Abstract

We build a life-cycle model of household consumption and saving decisions, where long term care (LTC) expenditures are endogenous. We use an LTC-state dependent utility function where regular consumption and LTC are valued differently. The model includes both married and single households, thus capturing important family dynamics that are important for precautionary savings and LTC decisions. Married individuals face the risk of a spouse needing LTC and quickly depleting joint assets. However, those needing LTC can benefit from the presence of a healthy spouse who provides informal care, lowering the costs of LTC given a fixed quality of care. We use the calibrated model to estimate the importance of family dynamics for savings and consumption decisions, and also to quantify the impacts of LTC policy reforms such as the provision of a universal public system that pays for a minimum level of LTC costs.

Keywords: Long Term Care, Medicaid Reform, Household Risk

JEL classification: D91, E21, H31, I10, I38, J14

1. Introduction

Rapid population aging poses significant challenges in terms of long term care (LTC) provision and financing. In countries that lack a universal public LTC insurance system, out-of-pocket LTC costs are high and persistent, and represent a large source of individual financial risk (De Nardi et al. (2010), Kopecky and Koreshkova (2014), De Nardi et al. (2016), Ameriks et al. (2017)). In the United States, which has no universal LTC coverage, expenses are paid out-of-pocket, using private insurance, or, when an individual is impoverished, by Medicaid. As a result, anticipated LTC expenses account for much saving among older households, and when the accumulated funds are not needed, accidental

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bequests (De Nardi et al. (2010), Kopecky and Koreshkova (2014), Ameriks et al. (2017)). In addition, private LTC insurance is not widely held (e.g., Brown and Finkelstein (2007), Brown and Finkelstein (2008), Ameriks et al. (2016)).

This paper contributes to the literature on LTC by building a life-cycle model with incomplete markets to consider two alternative scenarios relative to the current system for funding LTC. The first would introduce basic LTC coverage of the sort currently funded by Medicaid to all households as a feature of Medicare. However, the desired level of LTC demanded by households in our model may be larger than this basic coverage, and the difference would need to be funded through private saving. Given that this environment would still lead to potential accidental bequests, we consider a second scenario where actuarially fair insurance is available to cover the difference between the desired level of LTC and that covered by Medicare. The welfare benefits of these two scenarios relative to the current system (our benchmark) are evaluated.

This paper builds on the previous literature that explores how individuals insure against this risk and how current partial LTC insurance systems affect their choices. We advance the current literature by modeling two key features in a consumption/savings life-cycle model. First, we model family dynamics to capture informal care that can be provided by a healthy spouse. The risk of a spouse needing LTC and the risk of death of a spouse interact closely with an individual’s own LTC risk. A spouse with LTC needs is likely to quickly run down joint financial resources. However, the presence of a spouse in old age is not only a source of risk but also a source of insurance against an individual’s own LTC needs. The provision of informal care by healthy spouses greatly decreases average expenditures on formal LTC (Lakdawalla and Philipson (2002)).

Second, we allow for endogenous LTC expenditures, recognizing the fact that there is a wide range of quality types of LTC that are associated with different levels of utility for individuals. Our model features an LTC state dependent utility function as in much of the previous literature (Lillard and Weiss (1997), De Nardi et al. (2010), De Nardi et al. (2016), Ameriks et al. (2017)). Ameriks et al. (2017) show that savings behavior is strongly influenced by people’s preferences over LTC expenditures since the marginal utility from LTC expenditures is high.

The novel aspect of our paper is to study policy related to LTC in a model where these two features, family dynamics and endogenous LTC expenditures, interact. Couples where only one member needs LTC need to decide how to allocate resources between formal LTC and savings for the consumption and possible future LTC needs of the remaining healthy spouse. In addition, a couple with only one member needing LTC will require less formal care relative to a single individual given the informal care that can be provided by the healthy spouse. Hence, marital status is an important determinant of the risk associated with LTC faced by a given household, so taking this into account is important when considering any kind of policy reform affecting LTC. The model we study is a life-

\footnote{Brown and Finkelstein (2011) reports that estimates of the implicit value of informal care range from about 60 percent of market spending (formal care) to over 100 percent.}
cycle model of consumption/saving with heterogeneous households. While our focus is on retirees, we model the working part of the life-cycle in order to capture the precautionary savings motive for LTC at all ages, and analyze how asset accumulation throughout the working life-cycle changes in response to different LTC insurance schemes.

Households enter the economy at age 35 either single (male or female) or married and with a particular level of education and initial wealth. Single households do not marry and married households do not divorce. A married household becomes a single household upon the death of one member. Households face earnings risk, and each household member faces health and survival risk. All households, both single and married, supply labor inelastically to the labor market until the household head, assumed to be the male for married couples, retires at the exogenous age of 65.

All individuals face health risk throughout their lives, but after the age of 65, they also face disability risk, where disability can be mild or severe. Those with severe disabilities are classified as needing LTC. Preferences are standard over consumption for households where no member needs LTC. However, individuals in need of LTC have preferences over LTC rather than regular consumption. LTC expenditures are endogenous. An important feature is that individuals needing LTC can benefit from the presence of a healthy spouse who is assumed to be available to provide care and support, lowering the need for formal LTC to provide a given quality of care. We also model the Medicaid system and include social insurance in the form of a consumption floor.

We calibrate the model to the U.S. economy using data from the Medical Expenditures Panel Survey (MEPS) and the Health and Retirement Study (HRS).

To be continued....

2. Related Literature

Our paper relates to the macroeconomic literature on old-age out-of-pocket medical expense risk and savings decisions. OOP expense risk is found to be an important motive for precautionary saving among elderly Americans: together with heterogeneity in life expectancy and bequest motives, it explains to a large extent the slow dis-saving of wealthy elderly retirees (De Nardi et al. (2010), Kopecky and Koreshkova (2014), Ameriks et al. (2017)). Public-care aversion is a key driver (e.g., Ameriks et al. (2011), Ameriks et al. (2017)). On the other hand, the presence of means-tested Medicaid implies that OOP and longevity risk contribute to the low asset holdings of the poor (Hubbard et al. (1994b), Palumbo (1999), De Nardi et al. (2010)). With respect to LTC specifically, Kopecky and Koreshkova (2014) find that savings against nursing home (NH) expenditure risk account for a large share of aggregate wealth and Ameriks et al. (2017) find that the precautionary motive associated with LTC is relatively more important than the bequest motive as a driver of late-in-life saving behavior.

