Do Potential Future Health Shocks Keep Older Americans from Using Their Housing Equity?

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Abstract: Many retirees retain housing equity and do not utilize it to help finance spending on consumption. In this paper, I examine how older Americans (age 55+) may engage in precautionary savings where households would sell their house in the event they face an increase in out-of-pocket medical expenses due to a health shock. Using a counterfactual experiment, I find that older households are 13-percentage points less likely to own a home in their late retirement years when they know they will not have any out-of-pocket medical expenses. This indicates that many older households prefer not to own a home but choose to do so knowing they may get sick and thus are engaging in precautionary savings using their house. I conduct a policy experiment to examine how an insurance policy that would cover all out-of-pocket medical expenses would impact home ownership. I find that when an insurance policy of this nature is offered that costs four percent of income, the baseline economy has the same homeownership and moving rates as the counterfactual experiment where households do not have to pay for out-of-pocket medical expenses. This suggests that if seniors had more adequate health care coverage, they would be more willing to use the equity in their house to increase consumption in retirement.

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1. Introduction

With nearly 80 percent owning a home according to the US Census Bureau (2018), housing equity accounts for nearly half the net worth of retired Americans (Moulton et al. 2016). Households have housing equity that could be used to increase consumption in retirement, as is the case with other investments such as stocks and bonds. While households could extract equity from their home by taking out a reverse mortgage or moving, this typically is not the case. Previous research has shown that 57 to 75 percent of households 65 and older will live alone in their house after retirement with approximately 16 percent staying in that home until death (Borsch-Supan, Hajivassiliou, and Kotlikoff 1992). Households tend not to adjust their housing equity except in the event of a shock to the structure of the household such as divorce or the death of a spouse (Ai et al. 1990; Feinstein and McFadden 1989; Fisher et al. 2007; Poterba, Venti, and Wise 2011; Venti and Wise 2001, 2004, 1989, 1990). This contradicts the predictions of the Life-Cycle Hypothesis (LCH) which suggests that households save during their working years and draw down those savings in retirement (Modigliani and Brumberg 1954).

As homeowners age, it becomes more difficult to borrow money. Therefore, they may choose to engage in precautionary savings using their home and sell it to cover unexpected medical bills (Poterba, Venti, and Wise 2011; Nakajima and Telyukova 2013; Venti and Wise 2001; Stucki 2005; Fisher et al. 2007). In this paper, I explore how this option might preclude such homeowners from using the equity in their home to increase consumption in retirement. I construct a calibrated dynamic general equilibrium model to assess the impact of an increase in out-of-pocket medical expenses caused by potential health shocks in old age on the housing choices of older Americans in their late working and retirement years.

I model an economy that consists of overlapping generations of heterogeneous agents who must make decisions in each period: whether to rent or buy, what size house or apartment to inhabit, and how much to spend on consumption in each period. Agents can borrow (subject to a loan-to-value constraint) or save in each period. In the model, homeowners must pay property taxes and face transaction costs if they sell their homes. I show in Section 7 that this model produces similar homeownership rates to data found in the Health and Retirement Study.

I start by modeling an economy where agents in late retirement (age 72-77) have a chance of receiving a health shock where they incur out-of-pocket medical expenses that they are forced to pay for through either their income or accumulated assets, including the home. Next, I model an economy where agents know with certainty that they will not incur an increase in medical bills and compare the housing choices of the two groups. When agents are certain they are not at risk of an increase in medical bills, homeownership rates decrease by as much as 13-percentage points after reaching age 72. There is also an increase in the rates of moving and in changing from owning to renting. This indicates that households are using their home as a form of precautionary savings. This notion is reinforced in a sensitivity analysis showing that for higher rates of out-of-pocket medical expenses, rates of homeownership increase beyond what is seen in the benchmark model.

Medicare only covers 65 percent of retiree's medical bills (De Nardi et al. 2015). Because of this, many retirees have some sort of supplemental health insurance and long-term care insurance to help cover the additional costs that include coinsurance payments and premiums. However, even with supplemental insurance, many retirees still face high out-of-pocket medical expenses, particularly as the need for long-term care arises after age 70. A more thorough look at health insurance coverage for seniors and some of the costs they will encounter

can be found in Section 2. With the possibility of incurring large out-of-pocket medical bills, despite coverage from Medicare and supplemental insurance, it appears that households retain excess housing equity as a form of precautionary savings. This raises questions to the adequacy of the current health insurance structure for retirees. Considering this, I test the impact of an insurance policy that would cover *all* out-of-pocket medical expenses, particularly focusing on medical expenses incurred after age 71. This type of insurance frees up the equity in the house to help finance consumption in retirement and allows households to act more in accordance with the LCH. I find that if an insurance policy of this nature is offered, 12.8 percent of households would be willing to purchase this insurance policy if the cost was four percent of household income. With the inclusion of this policy along with a possible health shock, rates of homeownership and moving look like the economy where agents know with certainty that they will not incur an increase in medical bills. This suggests that if households do not have to worry about saving for potential out-of-pocket medical costs, they would be more willing to use the equity in their house to help finance consumption in retirement.

