579. These values are taken from [French and Jones \(2004\)](#).<sup>19</sup> The initial distribution of the persistent medical expense shock,  $\Gamma_{M_p}$ , is set to the distribution of OOP expenses at age 65–66 in our HRS data sample.

Previous work has found that an important source of variation in retirees medical expenses is long-term care needs.<sup>20</sup> To capture long-term care risk, we approximate the persistent shock with a five state Markov chain and assume that the fifth state is associated with nursing home care. This calibration of the Markov chain captures both the small variation in medical expenses due to acute costs and the large variation due to long-term care costs. In particular, we target data facts pertaining to the cost of nursing home care for a Medicaid recipient, the expected duration of nursing home stays, the distribution of age at first entry and the overall size of nursing home expenses. The resulting Markov process recovers the serial correlation and standard deviation of the AR(1) process but is not Gaussian. More details on this aspect of the calibration are reported in Section 3.1 of the Online Appendix.

Finally, we scale the medical expense profiles so that aggregate medical expenses in the model are 2.1% of GDP. This target corresponds to the average total expenses on medical care paid OOP or by Medicaid during the period 1999 to 2005.<sup>21</sup>

## 5.4 Government

The government raises revenue from three taxes: a proportionate corporate profits tax, and nonlinear income and payroll taxes. And it has three principal uses of funds: it pays social security benefits to retirees, provides means-tested social welfare benefits, and purchases goods and services from the private sector.

### 5.4.1 Sources of Government Revenue

We choose the corporate tax rate and level of income taxes to reproduce the revenues of each of these taxes expressed as a fraction of GDP in U.S. data. The specific targets are 2.8%

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<sup>19</sup>Their estimates are based on individuals. We use these values for the household but assume that the medical expense shocks to husbands and wives are independent.

<sup>20</sup>See for example [Kopecky and Koreshkova \(2014\)](#) who find that nursing home expenses are important drivers of wealth accumulation over the lifecycle.

<sup>21</sup>Total medical expenses paid OOP or by Medicaid are taken from the “National Health Expenditure Accounts,” U.S. Centers for Medicare and Medicaid Services and include payments for insurance premia.

of GDP for the corporate profits tax and 8% of GDP for the income tax. These targets are averages over the years 1950–2008 as reported in Table 11 of “Present Law and Historical Overview of the Federal Tax System.”

U.S. income tax schedules vary with marital status. Using the IRS Statistics of Income Public Use Tax File for the year 2000, [Guner, Kaygusuz and Ventura \(2012\)](#) estimate effective income tax functions for both married households and singles following the methodology of [Kaygusuz \(2010\)](#). We use their estimates (see Section 3.5 of the Online Appendix for more details.).

Contributions for SS and Medicare are financed by the payroll tax,  $\tau_e = \tau_{ss} + \tau_{mc}$ . The SS component of this tax,  $\tau_{ss}$ , is set to 12.4%, and subject to a cap of \$72,000. The Medicare component,  $\tau_{mc}$ , is set to 2.9%. All of these figures are year 2000 values.

#### 5.4.2 Uses of Government Revenue

Government expenditures on SS in our model are based on a social security benefit function that reproduces the progressivity of the U.S. social security system and provides spousal and survivor benefits. The calibration is standard and can be found in Section 3.6 of the Online Appendix.

MTSI expenditures in our model, are derived from equation (1) and represent public assistance programs in the U.S. for retirees, including Medicaid, SSI, food stamps, and energy and housing assistance programs. Medicaid and SSI are the two largest MTSI programs, but Medicaid has less stringent eligibility rules. Hence our asset and income thresholds are based on Medicaid program rules for the years 2009–10. The asset thresholds,  $\underline{a}^d$ ,  $d \in \{0, 1, 2\}$  are set to 14% of average earnings of full-time, prime-age, male workers.<sup>22</sup> The income thresholds,  $\underline{y}^d$ , are set to 43% and 33% for married and single households.<sup>23</sup>

We choose the consumption floors,  $\underline{c}^d$ , to reproduce Medicaid reciprocity rates by marital status of retirees but restrict them to fall in an interval ranging from 10 to 20% of male average earnings. This interval is consistent with previous estimates.<sup>24</sup> The first column of Table 6 shows Medicaid reciprocity rates in the model and the data. The resulting consumption floor for married households is 14% of average male earnings. For widows and widowers,

<sup>22</sup>According to the Social Security Administration, average earnings for full-time, prime-age, male workers was \$47,552 in the year 2000.

<sup>23</sup> There are alternative types of Medicaid beneficiaries. Our choices of the income and asset thresholds insure that the following groups qualify under the categorically needy criterion: individuals who receive SSI transfers, qualified Medicare beneficiaries, specified low-income beneficiaries and qualified income beneficiaries. See our data source: the Kaiser Commission on Medicaid and the Uninsured, “Medicaid Financial Eligibility: Primary Pathways for the Elderly and People with Disabilities,” (February, 2010) for more details.

<sup>24</sup>See [Kopecky and Koreshkova \(2014\)](#) for a discussion of the literature on consumption floors.

Table 6: Medicaid reciprocity rates by age and marital status

	65+	65–74	75–84	85+
<i>Married</i>				
data	0.07	0.07	0.07	0.11
model	0.07	0.07	0.07	0.10
<i>Widows</i>				
data	0.22	0.22	0.19	0.24
model	0.22	0.22	0.21	0.22
<i>Widowers</i>				
data	0.17	0.19	0.15	0.19
model	0.17	0.18	0.16	0.14

The fraction of individuals receiving Medicaid transfers by age group and marital status in the data and the model. Data source: Authors’ computations using our HRS sample.

reciprocity rates from the model are too low even at the upper end of the interval. This is because widows and widowers in our model have too much social security income. We use the low earnings state to reproduce the average distribution of social security income but not the distribution by marital status. In order to bring this distribution and ultimately Medicaid reciprocity rates more in line with the data, we fix the consumption floors for widows and widowers at 20% of average male earnings and adjust  $\zeta^i$ ,  $i \in \{m, f\}$  introduced in Section 4.2. The resulting loss of spousal income of a widow is 20% of the spouse’s average lifetime earnings and the corresponding figure for widowers is 90%.

In our HRS sample average OOP expenses of individuals on Medicaid are 46% of average OOP expenses of all retirees. Setting the Medicaid copay rate,  $1 - \varphi$ , to 13% allows the model to reproduce this data fact.<sup>25</sup>

Finally, we adjust government purchases,  $G$ , of goods and services to close the government budget constraint. This results in a  $G/Y$  ratio of 0.11 for our baseline parameterization of the model.

## 6 Assessment of Baseline Calibration

In this section we compare statistics from the model that were not targeted with the data. One way to assess the model is in terms of its implication for wealth. In U.S. data the share of wealth held by individuals aged 65 and older ranges from 0.25 to 0.33.<sup>26</sup> The share in our

<sup>25</sup>Given the variation in OOP expenses across the two paths to MTSI one might be concerned that we are overstating copayments by the poor (categorically needy). However, as Figure 5 shows the model understates OOP expenses of this group.

<sup>26</sup>These numbers are taken from Kopecky and Koreshkova (2014).

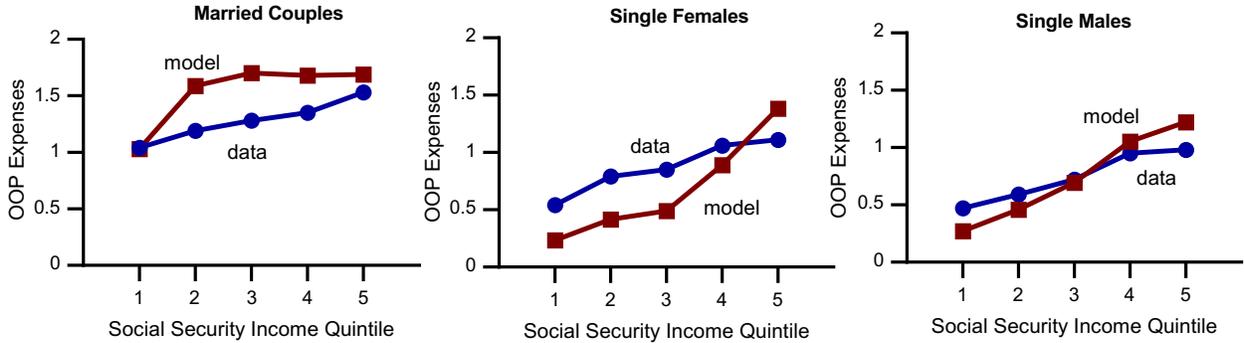


Figure 5: Out-of-pocket health expenses of married couples (left panel), single females (middle panel) and single males (right panel) relative to mean OOP expenses of all households by social security income quintile in the model (red squares) and the data (blue circles).

baseline model at 0.25 is on the low end of this interval. Given that we have not modeled all risks faced by retirees nor bequest motives, the fact that we are on the low end is not surprising.

We will now show that the model also delivers patterns close to the data on Medicaid reciprocity rates and OOP medical expenses by age and marital status. Then we will show that the model delivers an increased likelihood of impoverishment for individuals with large acute and long-term care OOP expenses, bad health status and those whose spouse has died, that is in line with the evidence documented in Section 2. Additional model assessment results can be found in Section 4 of the Online Appendix.

Medicaid reciprocity rates by age were not calibration targets and thus are another way to assess the model’s performance. The last three columns of Table 6 compare Medicaid reciprocity rates by age for the three household types in the model and the data. The model does a good job of reproducing reciprocity rates for each age group. The worst fit is for 85+ widowers. However, the number of individuals in this situation is very low in our HRS sample.

Figure 5 reports OOP medical expenses of households in the data and the model by marital status and social security income quintile. De Nardi et al. (2010) show that OOP medical expenses of single individuals are increasing by permanent income quintile.<sup>27</sup> Consistent with these findings, Figure 5 shows that household’s OOP expenses increase with social security income in the data. Observe that OOP expenses also increase with social security income in the model. The primary reason for this is that, as income increases, the fraction of medical expenses covered by Medicaid falls.

<sup>27</sup>De Nardi et al. (2010) use annuitized income to proxy for permanent income. Constructing annuitized income for households is subtle. So we use social security income instead. It is the largest component of annuitized income and we can observe it at the household level in both the model and the data.

Table 7: Conditional transitions into and persistence of low wealth

Cohort	Model			Data		
	65–74	75–84	85+	65–74	75–84	85+
<i>Marital Status, (Women)</i>						
married	3.57	9.05	9.63	5.49	5.76	10.64
widow	8.58	7.11	10.01	8.01	7.59	12.11
<i>Health Status</i>						
good	4.23	6.42	7.89	5.06	5.16	7.76
bad	4.90	7.01	8.72	7.94	8.68	10.78
<i>Nursing Home</i>						
no NH stay	4.35	6.21	6.12	5.79	5.67	7.16
NH stay	7.57	17.22	27.86	23.19	18.64	18.49
<i>Marital Status (Women)</i>						
married	68.4	51.2	63.2	72.5	69.6	80.2
widow	76.6	73.4	60.7	80.0	75.9	76.1
<i>Health Status</i>						
good	81.4	73.1	68.4	69.7	70.8	67.8
bad	85.3	75.3	65.2	80.9	79.3	73.1
<i>Nursing Home</i>						
no NH stay	82.2	71.9	58.9	75.8	74.4	67.5
NH stay	97.6	99.9	99.2	90.7	85.2	80.2

The upper (lower) panel numbers are the percentage of individuals in wealth quintiles 2–5 who move to (stay in) quintile 1 two years later conditional on their status. Wealth quintiles are determined from an individual wealth distribution specific to each age group. Married individuals are assigned half of the household wealth.