Hubbard et al. (1994a) and Palumbo (1999) find smaller effects, but as noted in De Nardi et al. (2016), this is likely because the data sets available at that time missed late-in-life medical spending and had poor measures of nursing home costs.
This previous literature is primarily focused on single individuals, and only a few papers account for family structure. Marital status is clearly important for life-cycle savings since it determines consumption needs and the size of the precautionary saving motive. Precautionary savings are affected by the risk of shocks to the spouse (disability or death) and by the degree of risk sharing (insurance and informal LTC) within the family. Lillard and Weiss (1997) study the effects of spousal poor health and spousal death for retirees. They document that the healthy partner makes large transfers to the sick partner because poor health raises the marginal utility from consumption. They also find that married couples save more than singles partly because of the households’ concern about the surviving spouse. Braun et al. (2016) also model married households and document the importance of spousal shocks to transitions into poverty.

In terms of intra-family insurance against LTC risk, Barczyk and Kredler (2016) document that almost two-thirds of all hours of care are provided informally, particularly by retired spouses and working-age children. Informal care provided by spouses is relatively more important than that provided by children: among disabled HRS respondents, those who are married receive 65% of their total hours of care from an old person (usually their spouse) (Barczyk and Kredler (2016)). Yet the small literature in this area has focused on care provided by children. Ko (2016) find that the LTCI market is small partly because the availability of informal care by children limits the size of the market by creating substantial adverse selection. Barczyk and Kredler (2016) study the effects of policy changes, including changes to Medicaid, and show that these depend greatly on the response of informal care provided by children. We contribute to this literature by modeling spousal informal LTC in a detailed way, taking into account that the health and relative age of the non-disabled spouse determine the expected amount of informal care they can provide.

In addition, we build on the literature modeling state-dependent utility and endogenous LTC expenditures (Lillard and Weiss (1997), De Nardi et al. (2010), De Nardi et al. (2016), Ameriks et al. (2017)). With the exception of Lillard and Weiss (1997), all literature has been based on singles. We add to this by studying how couples allocate resources between the healthy and disabled spouse in the presence of informal care.

Finally, our paper relates to the large literature studying the reasons for the small size of the private LTCI market, specifically the literature studying the crowd out of LTCI by means-tested government programs (Pauly (1990), Brown and Finkelstein (2008), Brown and Finkelstein (2009), Braun et al. (2016)). This arises due to the “implicit tax” that Medicaid imposes on the purchase of private policies. Brown and Finkelstein (2008) show

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3 Barczyk and Kredler (2016) model the informal care provided by spouses only in a very simple way: they only model informal care provided by wives, assuming that an exogenous fraction of disabled husbands receive informal care from the wife, but they assume that the husband dies once the wife becomes disabled or dies. In contrast, we model informal care by both husband and wife, and allow for men to be widowers too.

4 Lakdawalla and Philipson (2002) show that spousal provision of LTC leads to the interesting result that population aging (specifically, the increase in the healthy life-expectancy of males) may decrease the per capita demand for formal LTC if the supply of informal care given by spouses increases enough.
that even if comprehensive private LTCI were available at actuarially fair prices, nearly two-thirds of the wealth distribution would still not wish to purchase insurance due to the presence of Medicaid. Thus, fundamental Medicaid reform is necessary for the private insurance market to expand considerably. In addition, this result is robust to introducing state-dependent utility. However, previous literature has not studied the demand of private LTCI by married couples.\(^5\) As argued in Brown and Finkelstein (2008), having a spouse could increase the value that the household places on protecting assets while in care, thus potentially making private insurance more valuable. In addition, Medicaid allows a community-based spouse to retain more assets and income when one member of the couple enters a nursing home than an institutionalized individual is allowed on his own, which could increase the crowd-out effect of Medicaid. Finally the ability to engage in risk-sharing within couples serves as a partial substitute for formal insurance markets, which also reduces the value of private insurance. We contribute to this literature by conducting experiments to evaluate the viability of a larger LTCI market in the presence of a universal government provided LTCI covering a minimum of LTC expenditures, and we do this for both single and married households.

3. Model

3.1. Demographics Summary

The economy is populated by overlapping generations of households that live for a maximum of \(J\) periods where a model period is two years. Households consist of either a single individual of a particular sex \((g \in \{m, f\})\) or a married couple of mixed genders. We assume there is no marriage or divorce. However, households of all ages can transition from married to single as a result of the death of a spouse. We denote marital status by \(ms \in \{s, m\}\). Parameters and variables have subscripts \(s\) or \(m\) when they depend on marital status.

The first period of life for a household is age 35, which is denoted by \(j = 1\). A household retires exogenously at age 65 \((j = J_r = 16)\) and lives for a maximum of 109 years \((J = 38)\). Individuals within households face mortality risk each period.

Single households are described by a state vector \(\Phi_s = \{j, g, e, h, x^I, z, a\}\), which consists of age, gender, education status, health status, informal long term care, productivity and financial assets. The fraction of households that enter the model as singles is equal to \(\gamma\). Hence, the fraction of households of age \(j = 1\) that are married is \(1 - \gamma\).

Married couples consist of a husband and wife and are described by a state vector \(\Phi_m = \{j, j^*, e, h, h^*, x^I, x^{I^*}, z, a\}\), where \(j^*, h^*\) and \(x^{I^*}\) are the wife’s age, health status and informal care received. We assume that married households share the same education status, productivity level and asset level. Given a husband’s age \(j\), a wife can be of age

\(^5\)Brown and Finkelstein (2004) is an exception. They note in the appendix that allowing for within household financial risk sharing lowers the willingness to pay for private insurance. Their results also indicate that the implicit tax imposed by Medicaid is slightly smaller but still quite high in the joint decision model with married households.
\( j^* \in \{j - 5, j - 2, j + 1\} \)

This enables us to capture heterogeneity in age differences between husband and wife across married couples.