This paper contributes to two strands of literature. First, it supplements existing literature that addresses the question of why so many Americans do not use their housing equity toward consumption in retirement. Empirical studies, such as Borsch-Supan, Hajivassiliou, and Kotlikoff (1992); Feinstein and McFadden (1989); Fisher et al. (2007); Hurd (1992); Poterba, Venti, and Wise (2011); Venti and Wise (1989, 1990, 2001, 2004) and others, show that retirees are not using their housing equity in accordance with the LCH and explore possible causes such as precautionary savings, bequests, and high transaction costs. This paper uses an overlapping generations model of housing and consumption to explore how households may engage in precautionary savings using their house. This model complements the work of

Anagnostopoulos, Atesagaoglui, and Carceles-Poveda (2013); Davis and Heathcote (2005); Imrohoroglu, Matoba, and Tuzel (2018); Fisher and Gervais (2011); Li and Yao (2007); Cocco (2004) and others. While most of these investigations focus on the entire life cycle, this paper restricts its focus to Americans age 55 and older.

2. Health Insurance for Retirees

Medicare provides health insurance to adults age 65 and older in the United States and has several components[1]. Medicare Part A covers in-patient hospital visits, hospice care, and some health care. Most households do not pay a premium for Part A because they paid enough Medicare taxes while working, however, they are required to make coinsurance payments[2]. Medicare Part B covers doctors' visits, out-patient care, physical therapy, and some other health care costs not covered by Part A. There is a monthly premium for Part B that is based on adjusted-gross income and some services require a coinsurance payment once a deductible is met[3]. Medicare Part D covers prescription drugs and comes with a monthly premium paid in addition to the premium for Part B[4]. Medicare beneficiaries also have the option to enroll in a Medicare Advantage Plan, also called Medicare Part C. These are private health insurance plans, typically HMOs, that provide the same benefits covered by Part A and Part B[5]. 30 percent of Medicare beneficiaries were enrolled in Medicare Advantage plans in 2014 (Cubanski et al. 2015).

[1] Information on what Medicare covers and its various parts are available at: https://www.medicare.gov/what-medicare-covers.
[2] More information on costs for Medicare Part A is available at: https://www.medicare.gov/your-medicare-costs/part-a-costs
[3] More information on costs for Medicare Part B is available at: https://www.medicare.gov/your-medicare-costs/part-b-costs
[4] More information on costs for Medicare Part D is available at: https://www.medicare.gov/drug-coverage-part-d/costs-for-medicare-drug-coverage/monthly-premium-for-drug-plans
[5] More information on Medicare Part C is available at: https://www.medicare.gov/sign-up-change-plans/types-of-medicare-health-plans/medicare-advantage-plans

Medicare covers 65 percent of the medical expenses of retirees (De Nardi et al. 2015). The remaining 35 percent come from payments on premiums, deductibles, and other services not covered by Medicare (e.g., long-term services and dental care). This causes many older households to incur high out-of-pocket costs on health care (Cubanski et al. 2018). Because of these costs, 86 percent of Medicare beneficiaries had some sort of supplemental health insurance in 2010 (Cubanski et al. 2015). Supplemental insurance policies are available to individuals enrolled in Medicare Part A and B and are sold by private health care companies. These plans are highly regulated and require a monthly premium and cover some of the costs Medicare does not cover. However, even with supplemental insurance many households still pay between $4,000-$8,000 per year in out-of-pocket health care expenses (De Nardi et al. 2015; Cubanski et al. 2015)

Between the ages of 70 and 90, out-of-pocket medical expenses more than double. This is primarily driven by spending on long-term care and nursing home stay, which can cost around $80,000 a year (De Nardi et al. 2015; Fisher et al. 2007). Given the uncertainty of when long-term care will be necessary, this is a possibility why households hold on to excess housing equity as a form of precautionary savings. In this paper, I explore how using the house as precautionary savings may change if retirees had these additional costs covered by insurance.

3. Data

Due to its specific focus on Americans in their late working and retirement years, I use the Health and Retirement Study (HRS), to aid in the parameterization of the model and asses how well the output fits the data. I use individual and household level data from ten waves of the HRS from 1996-2014. The HRS is a longitudinal survey that includes about 20,000 households over age 50 selected through a multi-stage probability sample design that is a sample of the

United States population over age 50. This survey oversamples Black and Hispanic populations to support research on racial and ethnic disparities and defines an observational unit as an eligible household financial unit where at least one person is an eligible member the defined cohorts[6]. The HRS is administered by the University of Michigan Institute for Social Research in partnership with the RAND Center for the Study of Aging. When the study was initiated in 1992, the original target population for the HRS was adults born between 1931-1941 (HRS Cohort) and those born before 1924 (AHEAD cohort). Every six years the survey adds a new cohort starting in 1998 with those born between 1924-1930 (Children of the Depression) and 1942-1947 (War Babies Cohort). In 2004 those born between 1948-1953 (Early Baby Boomers Cohort) were added, and then lastly in 2010, those born between 1954-1959 (Mid-Baby Boomers Cohort) were added.