Table 7 shows that our model reproduces the differentials in downward mobility discussed in Section 2. The upper panel of this table reports conditional transitions into the lowest wealth state and the lower panel reports the persistence of the low wealth state over a period of two years. Singles have a higher incidence of transitions to the lowest wealth state as compared to married individuals. Poor health status and nursing home expenses also increase the likelihood of a low wealth outcome. The model also reproduces the magnitudes of the persistence of the bottom wealth quintile by marital and health status but overstates the magnitudes by nursing home status. This is due to our assumption that nursing home residents can only qualify for MTSI via the medically needy path.<sup>28</sup>

<sup>28</sup>In Section 5 of the Online Appendix we show that if nursing home residents can qualify for MTSI via either path the model understates the magnitudes by nursing home status but our welfare results are essentially unchanged.

## 7 Welfare Analysis

We now analyze the welfare effects of MTSI in our quantitative model of the U.S. economy. The analysis of the two-period model in Section 3 demonstrates that MTSI can improve welfare by insuring medical expense, life expectancy and permanent earnings risks. However, the welfare benefits depend on the pattern of endowments, the extent of the risks and the specification of the means tests. Our quantitative model specifies these parameters to reproduce features of the U.S. economy and this makes it possible to understand whether the effects documented in the two-period model are empirically relevant.

### 7.1 The Value of Means-Tested Social Insurance for Retirees

One way to assess the welfare effects of MTSI is to consider how welfare changes when MTSI is removed. This approach requires us to describe what informal insurance opportunities would be available to retirees if MTSI were absent. Our strategy here is to assume that, absent MTSI, retirees are guaranteed the largest consumption floor that all types of households, as indexed by education, can agree on. We refer to this as the Townsendian consumption floor. Our implicit assumption here is that if all newborn households can agree on a particular floor, given enough time, informal social arrangements would arise that deliver it. Households with two college-educated members turn out to be the marginal types who determine the size of this floor.<sup>29</sup>

Table 8 reports the welfare effects from removing MTSI in our baseline economy and two other versions of our quantitative model. The ‘no medical expenses’ economy has no medical expenses whereas the ‘no earnings risk’ economy has no idiosyncratic shocks to earnings. Welfare effects of removing MTSI are computed by comparing welfare of newborn households across steady-states. Welfare is measured as an equivalent consumption variation — a constant percentage change in consumption of each household in every period of its life which makes the household indifferent between the economy with MTSI and an alternative economy with no MTSI. The top rows of Table 8 display ex-ante welfare of a newborn before education is known, welfare of newborn households after educational status is known and welfare by male permanent earnings quintiles.<sup>30</sup> The bottom two rows of the table report reciprocity rates of MTSI by retirees in each economy when this insurance is provided

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<sup>29</sup>When computing the Townsendian consumption floors the asset thresholds are held fixed and the income thresholds are adjusted down proportionately. The Townsendian consumption floor for retirees is 0.001% of average earnings. At this level 0.001% of retirees are on the floor. We show that our results are robust to larger settings of the consumption floor, absent MTSI, in Section 4 of the Online Appendix.

<sup>30</sup>We use permanent earnings of males aged 21 to 55 because they are exogenous. This makes it possible to compare the same households across economies.

Table 8: Welfare effects of removing MTSI from three economies

<b>Economy</b>	Baseline	No Medical Expenses	No Earnings Risk
<b>Welfare</b>			
Ex-ante	-4.31	0.40	2.85
<i>By HH education type (female, male):</i>			
high school, high school	-5.36	0.26	2.99
high school, college	-2.27	0.72	1.73
college, high school	-1.74	0.62	4.91
college, college	0	0.93	2.31
<i>By male permanent earnings:</i>			
quintile 1	-7.02	0.04	2.99
quintile 2	-4.93	0.30	2.99
quintile 3	-3.89	0.45	2.99
quintile 4	-2.95	0.58	2.95
quintile 5	-1.21	0.83	2.11
<b>Initial levels of MTSI</b>			
reciency rates, %	13.1	8.1	1.0
outlays, % of GNP	1.02	0.41	0.12

The welfare effects of removing MTSI from the baseline (first column), an economy in which medical expenses have been set to zero (second column) and an economy in which each household faces the average earnings profile conditional on its education type (third column). Welfare is measured as the percentage change in consumption in every period of life that makes a household indifferent between the reference economy with MTSI and the economy with no MTSI. The bottom two rows show the reciency rates and total outlays to retirees of MTSI in each reference economy before MTSI is removed.

and the size of the associated government transfers expressed as a percentage of output. Removing MTSI requires adjustments to the government budget constraint. We hold the ratio of government purchases to GDP fixed and adjust the proportional tax coefficient in the income tax schedule to satisfy the government budget constraint.

The first column of Table 8 shows that MTSI provides valuable insurance against old-age risks in the quantitative model. The fall in ex-ante welfare when the MTSI program is replaced by the Townsendian floor is equivalent to a 4.3% decrease in consumption. Notice next that the insurance benefits of MTSI are broadly based. All newborn households experience welfare losses when welfare is indexed by permanent earnings quintile. This result may be surprising given that the high permanent earnings types preferred no MTSI in our two-period model. The insurance benefits of MTSI are so strong here, that they overwhelm the large income taxes that households in quintile 5 are paying to subsidize consumption and medical expenses of poor retirees. If welfare is indexed by educational attainment instead, all but the household with college-educated females and males benefit from MTSI. This final

group is by construction indifferent between the current scale of MTSI and the Townsendian floor.

Removing MTSI leads households to provision for their retirement by saving more and on aggregate working more. Table 11 displays changes in output (GNP), private consumption net of medical expenses, private wealth and various labor market indicators when MTSI is removed. Even though removing MTSI stimulates the economy, it also exposes households to more risk during retirement. With less insurance households save more and aggregate wealth goes up by 45%. Aggregate labor input also goes up, albeit slightly, from 1.00 to 1.002. The small increase in labor input may be surprising because social insurance programs for workers such as unemployment insurance and workers' compensation are known to have significant negative incentive effects on labor supply as described in the survey [Krueger and Meyer \(2002\)](#). However, our result is consistent with other research cited in their survey that finds that social insurance *for retirees* has much smaller effects on labor supply of working-age individuals.

Interestingly, the increase in aggregate labor when MTSI is removed is due to a rise in female labor input; male labor input actually declines. The decline in male labor is due to a positive wealth effect because income taxes fall. Females, in contrast, compensate for the loss of social insurance by working more. Working-age females have lower earnings on average but face less earnings risk than males. Thus having females work more helps to insure the household against the higher level of idiosyncratic risk they now face. The insurance benefit of higher female earnings is particularly valuable to poorer households absent MTSI. Not surprisingly, we find that the increases in female participation and hours reported in Table 11 are concentrated among the poorest households. Labor supply of females in more affluent households does not change or falls slightly.

Columns 2 and 3 provide additional welfare results that help to understand why the welfare gains are so large and broadly based. Comparing column 1 with column 2 shows that medical expenses significantly increase the benefits of MTSI. When medical expenses are absent all households, indexed either by permanent earnings quintile or educational status, actually prefer the Townsendian floors to those provided by MTSI. The intuition for this result was discussed in Section 3 where we illustrated that MTSI transfers are state-contingent offering large payouts in situations where medical expenses are large. We also demonstrated that the need for insurance is larger because these risks are correlated.

Our finding that the welfare benefits of MTSI are largest when medical expenses are present is surprising because the two negative incentive effects of MTSI described in Section 3 are also most pronounced in this setting. First, MTSI transfers, which are funded by the income tax, are 1.02% of GNP in the baseline economy but only 0.41% in the no medical

Table 9: Welfare and fiscal effects of changes in MTSI

Consumption Floors	30% up	30% up	no change	30% up	30% down
Income Thresholds	30% up	no change	30% up	30% up	30% down
Tax Adjusted	Payroll	Payroll	Payroll	Income	Income
<b>Welfare</b>					
Ex-ante	0.32	0.16	0.17	-0.77	0.25
<i>By HH education type (female, male):</i>					
high school, high school	0.35	0.18	0.19	-0.61	-0.06
high school, college	0.23	0.11	0.12	-1.17	0.69
college, high school	0.37	0.16	0.21	-0.92	0.50
college, college	0.22	0.10	0.12	-1.40	0.94
<b>Final levels of MTSI</b>					
reciprocity rates, %	21.7	15.7	16.5	22.0	6.32
outlays, % of GNP	1.82	1.15	1.44	1.87	0.40

The columns show the welfare and fiscal effects of changing both or one of the MTSI consumption floors and income thresholds by 30% financed by the indicated tax. The bottom two rows show the levels of the reciprocity rates and government outlays for MTSI in the economy after MTSI is changed.

expense economy. Second, when MTSI is present, some poorer households will choose not to save and to rely on MTSI when they retire. In the baseline economy 10.9% of individuals start receiving means-tested benefits when they retire at age 65. In the economy with no medical expenses, this fraction falls to about 7%.

A comparison of the results in column 1 with column 3 shows that removing lifetime earnings risk has an even bigger effect on the value of MTSI. The main reason why households don't value MTSI in the economy with no lifetime earnings risk is because this economy has less dispersion in wealth at retirement and social security retirement income. In particular, there are fewer poor households and thus fewer beneficiaries of MTSI. This can be seen by the fact that MTSI reciprocity rates fall from 13.1% in the baseline economy to 1.0% once lifetime earnings risk is removed.

## 7.2 Reforming Means-Tested Social Insurance for Retirees

Removing MTSI entirely is an interesting counterfactual because it measures the overall value of these programs. Given that the overall value is positive, it is worthwhile to explore whether the current scale of these programs is too big or too small. Table 9 reports welfare changes based on comparing the baseline economy to alternative economies in which MTSI consumption floors and/or income thresholds are either 30% higher or 30% lower.<sup>31</sup> We

<sup>31</sup>We do not report results where we vary the asset thresholds or copays because we found that they have significantly smaller effects on welfare for reforms of this scale.

report ex-ante utility and utility by educational type.

The most interesting result in this table is that the welfare of all newborn households increases if MTSI is expanded, either by increasing the consumption floors, the income thresholds or both, as long as it is financed with a payroll tax. This point is illustrated in columns 1–3. Ex-ante welfare is largest when the floors and thresholds are both increased and the effects of increasing each individually roughly add up. More importantly, all education types are better off in all three scenarios. Since educational status is the only source of initial heterogeneity, these results imply that all newborn households would prefer to be born into the economy with higher means-tested benefits and higher payroll taxes even after they know their educational type. A novel feature of this policy reform is that if implemented along a transition it would benefit both newborn households and current retirees since retirees would enjoy higher benefits at no change in taxes. As a result, in our open economy, the only possible compensations during a transition would go to workers and are likely to be small.