The initial distribution of households at age \( j = 1 \) is given by
\[
\gamma \Gamma_s(\Phi_s = (j = 1, g, e, h, x^t, z, a)) \quad \text{and} \quad (1 - \gamma) \Gamma_m(\Phi_m = (j = 1, j^*, e, h, h^*, x^t, x^{t'}, z, a)).
\]

### 3.2. Education

Households are endowed with education status at age \( j = 1 \) which does not change over the household’s life. In particular, households are either college educated (16 years of education or more) or have less than 16 years of education. That is, \( e \in \{e_l, e_h\} \).

### 3.3. Health

The health of each individual (either single or member of a married couple) is one of four possible states: good, bad, low disability and high disability
\( h \in \{h_g, h_b, ADL_l, ADL_h\} \).

We assume that disability states become possible at the age of 65, and no disability exists at younger ages. Good and bad health states \( h_g \) and \( h_b \) are assumed to be free of disability. \( ADL_l \) represents a state of mild disability where the individual needs help with only one or two activities of daily living (ADLs). \( ADL_h \) is a state of severe disability where an individual needs help with 3 or more ADLs. Only individuals in high disability states require LTC, so the \( ADL_h \) state is equivalent to an LTC state. The six ADLs considered are bathing, eating, dressing, walking across a room, getting in or out of bed, and using the toilet.

Health status evolves according to a Markov process that depends on marital status, sex, health, age, and education. The health transition probability matrices are given by
\[
H_s(h', h, j, g, e) \quad \text{for singles,} \quad H_m(h', h, j, e) \quad \text{for husbands, and} \quad H_m^*(h^*, h^*, j^*, e) \quad \text{for wives.}
\]

### 3.4. Survival

Survival probabilities depend on marital status, age, sex, education, and health. They are given by
\[
\rho_s(j, g, e, h) \quad \text{for single individuals,} \quad \rho_m(j, e, h) \quad \text{for married males, and} \quad \rho_m^*(j^*, e, h^*) \quad \text{for married females. If a married woman survives until her spouse reaches} \ J, \ \text{an extremely unlikely event, we assume that both members of the household die together.}
\]

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\(^6\)We discretize the possible age differences between spouses into these three groups based on our analysis of the age difference distribution observed in the HRS among married couples. We divide the distribution into 3 groups: the first group contains wives who are 8 or more years younger than the husbands; the second group contains wives who are between 1 and 7 years younger; and the third group contains wives who are the same age or older than their husbands. The first and the third groups each contains approximately 20% of couples, while the second group contains approximately 60% of couples when the husband is 65. On average, the wives’ ages relative to the husbands in these three groups are approximately: (1) 10 years younger; (2) 4 years younger; and (3) 2 years older. Details on this analysis are provided in the Appendix.

\(^7\)The health of the wife in a married couple is denoted by \( h^* \in \{h_g, h_b, ADL_l, ADL_h\} \).
3.5. Productivity

All single individuals younger than 65 and all couples where the husband is younger than 65 are assumed to participate in the labor force. Labor productivity (relative earnings) $z$ is measured at the household level. We assume that $z$ takes one of five possible values $z \in \{z_1, ..., z_5\}$. For singles, labor productivity depends on age, sex, education and health. Given an initial value for $z$ at age 35, productivity evolves according to the probability transition matrix $P_s(z', z, j, g, e, h)$.

For married couples, earnings evolve according to the probability transition matrix $P_m(z', z, j, e, h)$ that depends only on the age, education and health of the husband. We assume that when the husband reaches the age of 65, the married couple retires even if the wife is younger.

If a spouse dies and the surviving spouse is younger than 65 ($J_r = 16$), the survivor will participate in the labor force until they turn 65, just as any single individual. In the first period in which a spouse becomes single (a widow or widower), they draw a productivity level from the distribution $\Pi(j, g, e, h)$.

3.6. Medical Expenditures

We treat medical expenditures differently depending if $h \in \{h_g, h_b, ADL_l\}$ or if $h = ADL_h$. In the latter case, total consumption is denoted by $x$, which represents LTC expenditures. This is chosen by households to maximize expected lifetime utility. Note that we do not separate LTC consumption into a medical and non-medical component.

If $h \in \{h_g, h_b, ADL_l\}$, we model out of pocket (OOP) medical expenditures as exogenous wealth shocks. In working households, each individual’s OOP medical expenditures are given by $MEW(j, g, e, h, z)$, and in retired households, they are given by $MER(j, g, e, h)$, where these are set to zero when $h = ADL_h$. In general, they depend on the individual’s age, sex, and health and on the household’s education. For working households, they also depend on productivity level. Higher productivity is positively correlated with the provision of employer health insurance, implying lower OOP expenditures given everything else. A married couple’s medical expenditures are the sum of the two individual’s expenditures. To summarize, household medical expenditures are given by:

$$ME = \begin{cases} MEW(j, g, e, h, z) & \text{if } ms = s, j < 65 \\ MER(j, g, e, h) & \text{if } ms = s, j \geq 65 \\ MEW(j, g = m, e, h, z) + MEW(j^*, g = f, e, h^*, z) & \text{if } ms = m, j < 65 \\ MER(j, g = m, e, h) + MER(j^*, g = f, e, h^*) & \text{if } ms = m, j \geq 65 \end{cases}$$

(1)

3.7. Long Term Care Expenditures and Informal Care

Highly disabled individuals consume only long term care goods and services denoted by $x$. Total LTC consumed equals the sum of formal and informal care, denoted by $x^F$ and $x^I$, respectively ($x = x^F + x^I$).