I restrict the data to two household types: one-person households where the person is aged 55 or older and two-person households of married couples where the male is aged 55 or older[7].

4. A Model of Housing Dynamics with Potential Health Shocks at Old Age

A. Demographics and Income

In a framework that is similar in nature to Imrohoroglu, Matoba, and Tuzel (2018) and Gervais (2002), the economy is populated with overlapping generations of agents at three stages of life, $s_t \in \{1,2,3\}$. Agents work during the first stage (age 55-64) and are retired in the last two stages (age 65-71 and 72-77 respectfully). In each period t, agents advance from one stage to

[6] For more information on the HRS and its sample selection, see https://hrs.isr.umich.edu/publications/biblio/9047 (HRS Staff 2008)
[7] This includes divorced and widowed individuals

the next with probability π_s and spend another period in the current stage with probability $1-\pi_s$. When an agent dies, they are replaced by a new agent in the first stage of life.

During the first stage of life, labor income, y_t^s, is given by $\log\left(y_t^s\right)=\log\left(w^s\right)+e_t$. The term w^s represents the wage profile of the individual and e_t represents an AR(1) stochastic shock to income every period, given by $e_t=\Theta e_{t-1}+\varepsilon_t$. ε_t is normally distributed with mean zero and variance σ_ε^2 and $\Theta<1$, it captures the persistence of the stochastic component to labor income. During the final two stages of life, individuals are retired and face a certain retirement income that declines as they age. In the third stage of life, agents are subject to a possible health shock, λ_t, that is associated with unexpected medical bills that can potentially occur each period. Agents are aware that there is a possible health shock in the future but do not know whether they will receive one. Agents die with probability π_3 in the third stage and are replaced by an agent in the first stage. In stage 3, agents can potentially face immediate death (e.g., total acute myocardial infarction), a long-term illness (e.g., cancer), or a one-time health shock (e.g., broken bone).

B. Housing

Agents will be endowed with units of housing at time $t=0$ which they will live in the first period. After the first period, agents will have access to a mortgage market when purchasing a home. If they purchase a home, they are required to make a down payment. If an agent sells their home, they face transaction costs (e.g., realtor fees, moving costs, etc.). Homeowners have to pay property taxes, $T_t^p=\tau_t^p p_t h_t$, where τ_t^p is the property tax rate and p_t is the price of a unit of housing. Renters do not have to pay property taxes. Households make

decisions on consumption, housing arrangements, and their mortgage each period after observing their income and whether they receive a health shock[8].

In the background of the model, there are financial institutions that provide loans to homeowners, hold residential rental capital, and pool individual's deposits. These financial institutions own all the rental housing units. In this model, housing stock is fixed at $\overline{H}$. Housing stock is equal to housing owned by individuals plus housing owned by the financial institutions. Homeowners can either be savers – earning an interest rate of r^d; or borrowers in the mortgage market facing a mortgage rate of r^m. The interest payments on mortgages is tax deductible.

C. Individuals Problem

Homeowners must pay a transaction cost if they choose to sell their home. Let h_t be exogenous the quantity of housing an agent has at time t. Let h^{rent} be the set of house sizes available to renters and h^{own} be the sizes of homes available to owners. Let $h_t \in \{h^{rent}\}$ indicate an agent who is a renter and $h_t \in \{h^{own}\}$ indicate an agent who is a homeowner. Transaction costs, $F(h_t, h_{t+1})$, are defined by

$$F(h_t, h_{t+1}) = \begin{cases} \varphi p_t h_t & \text{if } h_t \in \{h^{own}\} \text{ and } h_{t+1} \neq h_t \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

where φ represents the proportion of the house value paid in transaction costs (e.g., real estate agent fees, moving costs, etc.). Homeowners who move to a different size home must pay

[8] In this paper, health shock refers to an increase in unexpected medical bills in the third stage of life. While individuals can suffer health shocks at any age, this study is specifically interested in how an increase unexpected medical bills after age 72 impacts homeownership decisions because this is where households are likely to see the largest increases in out-of-pocket medical spending. See De Nardi et al. (2015) for more information.

transaction costs. I assume that a household who remains in the same size house did not move. All renters who move do not pay the transaction cost.