Welfare falls, however, if the same expansion of MTSI is financed by higher income taxes instead. Ex-ante welfare of a newborn household declines by 0.77% and all educational types are worse off. The main reason for this difference is that the payroll tax only applies to labor income and is proportional, while the income tax applies to both labor and capital income and is progressive. As a result an expansion of MTSI financed by the income tax leads to a larger negative wealth effect which generates a larger reduction in savings, an *increase* in male labor supply and a greater increase in MTSI reciprocity rates.

Our finding that households don't want to increase MTSI if it is financed with a higher income tax raises the question of whether they would prefer a smaller MTSI program and lower income taxes. The final column of Table 9 shows that ex-ante utility is in fact 0.25% higher when MTSI is reduced by 30%. However, there is disagreement among newborn households. Households with two high school educated members are worse off. However, their loss is smaller than the combined gain of the other types.

### 7.3 The Value of Social Security

A large previous literature, which we discussed in the introduction, has failed to find a welfare-enhancing role for U.S. SS. As we have shown above, this does not mean that there is no role for social insurance for the elderly. Medicaid and other U.S. MTSI programs for retirees significantly enhance welfare. Our model is different from those used by previous literature to evaluate SS, in particular, we model medical expenses and MTSI. This raises the question of whether SS is also valued. In this section we show that the answer is no.

Columns 1 and 2 of Table 10 document the welfare effects of removing SS from our baseline economy and from an economy with no MTSI. Removing SS has large positive welfare effects whether MTSI is present or not. When SS is removed from the baseline economy, ex-ante welfare of a newborn household increases by 12.2%.<sup>32</sup> The welfare gains from removing SS are due to several factors. First, SS is a pay-as-you-go system and it is well known that the effective real return on SS contributions is lower than the return on capital in dynamically efficient economies such as ours. Second, SS is a much larger program than MTSI and financing it requires higher distortionary taxes. Third, many of the benefits provided by SS overlap with benefits that are provided by MTSI. When SS is removed from an economy with no MTSI, ex-ante welfare increases by only 2.6%.<sup>33</sup>

## 7.4 The Interactions of Means-Tested Social Insurance and Social Security

The final two columns of Table 10 report the welfare effects of removing MTSI from two economies. Column 3 removes MTSI from the baseline economy and was previously reported in Table 8. Column 4 considers removing MTSI in an economy with no SS. Comparing across these two economies shows that the benefits of MTSI are even larger when SS is absent. Reducing MTSI to the Townsendian consumption floor results in an ex-ante welfare loss of 13.9% of consumption absent SS. This is more than double the decline in welfare that occurs when MTSI is removed from the baseline economy.

Given that all agents prefer the economy with MTSI but no SS, it is of interest to consider in more detail how the properties of the model change when SS is removed. Removing SS increases MTSI reciprocity rates from 13.1% to 38.8%. This large increase in reciprocity rates can be decomposed into two effects. First, there is an incentive effect. SS forces some poorer households to save for retirement who would choose not to save otherwise. Forced savings increase the expected return from private savings and some households alter their strategy and choose to save on their own as well. Thus removing SS exacerbates the negative incentive effects that MTSI has on saving behavior. Second, there is an insurance effect. Some of the insurance against survival, lifetime earnings and medical expense risks that was provided by SS is now provided by MTSI.

Both effects can be seen in Figure 6 which displays the increase in MTSI reciprocity rates

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<sup>32</sup>Changes in aggregate variables when SS is removed are standard and reported in Table 11.

<sup>33</sup>The welfare cost of removing social security in the economy with no MTSI, though positive, is small in our model as compared to e.g. [Hong and Ríos-Rull \(2007\)](#) who consider a similar economy. They report about a 12% welfare gain from removing SS. An important distinction between our analysis and theirs is that we model medical expenses and their associated risks. When medical expenses are absent the welfare gain from removing SS increases to 10.8%.

Table 10: A comparison of the welfare effects of removing SS with the welfare effects of removing MTSI

<b>Economy</b>	Removing SS		Removing MTSI	
	Baseline	No MTSI	Baseline	No SS
<b>Welfare</b>				
Ex-ante	12.2	2.6	-4.3	-13.9
<i>By HH education type (female, male):</i>				
high school, high school	12.5	1.6	-5.4	-16.3
high school, college	11.3	4.7	-2.3	-8.8
college, high school	12.1	4.8	-1.7	-9.0
college, college	11.0	7.2	0	-3.8
<b>Initial (final) levels of MTSI</b>				
reciency rates, %	13.1 (38.8)	0.00	13.1	38.8
outlays, % of GNP	1.02 (3.49)	0.00	1.02	3.49

The first two columns show the percentage change in welfare when SS is removed from the baseline economy and the economy with no MTSI. The second two columns show the welfare change when MTSI is removed from the baseline and the economy with no SS. The last two rows show the MTSI reciency rates and outlays for retirees in the initial economies. Numbers in parenthesis are the levels after removal of SS. After removal of MTSI all levels are essentially zero.

by age for each male permanent earnings quintile when social security is removed. The negative incentive effect can be measured by the change in the fraction of households who choose to roll into MTSI at or shortly after retirement. This percentage increases by about 10% at age 65 for permanent earnings quintiles 1–3 and rises quickly during the first 5 years of retirement as these households exhaust their savings and qualify for MTSI. The insurance effect can be inferred from the change in the pattern of MTSI enrollment by age for quintiles 4 and 5. Recency rates don't change for these two quintiles until age 70. Thereafter they start to rise reaching nearly 20% at age 90 for those in quintile 4.

The increase in MTSI reciency rates when SS is removed is accompanied by an increase in MTSI outlays but, surprisingly, a decrease in taxes. Wealth in the economy without SS is so much higher that the government can both finance the increase in MTSI outlays and decrease tax rates at the same time.

Our finding that the MTSI reciency rate for retirees increases by 25.7% when SS is removed depends on the presence of both medical expenses and earnings risk. For reciency rates to increase significantly we need both poor people and significant shocks after retirement. If either one of these features is absent both the insurance and incentive effects of SS removal decline. In particular, if we consider an economy with no medical expenses, reciency rates only increase by 18.1% when SS is removed. If instead we consider an economy

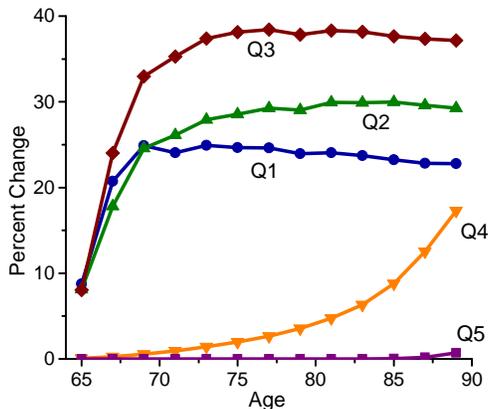


Figure 6: The percentage increase in MTSI reciprocity rates of retirees when social security is removed from the baseline economy. The change in the reciprocity rates is shown by age and male permanent earnings quintile. The percentage increase is calculated by subtracting the reciprocity rates in the baseline economy from those in the economy with MTSI only.

with no earnings risk, reciprocity rates increase by 8.7% when SS is removed.<sup>34</sup>

## 7.5 Robustness

Have we overstated the welfare-enhancing effects of U.S. MTSI programs for retirees? We have considered the robustness of our results to the setting of the no-MTSI consumption floors and income thresholds, the incidence of the low earnings shock, and the assumption that those experiencing the nursing home shock can only qualify for MTSI via the medically needy path. Results are reported in Section 5 of the Online Appendix. Here we briefly summarize them. Ex-ante households value MTSI even if the no-MTSI consumption floors and income thresholds are 1000 times larger than their Townsendian values. They also continue to value MTSI if only high-school-educated males are subject to the low earnings shock. If households experiencing a nursing home shock can qualify for MTSI under either path, the model understates the persistence of the lowest wealth quintile conditional on a nursing home event and yet the costs of removing MTSI are virtually the same as in our baseline specification.

There is a reason to believe that our estimates of the value of MTSI may be too conservative. The average Frisch labor supply elasticity for females in our model is 2.4. If we reduce it to about 1 which is more consistent with micro estimates, the welfare loss from removing MTSI increases from 4.3% to 5.3%. Also, we have assumed that medical expenses

<sup>34</sup> Our result that welfare is much higher in the economy with MTSI only is very robust to other details of the model: anticipated death, open economy, and/or general equilibrium. As long as lifetime earnings risk and medical expenses are present, utility of newborn households is higher when MTSI is the only form of social insurance available to retirees.

are not growing. Since 1980 health expenses as a fraction of GDP have doubled.<sup>35</sup> If we were to model this observation, the welfare benefits of MTSI would be even larger.

Our conclusions are premised on a model that abstracts from private insurance markets for the risk of being born into a particular type of household, experiencing low lifetime earnings, high medical expenses after retirement and/or a long life. For some of these risks, such as lifetime earnings risk, the extent of private insurance markets is very small and the coverage is incomplete.<sup>36</sup> For other risks such as long-term care and life insurance, private insurance products exist but appear to be imperfect. It is doubtless the case that if these markets were modeled and no social insurance was available, demand for products such as life insurance and long-term care insurance would increase. However, it is our view that the increase in take-up rates in these markets would be small. [Brown and Finkelstein \(2008\)](#) show that Medicaid may crowd out the demand for private long-term care insurance. However, [Hendren \(2013\)](#) finds that rejection rates in nongroup life, disability and long-term care insurance markets are high. He argues that an important reason for this is asymmetric information. Namely, individuals have superior information about their health status as compared to issuers and this information is significant in the sense that it can have a very large impact on payouts and thus pricing. Adverse selection limits the functioning of these markets in several ways. Insurers deny coverage to individuals who have observable characteristics that predispose them to these risks. Other individuals who know they have low risk will choose not to purchase insurance. Moreover, some poor individuals will not be able to afford private insurance even if they want it. Absent a government mandate or other types of regulation it is likely that many individuals will end up old, sick alone, poor and uninsured.

## 8 Conclusion

One of the central objectives of public policy is to provide for those who are sick and do not have the financial means to cover their medical and living expenses. For the aged, this risk is significant and can be compounded by a spousal death event leaving the retiree not only sick and poor but also alone. We have shown that U.S. MTSI programs are highly valued when these risks are recognized. In fact, the current scale of MTSI may be too small. We have found that there would be general agreement among households to increase the scale of current U.S. MTSI programs by 1/3 if that increase was financed with a higher payroll tax.

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<sup>35</sup>See OECD Health Data.

<sup>36</sup>The only private market we know of that offers even partial coverage against lifetime earnings risk is private disability insurance. Only 3% of nongovernment workers directly participate in this market and only 30% participate indirectly through their employer (see [Hendren \(2013\)](#)).