Informal care is discretized into three possible levels, zero, low or high care levels, so $x^I \in \{0, x^I, Low, x^I, High\}$. Individuals who just enter a high disability state draw an initial
Preferences are health-dependent. When not highly disabled, individuals derive utility from regular consumption goods. For singles, this distribution depends only on sex and education, while for married individuals, it also depends on the relative age of the spouse and the spouse’s health. For singles who stay highly disabled in consecutive periods, informal care evolves according to a Markov process that depends on gender, given by $\Delta_s(x^F, x^I, g)$. Married individuals make a new draw of informal care $x^I$ from the probability distribution $\Omega_m(x^I, g, e, h^*, j^*)$ in each subsequent period in which they are highly disabled. In the case where both spouses are highly disabled, we impose that each spouse receives the same level of informal care as the other, so in this case we set $x^I = x^I^* = \min\{x^I, x^I^*\}$.

Expenditures on formal LTC are endogenous, but we assume there is a minimum level of LTC that must be received in order to survive to the next period, denoted by $x_{med}$. If the household cannot afford a level of $x^F$ that satisfies this condition, social insurance is provided to ensure all individuals in an LTC state receive $x_{med}$. Social insurance is described in detail in Section 3.9.

### 3.8. Preferences

Preferences are health-dependent. When not highly disabled, individuals derive utility from regular consumption goods $c$. When highly disabled, they consume only long term care goods and services denoted by $x$, and these are valued differently than $c$.

Preferences for singles are given by:

$$
U_s(c, x^F) = \begin{cases} 
\theta^* c & \text{if } h \neq ADL_h \\
\frac{\theta^* x^F + x^I + \kappa}{1-\sigma} & \text{if } h = ADL_h 
\end{cases}
$$

As noted in Ameriks et al. (2017), the two key parameters are $\theta_x$ and $\kappa$. A higher $\theta_x$ increases the marginal utility of a unit of LTC, while a higher $\kappa$ indicates that LTC is valued as more of a luxury good. A negative $\kappa$ can be interpreted as the expenditure being a necessity.

Based on this, we specify a married couple’s preferences in a similar way:

$$
U_m(c, x^F) = \begin{cases} 
\frac{2\theta^* c (1-\sigma)}{1-\sigma} + \theta_x (x^F + x^I + \kappa)^{(1-\sigma)} & \text{if } h \neq ADL_h \text{ and } h^* \neq ADL_h \\
\frac{\theta^* x^F + x^I + \kappa}{1-\sigma} & \text{if } h = ADL_h \text{ and } h^* \neq ADL_h \\
\frac{\theta^* c (1-\sigma)}{1-\sigma} + \theta_x (x^F + x^I + \kappa)^{(1-\sigma)} & \text{if } h \neq ADL_h \text{ and } h^* = ADL_h \\
2\theta_x (x^F + x^I + \kappa)^{(1-\sigma)} & \text{if } h = ADL_h \text{ and } h^* = ADL_h .
\end{cases}
$$

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8In principle, we could also have a Markov process for informal care for married individuals who stay highly disabled. However, this process would have to depend on many states, including the spouses’ relative ages and the spouse’s past and present health. Unfortunately the data does not allow us to estimate such a detailed process as relatively few individuals are observed staying highly disabled over multiple periods. For this reason, it is preferred that they draw a new $x^I$ from a stationary distribution that is conditional on all the relevant states.

9Note that informal LTC can be interpreted as a shifter in $\kappa$, thus affecting the extent to which formal LTC is a luxury or necessity.
Household utility is obtained by adding up the utilities of the two members. If neither member is highly disabled, we assume that they each consume equal amounts equal to $c$. If both members are highly disabled, each member consumes $x^F + x^I$, where $x^I = x^I^*$. When one member is highly disabled and the other is not, the couple allocates consumption $c$ to the non-LTC spouse and $x^F$ to the LTC spouse. These do not have to equal in this case.

When a household (either a single individual or both members of a married couple) dies, any remaining wealth is left as a bequest $b = [1 + r(1 - \tau_a)]a$, which the household values according to a warm glow utility function as in De Nardi (2004). The utility from bequests is given by:

$$v(b) = \theta_b \frac{(b + \kappa^b)^{(1-\sigma)}}{1-\sigma}.$$  

(4)

3.9. Social Security and Social Insurance

All individuals 65 and over receive social security payments $SS(e)$ that depend on education. Married couples of a particular education type receive benefits equal to twice the single’s benefit.\(^{10}\)

The government also runs a social assistance program which guarantees a minimum level of consumption $\underline{c}$ to every individual who is not highly disabled. For singles who are not in a high disability state ($h \neq ADL_h$), when disposable income (net of required medical expenditures) falls below $\underline{c}$, a government transfer $Tr$ is given to compensate for the difference. Similarly, married couples where neither member is in a high disability state receive a transfer $Tr$ that allows both individuals to consume $\underline{c}$.

In addition, the Medicaid LTC program guarantees a minimum level of long-term care ($x_{med}$) to highly disabled individuals such that $x^F + x^I \geq x_{med}$. In the case of single individuals and married households where both members are highly disabled, if the household’s financial resources do not allow it to afford $x^F$ such that $x^F + x^I \geq x_{med}$, the government provides a transfer $Tr$ (Medicaid LTC) to ensure $x_{med}$ is attainable.

For a married couple where only one member is highly disabled, there are special rules that allow the disabled spouse to qualify for Medicaid LTC while the non-disabled spouse is allowed to keep joint income and assets up to a certain threshold.\(^{11}\) In the case when any left over resources for the non-disabled spouse are not enough to pay for the minimum consumption $\underline{c}$, the government also gives a transfer that makes $\underline{c}$ affordable. This is described in detail in the context of the married couple’s problem in Section 3.12.

3.10. Government

Government revenue consists of revenue from a labor income tax $\tau_l$ and a tax on asset income $\tau_a$. This revenue is used to finance social insurance (Medicaid LTC and the mini-

\(^{10}\)Using the HRS, we find that a couple’s social security benefits are approximately twice the single’s benefits (see Appendix).