Households can borrow against the value of their home (mortgage a_{t+1}) and are subject to a loan-to-value constraint η, given by

$$a_{t+1} \leq \eta p_t h_{t+1} \quad \text{if } h_{t+1} \in \{h^{own}\} \tag{3}$$

Homeowners are not allowed to default on their mortgages. Renters do not have access to the mortgage market and are only allowed to save. A negative mortgage represents savings that receives interest rate r^d

$$r = \begin{cases} r^m & \text{if } a_{t+1} > 0 \\ r^d & \text{if } a_{t+1} < 0 \end{cases} \tag{4}$$

Following Imrohoroglu, Matoba, and Tuzel (2018), this model implements progressive income taxes and uses the tax function from Gouveia and Strauss (1994), which has the following functional form:

$$T_t^i(\tilde{y}) = \left[\tilde{y} - \left(\tilde{y}^{-\tau_{\eta 0}} + \tau_{\eta_2} \right)^{-\frac{1}{\tau_{\eta_1}}} \right] \tag{5}$$

where $\tilde{y}$ is taxable income, and $\left(\tau_{\eta_0}, \tau_{\eta_1}, \tau_{\eta_2}\right)$ are policy parameters on income taxes that determine progressivity and level of taxes collected . Interest paid on mortgages, ra_t, and property taxes, T_t^p, are tax deductible and interest on savings is taxable. Taxable income during the first stage of life is

$$\tilde{y} = \max\left(0, \left[y_t - ra_t - T_t^p \right]\right) \tag{6}$$

For simplicity it is assumed that retirees do not pay income on their retirement income, but property taxes and mortgage interest are still tax deductible. Taxable income for the last two stages of life is

$$\tilde{y} = \max\left(0, \left[-ra_t - T_t^p\right]\right) \tag{7}$$

In the event an agent dies, the financial institution sells the house and distributes the net assets of all the deceased agents in the form of an accidental bequest in the next period. This bequest is denoted by q_t. Homes have a depreciation rate of δ. This can be viewed as the maintenance and upkeep costs of living in a home that homeowners must pay.

In each period agents seek to maximize utility and face budget constraints which are a function of current and future homeownership status. Agents derive utility from consumption and housing. Agents maximize the utility from consumption and housing in each stage given by:

$$\max u(c_t, h_t) = \frac{\left[c_t^{\chi} h_t^{1-\chi}\right]^{1-\sigma^s}}{1-\sigma^s} \tag{8}$$

where χ is the relative weight of housing and consumption and σ^s is relative risk aversion.

a. The First Stage

In the first stage, agents are considered working and receive income, y_t^1, as well as a bequest from the previous generation who just died, q_t. Agents are endowed with housing h_0 and can either be a homeowner or a renter depending on the value of h_0. After the initial period, households can stay in their current residence or they can move. All homeowners who move face transaction costs, F_t. During the first stage, agents must decide between spending on consumption, c_t, and saving for the next period, a_{t+1}. The first stage budget constraint is as follows:

$$c_t + \hbar_{t+1} - a_{t+1} = y_t^1 + \hbar_t - T_t^i - T_t^p + q_t - F_t \tag{9}$$

$$\hbar_t = \begin{cases} (1-\delta)\, p_t h_t & \text{if } h_t \in \mathrm{h}^{own} \\ 0 & \text{if } h_t \in h^{rent} \end{cases} \tag{10}$$

$$\hbar_{t+1} = \begin{cases} p_t h_{t+1} & \text{if } h_{t+1} \in \mathrm{h}^{own} \\ rent_t h_{t+1} & \text{if } h_{t+1} \in h^{rent} \end{cases} \tag{11}$$

The competitive market rental rate is determined by the financial institutions, which make zero profit in equilibrium. The rental rate covers the depreciation expenditure, property taxes, and mortgage interest payments:

$$rent_t = \left(r^m + \delta + \tau_t^p\right) p_t \tag{12}$$

b. The Second Stage

All agents retire at the beginning of the second stage and they observe their income, y_t^2. Agents then make decisions on how much to spend on consumption, c_t, and their choice of dwelling, h_{t+1}. Households can stay in their current residence or they can move. Those who purchase another home can choose to borrow against it in the mortgage market or save for the next period, a_{t+1}. The budget constraint in the second stage is as follows:

$$c_t + \hbar_{t+1} - a_{t+1} = y_t^2 + \hbar_t + (1+r)a_t - T_t^i - T_t^p - F_t \tag{13}$$

c. The Third Stage

At the beginning of each period in this stage, agents observe their income, y_t^3 and unexpected medical bills as a result of a health shock, λ_t. λ_t occurs with probability d_t which takes a value of 1 if the agent receives a health shock and 0 if they do not, and can reoccur each period. Agents must pay for their unexpected medical bills, either from current income, accumulated savings, or by selling their home. Agents make decisions on how much to spend on

consumption, c_t, and type of preferred dwelling, h_t, in light of the potential the health shock. The third stage budget constraint for a household is:

$$c_t + \ell_{t+1} - a_{t+1} = y_t^3 - d_t\lambda_t + \ell_t + (1+r)a_t - T_t^i - T_t^p - F_t \tag{14}$$

At the end of the third stage agents die, however agents do not know when this will occur. Any assets the agent does not consume are distributed as an accidental bequest to the first generation.

D. Government

It is assumed that the government has a balanced budget and finances its expenditures, G_t, with tax revenue collected through income and property taxes.