## 9 Appendix

### 9.1 Additional details on the two-period model

The government budget constraint is

$$(1+r)[\theta y_h + (1-\theta)y_l]\tau = \gamma \left\{ \phi [\theta TR_h^b + (1-\theta)TR_l^b] + (1-\phi) [\theta TR_h^g + (1-\theta)TR_l^g] \right\},$$

where  $TR_i^j$  are transfers to individuals of type  $i \in \{h, l\}$  who are in state  $j \in \{b, g\}$ . We assume that accidental bequests are taxed and consumed by the government. This assumption is made because we want to omit the potentially large redistributive consequences of giving the bequests to survivors. Thus government consumption  $g$  is given by

$$g = (1-\gamma)(1+r)(\theta a_h + (1-\theta)a_l),$$

where  $a_i$  is the savings of agents of type  $i$  where  $i \in \{h, l\}$ . The aggregate resource constraint is

$$\begin{aligned} \theta c_h^y + (1-\theta)c_l^y + \gamma [\phi(\theta c_h^b + (1-\theta)c_l^b) + (1-\phi)(\theta c_h^g + (1-\theta)c_l^g) + \phi m] + g = \\ (1+r\tau)(\theta y_h + (1-\theta)y_l) + r(\theta a_h + (1-\theta)a_l), \end{aligned}$$

where  $c_i^y$  is the consumption of individuals of type  $i \in \{h, l\}$  when young and  $c_i^j$ ,  $j \in \{b, g\}$ , is their consumption when old in each medical expense state.

### 9.2 Additional Tables

Table 11: Aggregate variables in baseline with and without MTSI

	Baseline	No MTSI	No SS
Output	1.00	1.07	1.07
Consumption	0.67	0.73	0.73
Wealth	2.78	4.03	4.21
Tax Revenue Relative to Output	0.20	0.17	0.13
Aggregate Labor input	1.00	1.00	0.98
Older Male Labor-Force Part.	0.71	0.68	0.68
Female Labor-Force Part.	0.50	0.53	0.47
Working Females' Hours	0.33	0.35	0.32

Results are reported for the baseline economy, baseline economy with MTSI at the Townsendian level and baseline economy with no SS. All flows are annualized. The measure of output is GNP.

## References

- ATTANASIO, O., S. KITAO AND G. VIOLANTE, “Financing Medicare: A General Equilibrium Analysis,” in J. B. Shoven, ed., *Topics in Demography and the Economy* (University of Chicago Press, 2011), 333–366.
- AUERBACH, A. J. AND L. J. KOTLIKOFF, *Dynamic Fiscal Policy* (Cambridge University Press, 1987).
- BROWN, J. R. AND A. FINKELSTEIN, “The Interaction of Public and Private Insurance: Medicaid and the Long-Term Care Insurance Market,” *American Economic Review* 98 (2008), 1083–1102.
- CONESA, J. C. AND D. KRUEGER, “Social Security Reform with Heterogeneous Agents,” *Review of Economic Dynamics* 2 (1999), 757–795.
- DE NARDI, M., E. FRENCH AND J. B. JONES, “Why do the Elderly Save? The Role of Medical Expenses,” *Journal of Political Economy* 118 (2010), 37–75.
- , “Medicaid Insurance in Old Age,” Working Paper, 2013.
- DE NARDI, M., E. FRENCH, J. B. JONES AND A. GOOPTA, “Medicaid and the Elderly,” *Economic Perspectives* 36 (2012), 17–34.
- FELDSTEIN, M., “Should Social Security Be Means Tested?,” *Journal of Political Economy* 95 (1987), 468–484.
- FRENCH, E. AND J. B. JONES, “On the Distribution and Dynamics of Health Care Costs,” *Journal of Applied Econometrics* 19 (2004), 705–721.
- FUSTER, L., A. İMROHOROĞLU AND S. İMROHOROĞLU, “Elimination of Social Security in a Dynastic Framework,” *Review of Economic Studies* 74 (2007), 113–145.
- GUNER, N., R. KAYGUSUZ AND G. VENTURA, “Taxing Women: A Macroeconomic Analysis,” *Journal of Monetary Economics* 59 (2012), 111–128.
- GUVENEN, F., “An Empirical Investigation of Labor Income Processes,” *Review of Economic Dynamics* 12 (2009), 58–79.
- HEATHCOTE, J., F. PERRI AND G. VIOLANTE, “Unequal We Stand: An Empirical Analysis of Economic Inequality in the United States, 1967–2006,” *Review of Economic Dynamics* 13 (2010a), 15–51.

- HEATHCOTE, J., K. STORESLETTEN AND G. VIOLANTE, “Insurance and Opportunities: The Welfare Implications of Rising Wage Dispersion,” *Journal of Monetary Economics* 55 (2008), 201–525.
- HEATHCOTE, J., K. STORESLETTEN AND G. L. VIOLANTE, “The Macroeconomic Implications of Rising Wage Inequality in the United States,” *Journal of Political Economy* 118 (2010b), 681–722.
- HENDREN, N., “Private Information and Insurance Rejections,” *Econometrica* 81 (2013), 1713–1762.
- HENDRICKS, L., “Bequests and Retirement Wealth in the United States,” , 2001.
- HONG, J. H. AND J. RÍOS-RULL, “Social Security, Life Insurance and Annuities for Families,” *Journal of Monetary Economics* 54 (2007), 118–140.
- HOOVER, D. R., S. CRYSTAL, R. KUMAR, U. SAMBAMOORTHY AND J. C. CANTOR, “Medical Expenditures during the Last Year of Life: Findings from the 1992-1996 Medicare Current Beneficiary Survey,” *Health Services Research* 37 (2002), 1625–1642.
- HUBBARD, R. G., J. SKINNER AND S. P. ZELDES, “Precautionary Savings and Social Insurance,” *Journal of Political Economy* 103 (1995), 360–399.
- HUGGETT, M., G. VENTURA AND A. YARON, “Sources of Lifetime Inequality,” *American Economic Review* 101 (2011), 2923–2954.
- İMROHOROĞLU, A., S. İMROHOROĞLU AND D. H. JOINES, “A Life Cycle Analysis of Social Security,” *Economic Theory* 6 (1995), 83–114.
- , “Social Security in an Overlapping Generations Economy with Land,” *Review of Economic Dynamics* 2 (1999), 638–665.
- KAYGUSUZ, R., “Taxes and Female Labor Supply,” *Review of Economic Dynamics* 13 (2010), 725–741.
- KEANE, M. AND R. ROGERSON, “Micro and Macro Labor Supply Elasticities: A Reassessment of Conventional Wisdom,” *Journal of Economic Literature* 50 (2012), 464–76.
- KOPECKY, K. AND T. KORESHKOVA, “The Impact of Medical and Nursing Home Expenses on Savings,” *American Economic Journal: Macroeconomics* 6 (2014), 29–72.

- KRUEGER, A. B. AND B. D. MEYER, “Labor Supply Effects of Social Insurance,” in A. J. Auerbach and M. Feldstein, eds., *Handbook of Public Economics*, (Elsevier, 2002), 2327–2392.
- NEUMARK, D. AND E. POWERS, “The Effect of Means-Tested Income Support for the Elderly on Pre-Retirement Saving: Evidence From the SSI Program in the U.S.,” (1998).
- NISHIYAMA, S. AND K. SMETTERS, “Does Social Security Privatization Produce Efficiency Gains?,” *The Quarterly Journal of Economics* 122 (2007), 1677–1719.
- POTERBA, J. M., S. F. VENTI AND D. A. WISE, “Family Status Transitions, Latent Health, and the Post-Retirement Evolution of Assets,” in *Explorations in the Economics of Aging* (University of Chicago Press.ed. D. Wise, University of Chicago Press: D. Wise, 2011).
- SEFTON, J., J. VAN DE VEN AND M. WEALE, “Means Testing Retirement Benefits: Fostering Equity or Discouraging Savings?,” *The Economic Journal* 118 (2008), 556–590.
- TRAN, C. AND A. WOODLAND, “Trade-Offs in Means Tested Pension Design,” Unpublished Manuscript, 2012.

## Online Appendix

### Old, Sick, Alone and Poor: A Welfare Analysis of Old-Age Social Insurance Programs

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*This Appendix is not intended for publication but is to be made available to readers on the Journal's webpage.*

# 1 Our HRS Sample and Wealth Transitions

The principal data set used in this paper is the 1995–2010 waves of HRS and AHEAD and includes retired individuals aged 65 and above who are single or married to retired spouses. Our sample is essentially the same as that of [Kopecky and Koreshkova \(2014\)](#) and we refer the interested reader to that paper for more specifics on the construction of the sample. We define healthy individuals to be those who self-report their health status to be excellent, very good or good.

## 1.1 Wealth Transition Computations

We use the wealth variable ATOTN which is reported at the household level in the HRS. This wealth measure is the sum of the value of owned real estate (excluding primary residence), vehicles, businesses, IRA/Keogh accounts, stocks, bonds, checking/savings accounts, CDs, treasury bills and “other savings and assets,” less any debt reported. To carry out an analysis of individuals, wealth is divided by two for married couples (and is left as is for single people). Additionally, irregular patterns in the dataset are fixed to eliminate spurious wealth transitions. For example, if a person has wealth  $> 0$  in period 1, wealth  $= 0$  in period 2, and wealth  $> 0$  in period 3, the wealth in period 2 is replaced by the average of the wealth in period 1 and period 3. These patterns are present in less than 1 percent of the total number of observations. Finally, wealth is censored at  $-\$500$  (if  $-\$500 < \text{wealth} < 0$ ) and at  $\$500$  (if  $0 \leq \text{wealth} < \$500$ ) to avoid problems of dividing by 0 or very small numbers when calculating percent changes in wealth from period to period. Wealth is reported in real terms. This is accomplished by deflating reported nominal wealth using the CPI.

For the unconditional wealth transitions, we omit most imputations of wealth performed by RAND. In particular, we only include observations where there is no imputation or wealth lies in a reported range. For the conditional wealth transitions, the resulting samples are too small if we omit the wealth imputations performed by RAND so we include all of their imputed wealth data. Their imputations of wealth only use a households current characteristics. As a result, we are concerned that some of these imputations create spurious wealth transitions. These effects are partially controlled for by the interpolation scheme we described above. To further control for these effects, we trim the top and bottom 1% of wealth transitions in each two year interval. The omitted observations do not appear to be clustered in any systematic way.

Table 1: Percentage of retired women moving from each quintile of the wealth distribution to quintile 1 two years later by marital status

Quintile	65–74 Year-olds		75–84 Year-olds		85+ Year-olds	
	Married	Widowed	Married	Widowed	Married	Widowed
1	72.5	80.0	69.6	75.9	80.2	76.1
2	17.3	22.9	17.2	20.6	28.1	28.0
3	3.4	6.5	4.4	6.9	8.1	11.5
4	1.0	1.6	1.1	2.4	3.7	6.2
5	0.4	1.1	0.3	0.5	2.6	2.8

The percentage of women moving down to quintile 1 from quintiles 2–5 in a 2-year period by marital status in the initial period. The first row is the percentage of women who stay in quintile 1. Source: Authors’ computations using our HRS sample.