\(^{11}\)These rules are commonly known as the spousal impoverishment rules. An overview is available at http://longtermcare.gov/medicare-medicaid-more/medicaid/medicaid-eligibility/considerations-for-married-people/.
mum consumption guarantee), the social security program, and government consumption $G$. Given the parameter values and tax rates associated with our benchmark economy, government consumption is determined as a residual. This value is held constant across policy experiments and the labor tax ($\tau_l$) is adjusted so that the government budget constraint is satisfied:

$$
G = \sum_{\Phi_s} \left[ \tau_l (wz + SS(\Phi_s)) + \tau_a ra - SS(\Phi_s) - Tr(\Phi_s) \right]
+ \sum_{\Phi_m} \left[ \tau_l (wz + 2SS(\Phi_m)) + \tau_a ra - 2SS(\Phi_m) - Tr(\Phi_m) \right]
$$

(5)

3.11. Single Individual’s Problem

At the beginning of each period, the state of a household consisting of a single individual is given by age, sex, education, health, informal care received when highly disabled, productivity (when younger than 65), and assets. It is summarized by $\Phi_s = \{j, g, e, h, x^I, z, a\}$. Given $\Phi_s$, each individual maximizes the expected discounted lifetime utility by making a consumption/saving decision. When not highly disabled, the individual chooses expenditures on regular consumption $c$ and when the individual is highly disabled, he/she chooses expenditures on formal long term care $x^F$. Borrowing and negative bequests are not allowed.

A single individual solves:

$$
V_s(\Phi_s) = \max_{c, x^F} \{ U_s(c, x^F) + \rho_s(j, g, e, h) \beta EV_s(\Phi_s') 
+ (1 - \rho_s(j, g, e, h)) \beta v(b) \}
$$

subject to

$$
y = \begin{cases} 
wz(1 - \tau_l) + [1 + r(1 - \tau_a)]a & \text{if } j < 65 \\
SS(e)(1 - \tau_I) + [1 + r(1 - \tau_a)]a & \text{if } j \geq 65 
\end{cases}
$$

(7)

$$
Tr = \begin{cases} 
\max\{0, c - y + ME\} & \text{if } h \neq ADL_h \\
\max\{0, x_{med} - x^I - y\} & \text{if } h = ADL_h
\end{cases}
$$

(8)

$$
y + Tr = \begin{cases} 
c + ME + a' & \text{if } h \neq ADL_h \\
x^F + a' & \text{if } h = ADL_h
\end{cases}
$$

(9)

$$
b = [1 + r(1 - \tau_a)]a
$$

(10)

$$
x^F \geq x_{med} - x^I
$$

(11)

$$
a' \geq 0
$$

(12)
In the first period, individuals start with asset levels drawn from an initial distribution of assets at the age of 35 that depends on marital status, gender (for singles) and education, $\Lambda^A(ms,g,e)$. In every period before the age of 65, available financial resources equal the sum of after taxes labor and asset income, assets, government transfers when applicable, minus required medical expenditures. These are allocated optimally between period consumption and savings for the next period. Starting with age 65, the individual retires and earns social security and asset income. High disability states become possible at these ages. When in an LTC state, the individual draws a level of informal care $x^I$ and optimizes between formal LTC ($x^F$) and next period assets. If the individual’s available financial resources do not allow $x_{med}$ to be attainable, the individual qualifies for Medicaid LTC and receives a government transfer $Tr$ equal to what is needed to just afford $x^F = x_{med} - x^I$. At all ages, when the individual is not in an LTC state and cannot afford the consumption floor, the government provides a transfer $Tr$ that allows for this minimum consumption.

3.12. Married Household’s Problem

A married couple’s state is given by the ages of the two members, education of the husband, the health states of each member, productivity (when the husband is younger than 65), and assets. It is summarized by $\Phi_m = \{j, j^*, e, h, h^*, x^I, x^F, z, a\}$. A married household solves:

$$V_m(\Phi_m) = \max_{c,x^F} \{U_m(c, x^F)$$
$$+(1 - \rho_m)\rho_m^*\beta EV_s(j^* + 1, g = f, e, h^*, z', a')$$
$$+\rho_m(1 - \rho_m^*)\beta EV_s(j + 1, g = m, e, h', z', a')$$
$$+\rho_m\rho_m^*\beta EV_m(\Phi'_m)$$
$$+(1 - \rho_m)(1 - \rho_m^*)\beta v(b)\} \quad (13)$$

subject to

$$y = \begin{cases} wz(1 - \tau_l) + [1 + r(1 - \tau_a)]a & \text{if } j < 65 \\ 2SS(e)(1 - \tau_l) + [1 + r(1 - \tau_a)]a & \text{if } j \geq 65 \end{cases} \quad (14)$$

$$y + Tr = \begin{cases} c(1 + \lambda) + ME + a' & \text{if } h \neq ADL_h \text{ and } h^* \neq ADL_h \\ c + x^F + ME + a' & \text{if } [h = ADL_h \text{ and } h^* \neq ADL_h] \text{ or } [h \neq ADL_h \text{ and } h^* = ADL_h] \\ 2x^F + a' & \text{if } h = ADL_h \text{ and } h^* = ADL_h \end{cases} \quad (15)$$

$$Tr = \begin{cases} \max\{0, c(1 + \lambda) - y + ME\} & \text{if } h \neq ADL_h \text{ and } h^* \neq ADL_h \\ \max\{T1, T2\} & \text{if } [h = ADL_h \text{ and } h^* \neq ADL_h] \text{ or } [h \neq ADL_h \text{ and } h^* = ADL_h] \\ \max\{0, 2(x_{med} - x^I) - y\} & \text{if } h = ADL_h \text{ and } h^* = ADL_h \end{cases} \quad (16)$$
where

\[
T_1 = \begin{cases} 
\max\{0, c + x_{med} - x'^I - y + ME\} & \text{if } h = ADL_h \text{ and } h^\ast \neq ADL_h \\
\max\{0, x_{med} - x'^I - y + ME\} & \text{if } h \neq ADL_h \text{ and } h^\ast = ADL_h 
\end{cases}
\] (17)

\[
T_2 = \begin{cases} 
\max\{0, x_{med} - x'^I - y \} & \text{if } h = ADL_h \text{ and } h^\ast \neq ADL_h \\
\max\{0, x_{med} - x'^I - y \} & \text{if } h \neq ADL_h \text{ and } h^\ast = ADL_h 
\end{cases}
\] (18)

\[
b = [1 + r(1 - \tau_a)]a \] (19)

\[
x^F \geq x_{med} - x'^I \text{ and } x^F \geq x_{med} - x'^I \] (20)

\[
a' \geq 0 \] (21)