5. Equilibrium

Individuals at time t are heterogeneous with respect to life stages s_t, assets/mortgages a_t ,housing h_t, and income y_t. Let $\Gamma(e,e')$ be the transition matrix for labor income; $\Lambda(s,s')$ be the transition matrix for life stages; $\vartheta^s(\lambda')$ be age dependent probability of a health shock; Ω_t represent the state (s,a,h,y) faced by an agent at time t; and $V(\Omega_t)$ be the maximized value of the objective function at state Ω_t. The dynamic programming problem faced by individuals is given by:

$$V_t(\Omega) = \max_{c,h',m'} u(c,h) + \beta \sum_{s'} \sum_{e'} \sum_{\vartheta'} \Lambda(s,s')\Gamma(e,e')\vartheta^s(\lambda')V_{t+1}(\Omega') \tag{15}$$

subject to the constraints (2)-(14).

A competitive equilibrium is a sequence of value functions $V_t(\Omega)$; individual decision rules for consumption goods, housing, and mortgages; a measure of agent types $\Pi_t(\Omega)$; and the

price of housing p_t – assuming the sequence government policy $\left\{\tau_{\eta_0}, \tau_{\eta_1}, \tau_{\eta_2}, \tau_t^p\right\}_{t=0}^{\infty}$ and mortgage and deposit rates $\left\{r^m, r^d\right\}_{t=0}^{\infty}$ are given – so that for all t:

- Given the price of the house, interest rates on mortgages and deposits, and the government policy, the dynamic programming problem is solved by the individual's decision rules.
- p_t clears the housing market, $\sum_{\Omega} \Pi_t(\Omega) h_t(\Omega) = \bar{H}$, where $h_t(\Omega)$ is the optimal housing allocation resulting from the dynamic programming problem of the household.
- Accidental bequests are given by

$$q_t = \frac{\pi_3 \sum_{m,h;a} \Pi_t(\Omega)\left[(1-\delta)\left(p_t(\Omega) h_t(\Omega)\right) - (1+r)\left(a_t(\Omega)\right)\right]}{\sum_{\Omega} \Pi_t(\Omega) y_t^s} \tag{16}$$

  Death occurs (with probability π_3) after agents in the third stage have made their homeownership, mortgage, and savings decisions.

6. Calibration[9]

[INSERT TABLE 1 HERE]

The goal for the benchmark economy is to match the housing market of Americans aged 55 and older using data from the HRS. A summary of all the parameters used in the model can be found in Table 1.

[9] The MATLAB code used by Imrohoroglu, Matoba, and Tuzel (2018), available at https://www.aeaweb.org/articles?id=10.1257/mac.20160327, was very helpful and parts of their code served as a template for the calibration of this paper. The MATLAB code used for this paper is available upon request

In each life stage, s, agents face a probability π_s of moving to life stage $s+1$. π_s is set so that on average, agents spend ten years in the first stage and six years in the last two life stages. This makes the average life expectancy 77 years. The transition matrix for life stages is:

$$\Lambda(s,s') = \begin{bmatrix} .90 & .10 & .00 \\ .00 & .83 & .17 \\ .00 & .00 & .83 \end{bmatrix} \tag{17}$$

The labor income process that is used in the model is calibrated in such a way so the output from the model match homeownership rates of the HRS (future use of calibrated is assumed for the same purpose). The idiosyncratic component of labor income, $e_t = \Theta e_{t-1} + \varepsilon_t$, is calibrated using the four-state Markov chain found in Imrohoroglu, Matoba, and Tuzel (2018). The values of e_t are (-0.41, -0.10,0.10,0.41) and the transition matrix is:

$$\Gamma(e,e') = \begin{bmatrix} .84 & .16 & .00 & .00 \\ .16 & .64 & .20 & .00 \\ .00 & .20 & .64 & .16 \\ .00 & .00 & .16 & .84 \end{bmatrix} \tag{18}$$

The tax function in equation 4 is calibrated to the US federal tax code. τ_{η_1} determines the progressivity of taxes and is estimated by Gouveia and Strauss (1994) to take the value of 0.768. They also estimate τ_{η_0} to be 0.258. τ_{η_2} is calibrated to be 0.5. Property tax rates in the US vary between 0.28 percent (Hawaii) to 2.38 percent (New Jersey) (Walczak 2015), so τ^p is set in the middle at 1.0 percent.