## 1.2 Additional Wealth Transitions

Table 1 has three noteworthy properties. Observe first that impoverishment increases with age among both married and widowed women. This point is clearest if one compares women aged 65–74 with those aged 85+. The probability of a transition into wealth quintile 1 is higher for those starting in each of quintiles 2–5 for women who are 85 or older. This regularity is equally apparent among married and widowed women and can also be seen if one compares women aged 75–84 with those aged 85+ instead. A second interesting property of Table 1 is that a higher percentage of widows transit to quintile 1 from each other wealth quintile as compared to married women. This pattern is robust across wealth quintiles and also across age with one exception. For 85+ year old women in the second wealth quintile, the percentage experiencing transitions to quintile 1 is about the same for married women and widows. The third property is that low wealth is more persistent for widows than married women aged 65–74 and 75–84. The percentage of quintile 1 to quintile 1 transitions for married women and widows is respectively 73% and 80% for women aged 65–74 and 70% for married versus 76% for widows in the 75–84 age group.

Table 2 reports wealth mobility transitions to the first wealth quintile for married men and widowers. Observe that the results for older men are similar to those for older women. Men aged 85+ also exhibit higher transitions into quintile 1 than men aged 65–74. However, this only occurs for those starting in wealth quintiles 3–5. Widowers have higher probabilities of impoverishment as compared to married men and the lowest wealth state is more persistent for widowers.

Poor health is also associated with higher flows into the lowest wealth quintile as Table 3 shows. Some of the differences are small, but we find it remarkable that the pattern is

Table 2: Percentage of retired men moving from each quintile of the wealth distribution to quintile 1 two years later by marital status

Quintile	65–74 Year-olds		75–84 Year-olds		85+ Year-olds	
	Married	Widowed	Married	Widowed	Married	Widowed
1	74.5	75.7	73.9	79.0	70.7	73.9
2	18.3	24.1	17.4	18.8	15.0	19.2
3	3.9	12.2	3.5	9.6	4.6	8.1
4	1.3	3.5	2.0	2.0	4.1	4.3
5	0.7	1.7	0.9	1.8	0.0	4.0

The percentage of men moving down to quintile 1 from quintiles 2–5 in a 2-year period by marital status in the initial period. The first row is the percentage of men who stay in quintile 1. Source: Authors’ computations using our HRS sample.

Table 3: Percentage of retired individuals moving from each quintile of the wealth distribution to quintile 1 two years later by health status

Quintile	65–74 Year-olds		75–84 Year-olds		85+ Year-olds	
	Healthy	Unhealthy	Healthy	Unhealthy	Healthy	Unhealthy
1	69.7	80.9	70.8	79.3	67.8	73.1
2	15.6	22.6	15.1	22.1	17.7	27.5
3	3.4	5.5	3.8	7.2	7.8	8.2
4	0.9	2.2	1.3	4.1	4.1	4.7
5	0.4	1.5	0.5	1.3	1.4	2.8

The percentage of individuals moving down to quintile 1 from quintiles 2–5 in a 2-year period by health status in the initial period. The first row is the percentage of individuals who stay in quintile 1. Source: Authors’ computations using our HRS sample.

consistent across quintiles and all three age groups. A report of poor health is also associated with higher persistence of low wealth. The difference is largest for the 65–74 age group and narrows a bit as individuals age.

Table 4 reports wealth mobility transitions to the first wealth quintile conditional on whether or not individuals experience a nursing home stay and Table 5 reports the transitions conditional on whether or not they experience a hospital stay. Both nursing home and hospital stays are associated with an increased frequency of transitions to quintile 1. Hospital stays have a smaller impact compared to nursing home stays but the impoverishing effect of a hospital stay is clearly discernible in Table 5. Given that acute medical expenses are transient in nature, it is not surprising at all to see a weaker pattern of impoverishment for hospital stays than nursing home stays.

Table 4: Percentage of retired individuals moving from each quintile of the wealth distribution to quintile 1 two years later conditional on having a nursing home (NH) stay

Quintile	65–74 Year-olds		75–84 Year-olds		85+ Year-olds	
	None	NH Stay	None	NH Stay	None	NH Stay
1	74.4	85.2	67.5	80.2	74.3	87.4
2	16.5	37.2	18.5	37.3	17.4	39.4
3	4.1	18.4	6.2	17.6	4.1	25.0
4	1.6	15.8	3.0	11.7	14.4	15.3
5	0.6	2.0	0.9	7.3	0.6	3.9

The percentage of individuals moving down to quintile 1 from quintiles 2–5 in a 2-year period conditional on spending at least 90 days in a nursing home during that period. The first row is the percentage of individuals who stay in quintile 1. Source: Authors’ computations using our HRS sample.

Table 5: Percentage of retired individuals moving from each quintile of the wealth distribution to quintile 1 two years later conditional on whether or not they stayed overnight in a hospital

Quintile	65–74 Year-olds		75–84 Year-olds		85+ Year-olds	
	None	Hospital Stay	None	Hospital Stay	None	Hospital Stay
1	75.1	78.3	73.8	77.3	70.7	71.8
2	17.9	18.8	16.4	18.8	19.7	24.3
3	3.4	5.1	4.3	5.5	6.6	9.6
4	1.0	1.3	1.4	3.0	3.1	5.4
5	0.5	0.7	0.5	0.9	2.0	1.7

The percentage of individuals moving down to quintile 1 from quintiles 2–5 in a 2-year period conditional on an overnight hospital stay during the 2-year period. The first row is the percentage of individuals who stay in quintile 1. Source: Authors’ computations using our HRS sample.

## 2 Additional Features of the Model

### 2.1 Evolution of the population

Let the fraction of households with health and marital status  $(h^m, h^f, d)$  at age  $j$  be denoted by  $\lambda_j(h^m, h^f, d)$  and be determined as follows. First, for  $j = 1, 2, 3, \dots, R$ , let  $\lambda_j(g, g, 0) = 1$ , and set it to 0 for all other combinations of  $h^m, h^f$  and  $d$ . Then set

$$\lambda_{R+1}(h^m, h^f, d) = \sum_{\mathbf{s}} \int_{\bar{e}^m} \Lambda_d(\bar{e}^m) \Lambda_h^m(s^m) \Lambda_h^f(s^f) \iota_R(\bar{e}^m, \mathbf{s}) d\bar{e}^m,$$

where  $\iota_R(\bar{e}^m, \mathbf{s})$  is the distribution of households across  $(\bar{e}^m, \mathbf{s})$  at age  $R$ . Finally, set

$$\begin{aligned} \lambda_j(g, g, 0) = & \\ & \lambda_{j-1}(g, g, 0) \pi_j(0|g, g, 0) \nu_j^m(g, 0) \nu_j^f(g, 0) + \lambda_{j-1}(b, g, 0) \pi_j(0|b, g, 0) \nu_j^m(b, 0) \nu_j^f(g, 0) \\ & + \lambda_{j-1}(g, b, 0) \pi_j(0|g, b, 0) \nu_j^m(g, 0) \nu_j^f(b, 0) + \lambda_{j-1}(b, b, 0) \pi_j(0|b, b, 0) \nu_j^m(b, 0) \nu_j^f(b, 0), \end{aligned}$$

$$\begin{aligned} \lambda_j(b, g, 0) = & \\ & \lambda_{j-1}(g, g, 0) \pi_j(0|g, g, 0) (1 - \nu_j^m(g, 0)) \nu_j^f(g, 0) + \lambda_{j-1}(b, g, 0) \pi_j(0|b, g, 0) (1 - \nu_j^m(b, 0)) \nu_j^f(g, 0) \\ & + \lambda_{j-1}(g, b, 0) \pi_j(0|g, b, 0) (1 - \nu_j^m(g, 0)) \nu_j^f(b, 0) + \lambda_{j-1}(b, b, 0) \pi_j(0|b, b, 0) (1 - \nu_j^m(b, 0)) \nu_j^f(b, 0), \end{aligned}$$

$$\begin{aligned} \lambda_j(g, b, 0) = & \\ & \lambda_{j-1}(g, g, 0) \pi_j(0|g, g, 0) \nu_j^m(g, 0) (1 - \nu_j^f(g, 0)) + \lambda_{j-1}(b, g, 0) \pi_j(0|b, g, 0) \nu_j^m(b, 0) (1 - \nu_j^f(g, 0)) \\ & + \lambda_{j-1}(g, b, 0) \pi_j(0|g, b, 0) \nu_j^m(g, 0) (1 - \nu_j^f(b, 0)) + \lambda_{j-1}(b, b, 0) \pi_j(0|b, b, 0) \nu_j^m(b, 0) (1 - \nu_j^f(b, 0)), \end{aligned}$$

$$\begin{aligned} \lambda_j(b, b, 0) = & \\ & \lambda_{j-1}(g, g, 0) \pi_j(0|g, g, 0) (1 - \nu_j^m(g, 0)) (1 - \nu_j^f(g, 0)) \\ & + \lambda_{j-1}(b, g, 0) \pi_j(0|b, g, 0) (1 - \nu_j^m(b, 0)) (1 - \nu_j^f(g, 0)) \\ & + \lambda_{j-1}(g, b, 0) \pi_j(0|g, b, 0) (1 - \nu_j^m(g, 0)) (1 - \nu_j^f(b, 0)) \\ & + \lambda_{j-1}(b, b, 0) \pi_j(0|b, b, 0) (1 - \nu_j^m(b, 0)) (1 - \nu_j^f(b, 0)), \end{aligned}$$

$$\begin{aligned}
& \lambda_j(h^m, b, 1) = \\
& \lambda_{j-1}(g, g, 0)\pi_j(1|g, g, 0) \left(1 - \nu_j^f(g, 0)\right) + \lambda_{j-1}(b, g, 0)\pi_j(1|b, g, 0) \left(1 - \nu_j^f(g, 0)\right) \\
& + \lambda_{j-1}(g, b, 0)\pi_j(1|g, b, 0) \left(1 - \nu_j^f(b, 0)\right) + \lambda_{j-1}(b, b, 0)\pi_j(1|b, b, 0) \left(1 - \nu_j^f(b, 0)\right) \\
& + \lambda_{j-1}(h^m, b, 1)\pi_j^f(b, 0) \left(1 - \nu_j^f(b, 0)\right) + \lambda_{j-1}(h^m, g, 1)\pi_j^f(g, 0) \left(1 - \nu_j^f(g, 0)\right),
\end{aligned}$$

$$\begin{aligned}
& \lambda_j(h^m, g, 1) = \\
& \lambda_{j-1}(g, g, 0)\pi_j(1|g, g, 0)\nu_j^f(g, 0) + \lambda_{j-1}(b, g, 0)\pi_j(1|b, g, 0)\nu_j^f(g, 0) \\
& + \lambda_{j-1}(g, b, 0)\pi_j(1|g, b, 0)\nu_j^f(b, 0) + \lambda_{j-1}(b, b, 0)\pi_j(1|b, b, 0)\nu_j^f(b, 0) \\
& + \lambda_{j-1}(h^m, b, 1)\pi_j^f(b, 0)\nu_j^f(b, 0) + \lambda_{j-1}(h^m, g, 1)\pi_j^f(g, 0)\nu_j^f(g, 0),
\end{aligned}$$

$$\begin{aligned}
& \lambda_j(b, h^f, 2) = \\
& \lambda_{j-1}(g, g, 0)\pi_j(2|g, g, 0) \left(1 - \nu_j^m(g, 0)\right) + \lambda_{j-1}(b, g, 0)\pi_j(2|b, g, 0) \left(1 - \nu_j^m(b, 0)\right) \\
& + \lambda_{j-1}(g, b, 0)\pi_j(2|g, b, 0) \left(1 - \nu_j^m(g, 0)\right) + \lambda_{j-1}(b, b, 0)\pi_j(2|b, b, 0) \left(1 - \nu_j^m(b, 0)\right) \\
& + \lambda_{j-1}(b, h^f, 2)\pi_j^m(b, 0) \left(1 - \nu_j^m(b, 0)\right) + \lambda_{j-1}(g, h^f, 2)\pi_j^m(g, 0) \left(1 - \nu_j^m(g, 0)\right),
\end{aligned}$$

and

$$\begin{aligned}
& \lambda_j(g, h^f, 2) = \\
& \lambda_{j-1}(g, g, 0)\pi_j(2|g, g, 0)\nu_j^m(g, 0) + \lambda_{j-1}(b, g, 0)\pi_j(2|b, g, 0)\nu_j^m(b, 0) \\
& + \lambda_{j-1}(g, b, 0)\pi_j(2|g, b, 0)\nu_j^m(g, 0) + \lambda_{j-1}(b, b, 0)\pi_j(2|b, b, 0)\nu_j^m(b, 0) \\
& + \lambda_{j-1}(b, h^f, 2)\pi_j^m(b, 0)\nu_j^m(b, 0) + \lambda_{j-1}(g, h^f, 2)\pi_j^m(g, 0)\nu_j^m(g, 0).
\end{aligned}$$