As for singles, initial assets are drawn from the distribution \(\Lambda_A(ms, g, e)\). The household receives labor income when the husband is younger than 65. When he is older than 65, both household members are assumed retired, and both earn social security income \(SS(e)\). In households where neither member is highly disabled, the husband and the wife benefit from jointly consuming \(c\). Therefore, the expenditures required for each member to enjoy a given level of \(c\) are \(c(1 + \lambda)\), where we assume \(1 + \lambda < 2\). The parameter \(\lambda\) controls the degree of joint consumption.

When one spouse is highly disabled and the other is not, the household decides how to allocate resources optimally between \(c\) for the non-LTC spouse and \(x^F\) for the LTC spouse. When both members are disabled, they each consume formal long term care equal to \(x^F\).

When the household’s financial resources fall below the threshold where they can afford the minimum consumption floor \(c\) or the minimum LTC \(x_{med}\), the government provides a transfer \(Tr\) that makes these minimum consumption levels attainable. In the case where only one spouse is in an LTC state, the household qualifies for a transfer if (1) it cannot afford to consume the minimum consumption plus LTC floor (equation 17), or (2) it cannot afford the minimum LTC required with half of the financial resources (equation 18).

3.13. Effects of LTC Risk

Consistent with the optimal behavior described in Ameriks et al. (2017), high income individuals have an incentive to self-insure against LTC risk since they can save enough to afford non-Medicaid LTC when needed, and leave a bequest. On the other hand, low income individuals would not find it optimal to save for LTC expenditures because even if they saved high fractions of their incomes and consumed very little, their savings would quickly run out in the advent of LTC needs, forcing them to rely on the Medicaid LTC and leave no bequest. In the middle, there exists a threshold of income above which it is optimal to save and accumulate wealth for LTC needs and bequests, conditional on all
other state variables. Below this threshold, individuals would find it optimal to consume more and not build up precautionary savings against LTC risk due to the means-tested Medicaid LTC program.

An interesting question is how this threshold is affected by marital status.

4. Parameterization, Estimation and Calibration

Following the standard approach, some parameters are set to values common in the literature, others are estimates directly from the data, and others are calibrated within the model. The parameters taken as given are listed in Table 1. Many other parameters are external to the model and are estimated using HRS, MEPS or PSID data. These include health status transitions, informal care probabilities, survival probabilities, productivity transitions, and medical expenditures. Other parameters are internal and are calibrated so the model matches a set of aggregate and distributional moments on demographics, LTC spending, government transfers and Medicaid recipiency. These parameters are listed in Table 2. All dollar values are CPI adjusted to 2010. The Appendix provides detailed information on all statistics obtained from the data.

4.1. Data

The main data set used in our analysis is the Health and Retirement Study (HRS). The HRS is a nationally representative panel survey of older individuals and their spouses that started in 1992 and is ongoing.\(^\text{12}\) The survey is conducted every two years, and currently twelve waves of data are available. It contains information on more than 37,000 individuals over age 50 in 23,000 households. Detailed information is collected on demographics, income, assets, health insurance, health, ADLs, and health care expenditures. In married households, both spouses receive all individual-level questions, making the HRS an ideal data set for studying health, LTC needs, and medical expenditures in households overtime. In our analysis, we use data from waves 3 to 12, covering years 1996 to 2014 since many variables are coded differently in the first two waves.\(^\text{13,14}\)

To estimate statistics at younger ages, we use data from the Medical Expenditure Panel Survey (MEPS) and the Panel Study of Income Dynamics (PSID). We use the MEPS to estimate the health status transition probabilities and the medical expenditures of non-retirees, and the PSID to estimate labor productivity transitions.

\(^{12}\) The RAND Center for the Study of Aging created a user-friendly version of a subset of the HRS. We use the RAND HRS Data File (v.P) which contains 12 waves of data.

\(^{13}\) We use all six cohorts of the HRS: Initial HRS, AHEAD, Children of Depression (CODA), War Baby, Early Baby Boomer and Mid Baby Boomer cohorts.

\(^{14}\) We are careful to use data from 2012-2014 only for variables that are not expected to be significantly impacted by the ACA.
4.2. Parameters Estimated from the Data

Health status and health transitions

In the data, health status is constructed using a combination of self-reported health and answers to questions on whether the respondent receives help with ADLs. We use the MEPS to estimate health status transitions at ages 35-63 when health is either Good or Bad. In the MEPS, we categorize respondents’ health based on the self-reported health measure as follows: excellent, very good and good responses are categorized as Good, and fair and poor responses are categorized as Bad. To estimate biennial health status transition probabilities, we use data from Rounds 1 and 5 which are approximately just under 2 years apart. A logit regression model is used that includes age, age squared, and marital status, estimated separately for each sex-education group.

We use the HRS to estimate health transitions at ages 65-109 when disability states are possible. In the HRS, we also categorize health as Good or Bad based on the self-reported health measure. However, if a respondent reports getting help with ADLs, we reclassify him/her as disabled. Low disability states are characterized by 1-2 ADLs, and high disability states by 3-6 ADLs. To estimate health transitions, we estimate probit models that include a cubic in age, marital status, sex, education and marital status. For transitions from ADL states, the regressions exclude education and marital status due to the small number of observations.