The interest rate on mortgages, r^m, is set to 4.05 percent[10] and the interest rate on deposits, r^d, is set to 1.7 percent.[11] The transaction cost of selling a home, φ, is 10 percent. This is slightly higher than what is seen in other studies modeling the entire life-cycle, but there is some evidence to suggest that transaction costs are higher for older households (Venti and Wise 1990; Ai et al. 1990; Borsch-Supan, Hajivassiliou, and Kotlikoff 1992; Feinstein and McFadden 1989). Following Imrohoroglu, Matoba, and Tuzel (2018), the maximum loan-to-value parameter, η, is set to 80 percent. The depreciation rate, δ, is set to 1.7 percent.[12]

The time period, t, is one year. The subjective time discount factor, β, is assumed to be 0.96, a value in line with what is commonly used in the literature. The 2016 Consumer Expenditure Survey shows that non-housing consumption makes up 66.4 percent of a household's personal expenditure (Bureau of Labor Statistics 2018), so the relative weight of consumption and housing, χ, is set at 0.66. This paper takes a slightly different approach to risk aversion than typically seen in these types of models due to its specific focus on retirees and near retirees. Risk Aversion, σ^s, takes the value of 5.0 in the first stage, 8.0 in the second stage, and 10.0 in the third stage. These rates are higher than what is traditionally found in the literature and increasing with age. It is intentionally calibrated this way as the model does not simulate the entire life cycle – only late working years and retirement and older individuals tend to have higher degrees of risk aversion than working age individuals (Tymula et al. 2013; Ablert and Duffy 2012).

[10] The average rate on a 30-year fixed mortgage is 4.05 percent between 2010-2017 (Freddie Mac 2018)
[11] The average one-year treasury rate from 2010-2017 is 0.38 percent (Board of Governors of the Federal Reserve System 2018). However, this is a period of Quantitative Easing (QE). Since low interest rates will not be the norm in the future, this paper uses the interest rate on deposits from Imrohoroglu, Matoba, and Tuzel (2018), the expected standard as QE ends
[12] The range of δ is between 1.5 and 2.0 percent in De Nardi (2004), Imrohoroglu, Matoba, and Tuzel (2018), and Nakajima and Telyukova (2017)

I find that within the HRS for households aged 72-77, between 40-45 percent of household's report having a bad health as well as an increase in out-of-pocket medical expenses. To determine bad health, I considered three metrics from the HRs: households that reported an increase in health conditions, households that reported bad health, and households that reported cancer, a stroke, lung disease, or heart disease Therefore, the probability of receiving a health shock, d_t, in each period is set to 40 percent when agents are in the third stage and 0 percent otherwise and the value of out-of-pocket medical bills, λ_t, is set to 0.75. A sensitivity analysis in section 7 explores what happens to the model with higher and lower values λ_t.

The housing grid is based on the square footage for homeowners and renters from the US Census Bureau, American Housing Survey 2017. Renters can choose between two house sizes: $h^{rent} = \{1.00, 1.25\}$ (a value of 1.00 can be interpreted as 1,000 square feet). Owners can choose between four house sizes: $h^{own} = \{1.75, 2.25, 3.00, 3.50\}$. The average house size is set to 2.25.

The state variables in the dynamic programing problem consist of life stages s_t, net assets (savings and mortgage) a_t, housing h_t, and employment state e_t. There are 3 grid points for life stages, 76 grid points for assets (-9.9 to 3.6), 6 grid points for housing (1 to 3.50), and 4 values for idiosyncratic income. This results in 5,472 possible state combinations in the model.

7. Results

In this section, I use the benchmark model to investigate whether Americans age 55 and older are using their house as a form of precautionary savings by simulating the housing choices made by this demographic. First, I simulate the benchmark model where individuals are aware that their health could change in the future, and they will be forced to pay out-of-pocket medical

bills. I then simulate a model eliminating the health shock to determine how this population makes housing decisions in its absence.

To solve for the steady state decision rules in the economy, I begin by guessing the house price and solving the decision rules using value function iteration. After each iteration, I compare aggregate housing demand to aggregate housing supply. The house price is updated, and this process is repeated until aggregate housing demand is equal to aggregate housing supply. Using these decision rules, I simulate an economy with 10,000 individuals for 3,750 periods and generate aggregate statistics for the economy. I discard the first 750 periods to avoid any issues with initial conditions.

[INSERT TABLE 2 HERE]

To assess the validity of the model, I compare homeownership rates in the benchmark model with a health shock to those in the HRS. Table 2 shows the results of the model compared to the HRS. The model generates an average homeownership rate of 78.1 percent compared with 77.8 percent in the HRS. The model also does a reasonable job of approximating homeownership rates for each stage of life which was the main target to match in the calibration. Table 4 also shows the percent of agents who moved compared to the data. Moving rates are close but slightly lower than what is seen in the data. The baseline model generates average moving rate of 9.1 percent compared to 10.7 percent seen in the HRS.

A. Economies with and without a Potential Health Shock

[INSERT TABLE 3 HERE]

Table 3 presents the results from the simulation of the benchmark economy and a counterfactual economy where agents are not subject to out-of-pocket medical expenses. If agents know that they will not receive a health shock, average homeownership rates are 70.7

percent (compared to 78.1 percent when a health-shock is possible). The counterfactual model shows almost a 6-percentage point decrease in the number of households that own a home in their late working years (stage 1) compared to the benchmark model. When households retire (stage 2), the percent of households who own is almost 4-percentage points lower and the rate of moving is 1-percentage point higher in the counterfactual model. In addition, there is a 1-percentage point increase in the percent of homeowners who move and downsize. In late retirement (stage 3), homeownership rates are 13-percentage points lower when there is no health shock and moving rates are 1.2-percentage points higher. There is also a 1.8-percentage point increase in the rate of homeowners who move to renting. In both retirement stages, households are more likely to move from owning to renting and more likely to downsize when moving in the counterfactual model compared to the benchmark model.