It follows that the fraction of households that are age  $j$  is given by

$$\eta_j = \frac{\eta_{j-1}}{1+n} \sum_{h^m} \sum_{h^f} \sum_d \lambda_j(h^m, h^f, d), \text{ for } j = 2, 3, \dots, J,$$

where  $\eta_1$  is set such that

$$\sum_{j=1}^J \eta_j = 1.$$

## 2.2 Definition of Equilibrium

For the purposes of defining an equilibrium in a compact way, we suppress the household state into a vector  $(j, x)$ , where

$$x = \begin{cases} x_W \equiv (a, \bar{\mathbf{e}}, \boldsymbol{\varepsilon}_e, \mathbf{s}), & \text{if } 1 \leq j \leq R, \\ x_R \equiv (a, \bar{\mathbf{e}}, \mathbf{h}, \boldsymbol{\varepsilon}_M, d, d'), & \text{if } R < j \leq J. \end{cases}$$

Accordingly, we redefine value functions, decision rules, income taxes, means-tested transfers and SS benefits to be functions of the household state  $(j, x)$ :  $V^W(j, x)$ ,  $V^R(j, x)$ ,  $c(j, x)$ ,  $a'(j, x)$ ,  $l_f(j, x_W)$ ,  $l_m(j, x_W)$ ,  $T_y(x)$ ,  $Tr(j, x)$  and  $S(x_R)$ . Define the household state spaces:

$$X_W \subset [0, \infty) \times [0, \infty) \times [0, \infty) \times \{(hs, hs), (hs, col), (col, hs), (col, col)\},$$

$$X_R \subset [0, \infty) \times [0, \infty) \times \{(g, g), (b, g), (g, b), (b, b)\} \times [0, \infty) \times \{0, 1, 2\} \times \{0, 1, 2\}.$$

and denote by  $\Xi(X)$  the Borel  $\sigma$ -algebra on  $X \in \{X_W, X_R\}$ . Let  $\Psi_j(X)$  be a probability measure of age- $j$  households with state  $x \in X$ . Note that these households constitute a fraction  $\eta_j \Psi_j(X)$  of the total number of households.

DEFINITION. Given a fiscal policy  $\{S(\bar{\mathbf{e}}, d), \tau_c, \tau_{mc}(e), \tau_{ss}(e), T_y(x), \underline{a}^d, \underline{c}^d, \underline{y}^d, \kappa\}$  and a real interest rate  $r$ , a steady-state competitive equilibrium consists of household policies  $\{c(j, x), a'(j, x), l_f(j, x), l_m(j, x)\}_{j=1}^J$  and associated value functions  $\{V^W(j, x)\}_{j=1}^R$ ,  $\{V^R(j, x)\}_{j=R+1}^J$ , government purchases and prices  $\{G, w\}$ , per capita capital stocks  $\{\bar{K}, K\}$  and an invariant distribution  $\{\Psi_j\}_{j=1}^J$  such that

1. At the given prices and taxes, the household policy functions  $c(j, x)$ ,  $a'(j, x)$ ,  $l_f(j, x)$  and  $l_m(j, x)$  achieve the value functions.
2. At the given prices, firms are on their input demand schedules:  $w = F_L(K, L)$  and  $r = F_K(K, L) - \delta$ .
3. Aggregate savings are given by  $\sum_j \eta_j \int_X a'(j, x) d\Psi_j = (1 + n)\bar{K}$ .
4. Markets clear:

$$(a) \text{ Goods } \sum_j \eta_j \int_X c(j, x) d\Psi_j + (1+n)\bar{K} + \tilde{M} + G = F(K, L) + (1-\delta)\bar{K} + (r+\delta)(\bar{K}-K),$$

where  $\tilde{M} = \sum_{j=R}^J \eta_j \int_{X_R} \Phi(j, \mathbf{h}, \boldsymbol{\varepsilon}_M, d, d') d\Psi_j$ .

$$(b) \text{ Labor: } \sum_j \eta_j \int_X \{(1 - l_f(j, x))\Omega^f(j, \boldsymbol{\varepsilon}_e, s^f) + (1 - l_m(j, x))\mathbf{I}_{j \geq \bar{j}} - \bar{\mathbf{I}}_{j < \bar{j}}\Omega^m(j, \boldsymbol{\varepsilon}_e, s^m)\} d\Psi_j = L.$$

5. Distributions of households are consistent with household behavior:

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

for all  $X_0 \in \Xi$ , where  $\mathbf{I}$  is an indicator function and  $Q_j(x, x')$  is the probability that a household of age  $j$  and current state  $x$  transits to state  $x'$  in the following period.

6. The government's budget is balanced:

$$\begin{aligned} & \text{IncomeTaxes} + \text{CorporateTaxes} + \text{MedicareTaxes} + \text{PayrollTaxes} = \\ & \text{SSbenefits} + \text{Transfers} + G \end{aligned}$$

where income tax revenue is given by

$$\text{IncomeTaxes} = \sum_{j=1}^J \eta_j \int_X T_y(x) d\Psi_j,$$

corporate profits tax revenue is

$$\text{CorporateTaxes} = \sum_{j=1}^R \eta_j \int_{X_W} \tau_{cra}(j, x) d\Psi_j,$$

Medicare tax revenue is

$$\text{MedicareTaxes} = \sum_{j=1}^R \eta_j \int_{X_W} \left\{ \tau_{mc}(e^m(j, x)) e^m(j, x) + \tau_{mc}(e^f(j, x)) e^f(j, x) \right\} d\Psi_j,$$

payroll tax revenue is

$$\text{PayrollTaxes} = \sum_{j=1}^R \eta_j \int_{X_W} \left\{ \tau_{ss}(e^m(j, x)) e^m(j, x) + \tau_{ss}(e^f(j, x)) e^f(j, x) \right\} d\Psi_j$$

SS benefits are

$$\text{SSbenefits} = \sum_{j=R+1}^J \eta_j \int_{X_R} S(x) d\Psi_j$$

and means-tested transfer payments are

$$Transfers = \sum_{j=1}^J \eta_j \int_X Tr(j, x) d\Psi_j.$$

## 2.3 Computational Algorithm

The steps in computing the equilibrium of the baseline economy are as follows. First, a guess of average earnings is made. From this guess, a guess on average household income is derived. Second, individual maximization problems are solved. Agents' problems in the last period of their lives are solved first, followed by the previous period, up to the first period. To this end, the state space is discretized and optimal assets and labor supply are found via grid search. Value functions are constructed using piecewise linear interpolation. The grids for assets and average lifetime earnings consist of 100 and 10 nonlinearly-spaced points, respectively. Increases in these grid sizes does not significantly change the solution. Female labor supply is chosen from an evenly-spaced grid of 10 points. Third, the distribution of the population over the discrete state is computed using forward iteration. Finally, average earnings and average household income are updated. This procedure is iterated on until both average earnings and average household income converge. The government budget constraint is cleared by setting government spending to the residual.

The algorithm to compute counterfactual economies is similar. The main difference is that, in addition to average earnings and average household income, the tax rate used to clear the government budget constraint is also iterated on while government spending as a fraction of output is held fixed at the baseline economy level.

## 3 Calibration Details

### 3.1 Stochastic Structure of Medical expenses

When calibrating the five state Markov process of medical expense shocks, we allow one of the states to be associated with nursing home stays. We set the fifth state to reproduce the average annual cost of a nursing home stay for a Medicaid recipient. This cost is \$33,500 in year 2000 dollars and includes both the cost of care and the cost of room and board.<sup>1</sup> We focus on Medicaid recipients because it allows us to decompose this expense into a consumption and medical expense component. In particular, for these individuals, the consumption component

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<sup>1</sup>This number is based on Medicaid per diem rates in Meyer (2001).

is given by  $\underline{c}$ . One way to assess this calibration is to consider the situation of a private payer. Under the assumption that 1/2 of total consumption is room and board for nursing home care, total average nursing home expenses for a private payer in the model are about \$70,000 per year in year 2000 dollars. For purposes of comparison the average annual cost of a semi-private room was \$60,000 in 2005 and the cost of a private room was \$75,000 in 2005 according to the Metlife Market Survey of Nursing Home and Assisted Living Costs.

The probabilities of a nursing home stay are assumed to vary with age. We estimate the transition probabilities in and out of this state using the following targets. The probabilities of entry into the nursing home state are chosen to match the distribution of age of first nursing home entry for individuals aged 65 and above. This distribution is taken from [Murtaugh, Kemper, Spillman and Carlson \(1997\)](#). They find that 21% of nursing home stayers have their first entry between ages 65–74, 46% between ages 75–84, and 33% after age 85. The probabilities of exiting the nursing home state are chosen to match the average years of nursing home stay over their lifetime organized by age of first entry. We limit attention to stays of at least 90 days because we want to focus on true long-term care expenses. [Murtaugh et al. \(1997\)](#) do not report the figures we need. However, we are able to impute these durations by combining data they provide with data from [Liu, McBride and Coughlin \(1994\)](#). The specific targets are as follows. For those who had a first entry between 65-74, the average duration of all nursing home stays is 3.9 years. For those whose first entry is between the ages of 75-84 the average duration is 3.2 years and for those with first entry after age 85 the average duration is 2.9 years.

The above targets are all conditional on a nursing home entry. In order to estimate the unconditional probability of a nursing home entry, we target the probability that a 65 year old will enter a nursing home before death for a long term stay. That probability is 0.295 and is imputed using data from the two sources above.

In order to hit these targets, as well as the [French and Jones \(2004\)](#) AR(1) targets, we use a simulated method of moments procedure that does a bias correction for the well known downward bias in estimated AR(1) coefficients.