Informal Care Probabilities

The HRS Core files contain information on who helps most with each of the 6 ADLs. Individuals specify whether the helper is a family member (and their specific relationship) or an employee of an institution, organization, paid helper, professional or other individual. We classify highly disabled individuals as receiving informal care if they report receiving help with any of the ADLs from a family member. All nursing home residents are recoded as not receiving any informal care. We then estimate the probabilities of having any informal care (low or high levels) conditional on the model state variables (e.g., marital status, education, sex, the age of the wife relative to the husband, health of the spouse, etc.). We also estimate informal care transition probabilities for singles who are highly disabled in consecutive periods.

As expected, we find that the probability of having informal care is higher for married individuals than for singles, for husbands with younger wives than for those with older wives, for the non-college educated than the college graduates, and for married individuals whose spouses are in better health states.\[^{15}\]

Finally, we infer the probabilities of low and high levels of care \( x^{I,Low} \) and \( x^{I,High} \) among those who receive any informal care by using information on Medicaid recipiency. We restrict the sample to highly disabled individuals with low financial wealth (under

\[^{15}\]The non-college educated have more children to provide care, and their children are also more likely to be non-college educated and thus have lower opportunity costs of providing care since they have lower wages (Barczyk and Kredler (2016)).
who receive informal care, and calculate the fractions receiving Medicaid benefits conditional on marital status and the spouse’s health. We assume that those who receive Medicaid have low levels of care, while those not on Medicaid have high levels of informal care. We note that the Medicaid recipiency rate is the lowest (24%) among those married to spouses in good health and is increasing with worse spousal health. It is highest among singles (55%). All estimated informal care probabilities and additional details are provided in the Online Appendix.

Survival probabilities

The HRS contains information on the exact date of death of each respondent who dies during the survey period. We use the HRS to estimate biennial survival probabilities for ages 55 to 109, using logit regressions. We then use linear interpolation to obtain survival for ages 35 to 53, assuming that the survival probability is 1 at the age of 35.

Productivity Transitions

Productivity groups and productivity transitions are estimated using PSID data from years 1984 to 1993. We conduct the analysis using households where the head is between 35 and 64 years of age and has a valid education and health status. We divide households into quintiles based on their labor earnings (measured over two consecutive years). The average earnings in these quintiles give the productivity levels $z_1 - z_5$ in the model (see Appendix). We then estimate biennial transition probabilities between these quintiles using ordered probit models.

As predicted, we find that the probabilities of staying in low productivity states ($z_1$) are highest for single women, for the non-college, and for those in bad health. The probabilities of moving from low to high productivity states are highest for married couples and single men, college educated, and those in good health. Selected transition probabilities are plotted in the Appendix.

Medical Expenditures

We estimate out-of-pocket (OOP) medical expenditures using the MEPS for non-retired households, and using the HRS for retired households. We use the predicted values from OLS regressions of OOP expenditures (measured over 2 years) on the individual’s age, sex, health, household education, and household productivity (earnings) for non-retired households.

\[ \text{Without the presence of informal care, the model would generate Medicaid recipiency rates of 100\% among highly disabled individuals with such low wealth levels, as opposed to the much lower rates observed in the data. Restricting the data to only low wealth individuals who have informal care, we still observe large fractions not on Medicaid in the data. The high and low informal care states help the model match these statistics. It is implicit that } x^{i,\text{Low}} < x_{med} \leq x^{i,\text{High}}. \]

\[ \text{Health status is constructed as in the MEPS, based on the self reported health measure.} \]
**Social Security**

Using HRS data, we find that the average annual social security benefits (per individual) are 11,136 in non-college households and 12,253 in college educated households.

**4.3. Calibration of remaining parameters**

**Demographic population structure at age 35**

Since our paper is focused on ages 65 and above, it is important to have the right demographic structure at these ages in terms of the fraction of single and married households, fractions of males and females among singles, and fractions by education type within these groups. In our model, we abstract from marriage and divorce, so it is non trivial to obtain the right demographic distribution at the age of 65. If we imputed the demographic structure observed in the data at the age of 35, we would obtain a very different demographic structure at older ages than in the data. Therefore, our strategy is to calibrate an initial demographic structure at the age of 35 such that, given the estimated health transitions and survival probabilities, we obtain a demographic structure at the age of 65 that matches the data. The details and results are provided in the Appendix.

**Remaining parameters: utility and social insurance**

The remaining parameters that need to be calibrated are listed in Table 2. The discount factor $\beta$ is calibrated to match the average growth in assets over the working life cycle. The parameter $\theta_x$ determines the marginal utility of a unit of LTC consumption versus regular consumption, so this is pinned down by targeting the ratio of average LTC consumption (for those highly disabled) to regular consumption (for all others) observed among single households without any informal care that are otherwise similar in demographics and wealth levels. (Consumption is inferred using the budget constraint, making use of the HRS which contains income information as well as changes in wealth observed in consecutive periods.)

The parameter $\kappa$ determines the extent to which LTC consumption is a luxury versus a necessity, so we target the average expenditures on LTC observed in the data (within demographic groups) by wealth quintiles, for those receiving no informal care.

The minimum consumption floor $c$ is calibrated to match the fraction on non-retirees receiving government transfers.

**5. Results**

TBA

**6. Conclusion**

TBA
### Table 1: Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda$</td>
<td>Parameter for married consumption</td>
<td>0.67</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>Power of consumption $(1 - \sigma)$</td>
<td>3</td>
</tr>
<tr>
<td>$\tau^e$</td>
<td>Taxes on labor and SS income</td>
<td>0.27</td>
</tr>
<tr>
<td>$\tau^a$</td>
<td>Taxes on asset income</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Notes: The value of the parameter $\lambda$ is taken from Attanasio et al. (2008).