Since fewer households choose to own a home and those that move are more likely to either downsize or rent when an increase households know they will not face an increase in out-of-pocket medical expenses, this suggests that more older households would prefer to use their housing equity to help finance consumption but fear they might need to sell it if they get sick in the future. This provides evidence that households are engaging in precautionary savings using the home.

B. Insurance Policy

The fact that households are more likely to behave in accordance with the LCH when they know there is no possibility of future out-of-pocket medical expenses suggests that the existing health insurance market for seniors is incomplete. As an experiment, I will incorporate an insurance policy, that goes beyond what is currently covered by Medicare and supplemental coverage, to determine its impact on homeownership decisions of older Americans.

Individuals can choose to purchase insurance that would cover all out-of-pocket medical expenses. The cost of insurance is α, a fraction of individual income. Here, if an individual chooses to purchase such a policy, then $\kappa_t = 1$; and if they choose not to purchase the policy, $\kappa_t = 0$. With this insurance policy, I_t, available, the budget constraint faced by agents in the model becomes:

$$c_t + \mathbb{k}_{t+1} - a_{t+1} = y_t^s - d_t \lambda_t \kappa_t - \kappa_t I_t + \mathbb{k}_t + (1+r)a_t - T_t^i - T_t^p - F_t \tag{19}$$

where,

$$I_t = \begin{cases} \alpha y_t^s & \text{if } \kappa_t = 1 \\ 0 & \text{if } \kappa_t = 0 \end{cases} \tag{20}$$

An agent who purchases insurance might still get sick, however they will not be forced to pay medical bills out of their income, savings, or by selling their house. It will be covered by the insurance policy. So, the health shock λ_t becomes:

$$\lambda_t \kappa_t = \begin{cases} \lambda_t & \text{if } \kappa_t = 0 \\ 0 & \text{if } \kappa_t = 1 \end{cases} \tag{21}$$

[INSERT TABLE 4 HERE]

The goal of this experiment was to determine what the price of insurance would so the output of the benchmark economy with insurance matched the output of the counterfactual economy. If $\alpha = 0.04$, 12.8 percent of households purchase the insurance. With the insurance policy available, homeownership and moving rates become very similar to the counterfactual model where there are no health shocks. Table 4 compares the output of the benchmark model with insurance where $\alpha = 0.04$ to the output of the counterfactual model. This provides evidence that with the proper insurance coverage in their later years, Americans age 55 and older would be more willing to use the equity in their homes which is demonstrated by an increased likelihood

of moving from owning to renting and downsizing. Thus, more individuals act in a manner that would be expected by the LCH if they knew all future medical expenses would be covered.

8. Sensitivity Analysis

[INSERT TABLE 5 HERE]

This section provides a sensitivity analysis to the results of the calibration, which are shown in Table 5. First, I evaluate the impact of higher and lower values of possible out-of-pocket medical expenses, λ_t. Lowering λ_t to 0.25 from 0.75 results in a decrease in the rate of homeownership to 71.6 percent compared with 78.1 percent in the benchmark model. Also, this results in an increase in the rate of moving to 10.2 percent from 9.1 percent. Increasing λ_t to 1.25 yields the opposite effect. The rate of homeownership increases to 95.3 percent and the rate of moving decreases to 7.6 percent. This provides further evidence that Americans aged 55 and older are engaging in precautionary savings where they would sell their house to pay for possible future medical bills. The higher the cost of medical bills from a potential health shock, λ_t, an increasing number of households stay in their home late into retirement and a decreasing number move. The higher the potential medical bills, the more likely households are to stay in their home in case they need to sell it to offset these costs.

Additionally, I evaluate the impact of transaction costs on the model by comparing a model without transaction costs to the benchmark model. When households do not have to pay transaction costs, it has a minimal impact on the distribution of homeownership rates in each stage, however, there is an increase in the rate of moving in each stage. While this is not something I set out to investigate in this paper, several studies have proposed this as one possible explanation for why older households do not use their housing equity (Venti and Wise 1990; Ai et al. 1990; Borsch-Supan, Hajivassiliou, and Kotlikoff 1992; Feinstein and McFadden 1989).

Since the rate at which current homeowners move increases compared to the benchmark economy, this may provide some evidence that high transaction costs are keeping some Americans age 55 and older in their home when they otherwise might move .