## 3.2 Preferences

We set  $\beta = 0.944$  to obtain a wealth to earnings ratio in the model of 3.2. This is the wealth to earnings ratio for the bottom 95 percent of the wealth distribution in the US and the same target used by [Hong and Ríos-Rull \(2007\)](#). Following the macro literature, we set  $\sigma$  equal to 2.0.<sup>2</sup> The degree of joint consumption is governed by  $\chi$ . We set  $\chi$  to 0.67 following

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<sup>2</sup>See for example [Castañeda, Díaz-Giménez and Ríos-Rull \(2003\)](#), [Heathcote, Storesletten and Violante \(2010\)](#) and [Storesletten, Telmer and Yaron \(2004\)](#).

Attanasio, Low and Sanchez-Marcos (2008).

We set  $\gamma$ , the leisure exponent for females to 2. This is the baseline value used by Erosa, Fuster and Kambourov (2014). This choice in conjunction with steady-state hours worked implies a theoretical Frisch-elasticity of 2.43. This choice implies that the correlation between the year-on-year growth rate of the husbands wages and the corresponding growth rate of the wife's hours worked is  $-0.34$  in our model. For purposes of comparison, the model of Heathcote et al. (2010) produces a correlation of  $-0.11$  for the same statistic.

We allow  $\psi(\mathbf{s})$  to vary with the education level of each household member. The targets, taken from McGrattan and Rogerson (2007), are average female hours by educational attainment of both household members. Expressed as a fraction of a total time endowment of 100 hours per week, they are 0.16 for high-school-educated households, 0.17 for households where the female has a high-school degree and her spouse has a college degree, 0.24 for households where the female has a college degree and her husband has a high-school degree, and 0.21 for college-educated households. The corresponding parameter values are 3.5, 1.7, 2.25, and 1.7.

The parameters that governs the extent of disutility the household experiences if the female or older male is participating in the labor market,  $\phi_f(\mathbf{s})$  and  $\phi_m(\mathbf{s})$ , also vary with education. The targets for  $\phi_f(\mathbf{s})$ , taken from Kaygusuz (2010), are female participation rates by educational attainment of each household member. The participation rates are for married females aged 50 to 59. For high-school-educated households the rate is 0.48. For households with high-school-educated females and college-educated males the rate is 0.45. For households with college-educated females and high-school-educated males the rate is 0.68 and for college-educated households the rate is 0.58. The corresponding parameter values are 0.21, 0.16, 0.11, and 0.11. The targets for  $\phi_m(\mathbf{s})$  are the participation rates by educational attainment of each household member for married males aged 55 to 64. For high-school-educated households the rate is 0.68. For households with high-school-educated females and college-educated males the rate is 0.77. For households with college-educated females and high-school-educated males the rate is 0.72 and for college-educated households the rate is 0.82. The corresponding parameter values are 1.33, 0.94, 0.71, and 0.59. The targets for all these parameters are based on IPUMS data from the 1980 and 1990 U.S census.

### 3.3 Technology

Consumption goods are produced according to a production function,

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

where capital depreciates at rate  $\delta$ . The parameters  $\alpha$  and  $\delta$  are set using their direct counterparts in the U.S data: a capital income share of 0.3 and an annual depreciation rate of 7% (Gomme and Rupert, 2007). The parameter  $A$  is set such that the wage per efficiency unit of labor is normalized to one under the baseline calibration.

### 3.4 Earnings Process

The basic strategy for calibrating the labor productivity process follows Heathcote et al. (2010) who also consider earnings for married households. We assume that college graduates begin their working career four years later than high school graduates. The specific form of the labor productivity process is:

$$\log \Omega^i(j, \epsilon_e, s^i) = \alpha_1 \mathbf{I}(s^i = col) + \alpha_2 \mathbf{I}(i = f) + \beta_1 j + \beta_2 j^2 + \beta_3 j^3 + \epsilon_e^i,$$

where  $\alpha_1$  and  $\alpha_2$  are intercepts that capture the college premium and the gender gap. The  $\beta$ 's determine the experience premium. The specific values of these parameters are  $\alpha = 4.96 \times 10^{-1}$ ,  $\alpha_2 = -4.78 \times 10^{-1}$ ,  $\beta_1 = 4.80 \times 10^{-2}$ ,  $\beta_2 = -8.06 \times 10^{-4}$  and  $\beta_3 = -6.46 \times 10^{-7}$ . All these values are taken from Heathcote et al. (2010).

Following Heathcote et al. (2010), we assume that females and males face a persistent productivity shock process. In particular,  $\epsilon_e^i$  is assumed to follow an AR(1) process with a serial correlation coefficient of  $\epsilon_e^i = 0.973$  and a standard deviation of 0.01. We allow the innovation to earning productivity to be correlated with the spouse's innovation. Heathcote et al. (2010) choose this correlation to reproduce a targeted correlation of male wage growth and female wage growth of 0.15. We set the correlation of the earnings innovations to match this same target. The resulting correlation between the two earnings innovations is 0.05.

Heathcote et al. (2010) also allow for a transient shock to labor productivity. We abstract from this second shock. This reduces the size of the state space for working households and allows us to model the problem of retirees in more detail.

The distribution of initial productivity levels  $\Gamma_e$  is assumed to be bivariate normal with a standard deviation of 0.352, a correlation of 0.517 and a gender productivity gap of 0.62 in 1970. All of these targets are taken from Heathcote et al. (2010) and apply to males and females.<sup>3</sup>

One difference between us and Heathcote et al. (2010) is that we allow for an earnings state that has a much lower level of earnings as compared to what Gaussian quadrature methods would imply. See Section 5.2 of the paper for more details.

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<sup>3</sup>Specifications similar to this have been used by Attanasio et al. (2008) and Heathcote, Storesletten and Violante (2008) to model the joint earnings of married couples.

### 3.5 Progressive Income Tax Formula

The effective progressive income tax formula is given by:

$$\tau^y(y^{disp}, d) = \left[ \eta_1^d + \eta_2^d \log \left( \frac{y^{disp}}{\bar{y}} \right) \right] y^{disp} \quad (1)$$

where  $y^{disp}$  is disposable household income,  $\bar{y}$  is mean income in the economy. [Guner, Kaygusuz and Ventura \(2012\)](#) estimate  $\eta_1^0 = 0.113$  and  $\eta_2^0 = 0.073$  for married households and  $\eta_1^{d \in \{1,2\}} = 0.153$  and  $\eta_2^{d \in \{1,2\}} = 0.057$  for single households. We shift the income tax formula down by 0.07 to match income tax revenue as a fraction of GDP in the model and the data.

The U.S. Federal tax code allows tax-filers a deduction for medical expenses that exceed 7.5% of income. Our income tax schedules indirectly account for deductions when estimating effective tax functions. However, their effective tax functions are averages across many households and do not capture the full benefit of this deduction to those who experience large medical expense shocks such as long-term care. We allow for a deduction for medical expenses that exceed 7.5% of income.

U.S. Federal tax code provides for an exemption of SS benefits. This exemption is phased out in two stages as income rises. [Table 6](#) reports exemption thresholds and minimum income levels by marital status. The left column of [Table 6](#) reports the actual dollar amounts in the year 2000. The right column expresses these figures as a fraction of average earnings of full-time, prime-age male workers. According to our source, the thresholds and minimum income are not indexed to inflation or wage growth.

We use these thresholds to compute the exemptions formulas in the following way. We start by calculating provisional income,  $Y$ , which is defined as asset income,  $Y^a$ , plus half of the household's SS income,  $Y^{ss}$ . If  $Y < T_i^1, i \in \{s, m\}$ , there is a full exemption for SS benefits and taxable income for that household is equal to  $Y^a$  net of the medical expense tax deduction. If  $T_i^1 < Y < T_i^2, i \in \{s, m\}$ , taxable income is given by

$$Y^a + 0.5 \min(Y^{ss}, Y - T_i^1),$$

net of the medical expense tax deduction if eligible. If  $Y > T_i^2, i \in \{s, m\}$ , then taxable income is given by

$$Y^a + \min \left\{ 0.85Y^{ss}, 0.85 \left[ Y - T_i^2 + \min(\underline{Y}_i, 0.5Y_i^{ss}) \right] \right\},$$

net of medical expense tax deduction if eligible.

Table 6: Exemption thresholds and minimum income levels for taxation of social security benefit income

Description	Levels (\$)	% of ave. earnings
<b>Threshold 1</b>		
Single ( $T_s^1$ )	25,000	53
Married ( $T_m^1$ )	32,000	67
<b>Threshold 2</b>		
Single ( $T_s^2$ )	34,000	72
Married ( $T_m^2$ )	44,000	93
<b>Minimum income</b>		
single ( $Y_s$ )	4,500	9
married ( $Y_m$ )	6,000	13

Source: Scott, C. and J. Mulvey (2010). “Social Security: Calculation and History of Taxing Benefits”, *Congressional Research Service*.

### 3.6 Social Security Benefits

The U.S. Social Security system links a worker’s benefits to an index of the worker’s average earnings,  $\underline{e}$ . Benefits are adjusted to reflect the annual cap on contributions and there is also some progressivity built into the U.S. Social Security system. We use the following formula to link contributions to benefits for an individual

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

Following the Social Security administration, we set the marginal replacement rates,  $s_1$ ,  $s_2$ , and  $s_3$  to 0.90, 0.33, and 0.15, respectively. The threshold levels,  $\tau_1$ ,  $\tau_2$ , and  $\tau_3$ , are set to 20%, 125% and 246% of average earnings for all workers. The U.S. Social Security system also provides spousal and survivor benefits. We model these benefits. Household benefits are determined using the following formula

$$S(\bar{\mathbf{e}}, d) = \begin{cases} \hat{S} \left( \max_{i \in \{m, f\}} \{\bar{e}^i\} \right) + \max \left\{ 0.5 \hat{S} \left( \max_{i \in \{m, f\}} \{\bar{e}^i\} \right), \hat{S} \left( \min_{i \in \{m, f\}} \{\bar{e}^i\} \right) \right\}, & \text{if } d = 0, \\ \max \{ \hat{S}(\bar{e}^m), \hat{S}(\bar{e}^f) \}. & \text{if } d \in \{1, 2\}. \end{cases}$$

Table 7: Bi-annual Flows into Medicaid by Age and Marital Status

<b>Age</b>	65–74	75–84	85+
<i>Married</i>			
data	0.028	0.029	0.043
model	0.017	0.031	0.037
<i>Widows</i>			
data	0.065	0.055	0.088
model	0.079	0.061	0.058
<i>Widowers</i>			
data	0.077	0.066	0.090
model	0.057	0.049	0.056

The flows are the fraction of retirees with given initial marital status not receiving Medicaid but who become recipients over the next two years. Data source: Authors’ computations using our HRS sample.

## 4 Other Model Assessment Results

### 4.1 Medicaid Flows

Another implication of the model that was not targeted is flows into Medicaid. Table 7 reports flows into Medicaid by age and marital status. Observe that in the data, the flows into Medicaid are much lower for married than singles. Moreover, the flows increase monotonically with age for married but follow a U-shaped pattern for singles. Model flows into Medicaid reproduce almost all of these features of the data.

### 4.2 Other Wealth Transitions

Table 8 indicates that the model is in reasonably good accord with the data with respect to both wealth transitions conditional on widowhood for men and medical expenses. First, observe that widowers of all ages face a higher probability and a higher persistence of low wealth compared to married men. One way to compare the effects of medical expenses is to interpret the second highest draw of the medical expense shock in the model as a hospital stay. Notice that, with this interpretation, hospital stays increase the likelihood and persistence of low wealth in the model as in the data. We do not read much into these statistics from the model for the 85+ widowers because the sample size for this group in our model simulated data is extremely small.