### Table 2: Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Time discount factor</td>
<td>Assets growth</td>
</tr>
<tr>
<td>$\theta_x$</td>
<td>Weight of LTC</td>
<td>Avg $x^F/c$ for singles, by wealth</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>LTC parameter</td>
<td>Avg $x^F$ by wealth quintile</td>
</tr>
<tr>
<td>$x_{I,Low}$</td>
<td>Informal care</td>
<td>TBD</td>
</tr>
<tr>
<td>$x_{I,High}$</td>
<td>Informal care</td>
<td>TBD</td>
</tr>
<tr>
<td>$\theta_b$</td>
<td>Bequest parameter</td>
<td>Wealth dist of non-LTC HH</td>
</tr>
<tr>
<td>$k^b$</td>
<td>Bequest parameter</td>
<td>Wealth dist of non-LTC HH</td>
</tr>
<tr>
<td>Social Insurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\xi$</td>
<td>Consumption floor</td>
<td>% receiving gov. transfers, &lt;65</td>
</tr>
<tr>
<td>$x_{med}$</td>
<td>Medicaid LTC level</td>
<td>TBD</td>
</tr>
</tbody>
</table>
Table 3: Fraction of Individuals with LTC Needs Receiving Medicaid

<table>
<thead>
<tr>
<th>Sample</th>
<th>Single</th>
<th>Married</th>
<th>Married, by Spouse Health</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>Good</td>
</tr>
<tr>
<td>All</td>
<td>0.47</td>
<td>0.28</td>
<td>0.18</td>
</tr>
<tr>
<td>All, HH Wealth&lt;120,000</td>
<td>0.54</td>
<td>0.36</td>
<td>0.25</td>
</tr>
<tr>
<td>All, HH Wealth&lt;70,000</td>
<td>0.57</td>
<td>0.39</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Table 4: OOP Expenditures if Highly Disabled, (excludes Medicaid and Private LTC Insurance recipients)

<table>
<thead>
<tr>
<th>Wealth = 0-70,000</th>
<th>Wealth =70-150,000</th>
<th>Wealth = 150,000+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Singles Married</td>
<td>Age Singles Married</td>
<td>Age Singles Married</td>
</tr>
<tr>
<td>65-74 11.16 5.70</td>
<td>79.23 2.44</td>
<td>35.05 30.31</td>
</tr>
<tr>
<td>75-84 19.09 6.86</td>
<td>61.42 20.70</td>
<td>67.65 21.76</td>
</tr>
<tr>
<td>85+ 19.98 7.87</td>
<td>39.88 32.60</td>
<td>67.78 50.12</td>
</tr>
</tbody>
</table>

Notes: We exclude individuals receiving Medicaid or covered by private LTC insurance. We also exclude individuals with negative or missing wealth. All amounts are in thousand 2010 US dollars.

Table 5: Average OOP Expenditures if Highly Disabled

<table>
<thead>
<tr>
<th>Sample</th>
<th>Single</th>
<th>Married</th>
<th>Married, by Spouse Health</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>Good</td>
</tr>
<tr>
<td>All</td>
<td>28.79 (533)</td>
<td>14.91 (441)</td>
<td>14.41 (267)</td>
</tr>
<tr>
<td>HH Wealth=0-70,000</td>
<td>18.05 (401)</td>
<td>6.43 (266)</td>
<td>7.03 (144)</td>
</tr>
<tr>
<td>HH Wealth=70-150,000</td>
<td>50.40 (46)</td>
<td>17.03 (49)</td>
<td>16.42 (36)</td>
</tr>
<tr>
<td>HH Wealth=150,000+</td>
<td>65.45 (86)</td>
<td>31.97 (126)</td>
<td>25.80 (87)</td>
</tr>
</tbody>
</table>

Notes: We exclude individuals receiving Medicaid or covered by private LTC insurance. We also exclude individuals with negative or missing wealth. All amounts are in thousand 2010 US dollars.

Table 6: Percentage in Nursing Homes if Highly Disabled

<table>
<thead>
<tr>
<th>Sample</th>
<th>Single</th>
<th>Married</th>
<th>Married, by Spouse Health</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>Good</td>
</tr>
<tr>
<td>All</td>
<td>36.71 (1343)</td>
<td>11.74 (954)</td>
<td>10.67 (581)</td>
</tr>
<tr>
<td>HH Wealth=0-70,000</td>
<td>34.49 (951)</td>
<td>9.44 (540)</td>
<td>7.95 (302)</td>
</tr>
<tr>
<td>HH Wealth=70-150,000</td>
<td>39.68 (126)</td>
<td>11.63 (129)</td>
<td>10.84 (83)</td>
</tr>
<tr>
<td>HH Wealth=150,000+</td>
<td>43.23 (266)</td>
<td>16.14 (285)</td>
<td>14.80 (196)</td>
</tr>
</tbody>
</table>

Notes: We exclude individuals receiving Medicaid or covered by private LTC insurance. We also exclude individuals with negative or missing wealth, and those where the spouse’s health is missing.
Table 7: Average OOP, Highly Disabled, with Wealth>$100,000

<table>
<thead>
<tr>
<th>Sample</th>
<th>Single</th>
<th>Married</th>
<th>Married, by Spouse Health</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>Good</td>
<td>Bad/ADL</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>All</td>
<td>Good</td>
<td>Bad/ADL</td>
</tr>
<tr>
<td>% in Nursing Home (NH)</td>
<td>44.31</td>
<td>15.23</td>
<td>13.02</td>
<td>17.89</td>
</tr>
<tr>
<td>Avg OOP</td>
<td>59,030</td>
<td>30,123</td>
<td>26,395</td>
<td>36,882</td>
</tr>
<tr>
<td>Avg OOP if in NH</td>
<td>89,257</td>
<td>104,244</td>
<td>97,249</td>
<td>112,274</td>
</tr>
<tr>
<td>Avg OOP if not in NH</td>
<td>38,224</td>
<td>23,989</td>
<td>20,892</td>
<td>33,113</td>
</tr>
<tr>
<td></td>
<td>97,196</td>
<td>134,840</td>
<td>227,768</td>
<td></td>
</tr>
</tbody>
</table>

Notes: We exclude individuals receiving Medicaid or covered by private LTC insurance. We also exclude individuals with negative or missing wealth, those where the spouse’s health is missing, and those with zero reported medical expenditures.
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