Table 8: Additional conditional transitions into and persistence of low wealth statistics

Cohort	Model			Data		
	65–74	75–84	85+	65–74	75–84	85+
<i>Marital Status (Men)</i>						
married	1.10	3.24	5.83	6.08	5.93	5.90
widower	4.05	5.14	32.96	10.36	8.05	8.89
<i>Hospital</i>						
no hospital stay	3.71	5.60	6.28	5.71	5.67	7.87
hospital stay	7.86	14.21	18.69	6.47	7.04	10.25
<i>Marital Status (Men)</i>						
married	87.2	74.6	26.4	74.5	73.9	70.7
widower	97.5	89.9	100	75.7	79.0	73.9
<i>Hospital</i>						
no hospital stay	78.1	66.5	67.7	75.1	73.1	70.7
hospital stay	96.3	90.6	67.1	78.3	77.3	71.8

The upper-panel numbers are the percentage of individuals in wealth quintiles 2–5 who move to quintile 1 two years later conditional on their initial status. The lower-panel numbers are the percentage of individuals in wealth quintile 1 who are still in quintile 1 two years later conditional on their initial status. Wealth quintiles are determined from an individual wealth distribution specific to each age group. Married individuals are assigned half of the household wealth.

## 5 Additional Figures

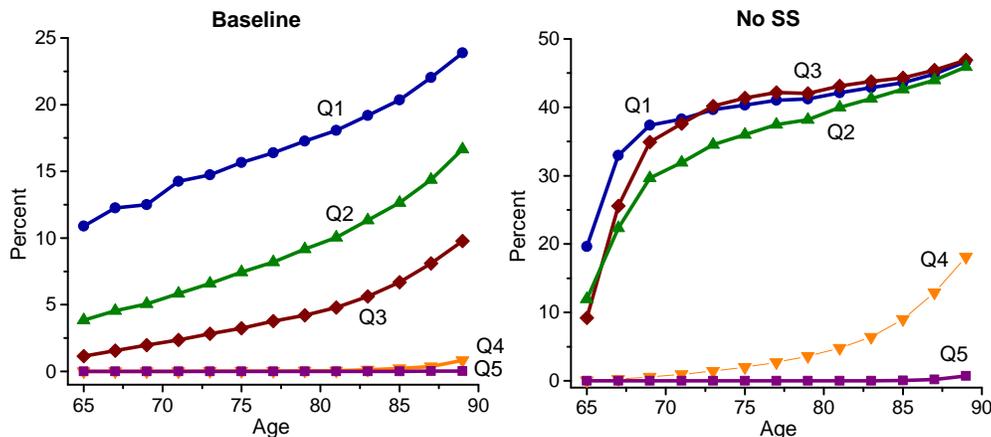


Figure 1: MTISI reciprocity rates of retirees in the baseline economy and the baseline economy without SS.

The left panel of Figure 1 shows the MTISI reciprocity rates in the baseline economy. The right panel shows the same rates in the economy without SS. These rates were used to construct the changes in reciprocity rates shown in Figure 6 in the paper.

## 6 Additional Robustness Experiments

Table 9 reports the welfare costs of removing MTISI under our baseline and three alternative scenarios about the size of the consumption floors and income thresholds delivered by informal insurance arrangements when MTISI is absent. In each scenario, the floors and income thresholds are adjusted proportionately. Ex-ante welfare of a newborn household falls even when the floors offered by informal insurance are increased by a factor of 1000 relative to their baseline values. In addition, most types of households continue to experience a welfare loss when MTISI is absent.

We have posited a non-Gaussian process for earnings. In particular, we have included a low earnings state that helps us reproduce the left tail of the earnings distribution. In the baseline model this shock hits all households with equal probability. For retirees in the HRS this was a reasonable assumption. However, in more recent cohorts the poverty rate of high-school educated individuals relative to college-educated individuals has doubled.<sup>4</sup> The second column of Table 10 illustrates how the welfare effects of removing MTISI change when the low earnings shock is assumed to hit households with high-school-educated males

<sup>4</sup>Pew Research Center (2014) “The Rising Cost of Not Going to College”

Table 9: Welfare effects of removing MTSI under different assumptions about the alternative consumption floor

<b>Economy</b>	Baseline $\underline{c} = 1.1\text{e-}5$	$\underline{c} = 1.1\text{e-}4$	$\underline{c} = 0.0011$	$\underline{c} = 0.011$
<b>Welfare</b>				
Ex-ante	-4.3	-2.8	-1.7	-0.67
<i>By male permanent earnings:</i>				
quintile 1	-7.0	-4.9	-3.2	-1.8
quintile 2	-4.9	-3.3	-2.1	-0.99
quintile 3	-3.9	-2.5	-1.5	-0.54
quintile 4	-3.0	-1.8	-0.9	-0.12
quintile 5	-1.2	-0.41	0.20	0.70
<i>By household education type (female, male):</i>				
high school, high school	-5.4	-3.7	-2.3	-1.2
high school, college	-2.3	-1.1	-0.21	0.49
college, high school	-1.7	-0.96	-0.34	0.17
college, college	0.0	0.52	0.90	1.2
<b>No MTSI</b>				
percent of retirees at floor	0.07	0.34	2.5	2.6

The welfare effects of replacing MTSI in the baseline economy with the Townsendian consumption floor (first column) and consumption floors that are 10 (second column), 100 (third column) and 1000 (fourth column) times larger than the Townsendian level. The last row of the table shows the percent of retirees at the floors when MTSI is not available.

Table 10: Welfare effects of removing MTSI under different model assumptions

<b>Economy</b>	Baseline	HS only shock	NH not med. needy
Ex-ante	-4.3	-4.2	-4.3
<i>By household education type (female, male):</i>			
high school, high school	-5.4	-5.6	-5.4
high school, college	-2.3	0.69	-2.2
college, high school	-1.7	-1.9	-1.7
college, college	0.0	1.8	0.08

The welfare effects of replacing MTSI with the Townsendian consumption floor in the baseline economy (first column), an economy where only high-school-educated males can get the low-earnings shock (second column) and an economy where households that get the nursing home shock are not only eligible for MTSI through the medically-needy pathway (third column).

Table 11: Conditional transitions into and persistence of low wealth

Cohort	Baseline			NH not med. needy			Data		
	65–74	75–84	85+	65–74	75–84	85+	65–74	75–84	85+
<b>Transitions to Quintile 1</b>									
no NH stay	4.35	6.21	6.12	5.23	7.86	9.43	5.79	5.67	7.16
NH stay	7.57	17.22	27.86	7.79	9.92	12.7	23.19	18.64	18.49
<b>Persistence of Quintile 1</b>									
no NH stay	82.2	71.9	58.9	78.9	67.9	59.9	75.8	74.4	67.5
NH stay	97.6	99.9	99.2	80.7	73.9	66.4	90.7	85.2	80.2

The upper (lower) panel numbers are the percentage of individuals in wealth quintiles 2–5 who move to (stay in) quintile 1 two years later conditional on nursing home status. Wealth quintiles are determined from an individual wealth distribution specific to each age group. Married individuals are assigned half of the household wealth.

only. The ex-ante welfare benefits of MTSI are smaller and there is now disagreement among households. Households with college-educated males now prefer the economy with Townsendian consumption floors to the one with MTSI.<sup>5</sup>

In the baseline economy we assume that residents can only qualify for MTSI via the medically needy path. The final column of the same table shows how the welfare results change when we assume that can qualify for MTSI via either path. Notice that the welfare results are essential identical to those of the baseline. This economy is of interest because nursing home stays are less persistent in this economy as compared to the baseline as Table 11 shows.

<sup>5</sup>Notice that the welfare rankings also change. In the baseline economy, the households with high-school-educated females value MTSI the most as it is more costly for these households to self-insure by increasing female labor supply when MTSI is removed. However, once college males no longer face the risk of incurring the low-income shock, households with high-school-educated females and college-educated males value MTSI much less.

## References

- ATTANASIO, A., H. LOW AND V. SANCHEZ-MARCOS, “Explaining Changes in Female Labor Supply in a Life-Cycle Model,” *American Economic Review* 98 (2008), 1517–52.
- CASTAÑEDA, A., J. DÍAZ-GIMÉNEZ AND J.-V. RÍOS-RULL, “Accounting for the US Earnings and Wealth Inequality,” *Journal of Political Economy* 111 (2003), 818–857.
- EROSA, A., L. FUSTER AND G. KAMBOUROV, “Towards a Micro Founded Theory of Aggregate Labor Supply,” University of Toronto Working Paper 516, 2014.
- FRENCH, E. AND J. B. JONES, “On the Distribution and Dynamics of Health Care Costs,” *Journal of Applied Econometrics* 19 (2004), 705–721.
- GOMME, P. AND P. RUPERT, “Theory, Measurement and Calibration of Macroeconomic Models,” *Journal of Monetary Economics* 54 (2007), 460–497.
- GUNER, N., R. KAYGUSUZ AND G. VENTURA, “Taxing Women: A Macroeconomic Analysis,” *Journal of Monetary Economics* 59 (2012), 111–128.
- HEATHCOTE, J., K. STORESLETTEN AND G. VIOLANTE, “Insurance and Opportunities: The Welfare Implications of Rising Wage Dispersion,” *Journal of Monetary Economics* 55 (2008), 201–525.
- HEATHCOTE, J., K. STORESLETTEN AND G. L. VIOLANTE, “The Macroeconomic Implications of Rising Wage Inequality in the United States,” *Journal of Political Economy* 118 (2010), 681–722.
- HONG, J. H. AND J. RÍOS-RULL, “Social Security, Life Insurance and Annuities for Families,” *Journal of Monetary Economics* 54 (2007), 118–140.
- KAYGUSUZ, R., “Taxes and Female Labor Supply,” *Review of Economic Dynamics* 13 (2010), 725–741.
- KOPECKY, K. AND T. KORESHKOVA, “The Impact of Medical and Nursing Home Expenses on Savings,” *American Economic Journal: Macroeconomics* 6 (2014), 29–72.
- LIU, K., T. MCBRIDE AND T. COUGHLIN, “Risk of Entering Nursing Homes for Long versus Short Stays,” *Medical Care* 32 (1994), 315–327.

- MCGRATTAN, E. R. AND R. ROGERSON, "Changes in the Distribution of Family Hours Worked since 1950," Technical Report, Staff Report 397, Federal Reserve Bank of Minneapolis, 2007.
- MEYER, M. H., "Medicaid Reimbursement Rates and Access to Nursing Homes Implications for Gender, Race, and Marital Status," *Research on Aging* 23 (2001), 532–551.
- MURTAUGH, C. M., P. KEMPER, B. C. SPILLMAN AND B. L. CARLSON, "The Amount, Distribution, and Timing of Lifetime Nursing Home Use," *Medical Care* 35 (1997), 204–218.
- STORESLETTEN, K., C. I. TELMER AND A. YARON, "Consumption and Risk Sharing over the Life Cycle," *Journal of Monetary Economics* 51 (2004), 609–633.