9. Conclusions

In this paper, using an economy populated with overlapping generations of heterogeneous agents, I examine how homeowners are engaging in precautionary savings using their house to pay for potential future medical bills, rather than using its equity toward consumption in retirement. It appears that due to gaps in health insurance that exist for retirees, a significant number of Americans appear to own a house well into retirement to offset the costs of possible future out-of-pocket medical bills. In a counterfactual economy where individual's do not face out-of-pocket medical expenses, there is a 13-percentage point decrease in the number of homeowners compared to the benchmark model where potential health shocks are a factor. Additionally, there is an increase in the percent of homeowners who move from owning to renting and downsize. These are ways in which households can extract equity from their house. Evidence that homeowners engaging in precautionary savings using their house is further reinforced as the more money that households might have to spend for potential increases in medical bills leads to an increase in the number of Americans age 55 and older who own homes.

Using this framework, I explore what would happen if seniors had access to health insurance that covered *all* their out-of-pocket medical expenses in their late retirement years, so individuals do not need to engage in precautionary savings. I show that if the cost of such a policy is four percent of household income, then 12.8 percent of households will purchase it. Agents may still receive a health shock, but they will not be forced to pay for it from their income, savings, or selling their house. The two model economies in this study – the one where

agents face a potential health shock and the one where they do not – exhibit similar rates of homeownership and moving when the insurance policy is available. This shows that with more adequate health insurance coverage for seniors, households will be more likely to use the equity in their house to increase consumption in retirement which is what would be expected per the Life Cycle Hypothesis.

There are other important and interesting questions related to housing equity and precautionary savings that I did not explore in this paper. Future research should seek to investigate the impact of local and state policies on how Americans age 55 and older make housing decisions. Also, the impact of changes to reverse mortgages and changes to the way they are administered could allow homeowners to use the equity in their home without moving to cover out-of-pocket medical expenses is left to future research. Finally, extending this model to include altruism and bequeathing the house would provide additional insights as to why older Americans are not using their housing equity to increase consumption in retirement.

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11. Tables

Table 1. Summary of Model Parameters

Parameter	Description	Value	Source
τ^p	Property Tax Rate	1.0%	Walczak (2015)
r^d	Interest Rate for Deposits	1.7%	Imrohoroglu et al. (2018)
r^m	Interest Rate for Mortgages	4.05%	Freddie Mac (2018)
φ	Transaction Cost of Selling a Home	10.0%	Calibrated
η	Maximum Loan-to-Value	80%	Imrohoroglu et al. (2018)
τ_{η_0}	Income Tax Parameter	0.258	Gouveia and Strauss (1994)
τ_{η_1}	Income Tax Parameter	0.768	Gouveia and Strauss (1994)
τ_{η_2}	Income Tax Parameter	0.50	Calibrated
χ	Relative Weight of c in Utility	0.66	Bureau of Labor Statistics (2016)
σ	Relative Risk Aversion	5.0, 8.0, 10.0	Calibrated – Albert and Duffy (2012), Tymula et al. (2013)
δ	Housing Depreciation Rate	1.7%	De Nardi (2004), Imrohoroglu et al. (2018)
β	Time Discount Factor	0.96	Common in literature
w^s	Wage Profile	2.5, 2.2, 1.7	Calibrated
λ_t	Health Shock to Income	0.75	Calibrated
d_t	Probability of Health Shock	0.40	Health and Retirement Study

Notes: the values of calibrated parameters are set so the output of model fits the data in the HRS

Table 2. Model Fit vs HRS Data

Percent	First Stage	Second Stage	Third Stage
Own a House			
Model	76.0	81.3	72.8
HRS Data	76.0	80.4	78.9
Move			
Model	11.2	7.4	7.2
HRS Data	11.9	9.9	9.0

Table 3. Results of Economy with Health Shock vs No Health Shock

		Economy	
	Percent	**Health Shock**	**No Health Shock**
Stage 1	Own	79.2	73.3
	Move	11.2	12.1
	Move Own to Rent	1.6	2.2
	Move and Downsize	3.5	3.7
Stage 2	Own	81.3	77.5
	Move	7.4	8.3
	Move Own to Rent	1.0	1.0
	Move and Downsize	2.8	3.8
Stage 3	Own	72.8	59.7
	Move	7.2	8.4
	Move Own to Rent	1.8	3.6
	Move and Downsize	3.1	3.3
Overall	Own	78.1	70.7
	Move	9.1	10.1

Table 4. Homeownership and Moving Rates with the Insurance Policy

	Percent	No Health Shock	Health Shock with Insurance
Stage 1	Own	73.3	72.7
	Move	12.1	12.1
	Move Own to Rent	2.2	2.2
	Move and Downsize	3.7	3.7
Stage 2	Own	77.5	76.8
	Move	8.3	8.4
	Move Own to Rent	1.0	1.0
	Move and Downsize	3.8	3.8
Stage 3	Own	59.7	59.6
	Move	8.4	9.1
	Move Own to Rent	3.6	3.5
	Move and Downsize	3.3	3.2
Total	Own	70.7	70.2
	Move	10.1	10.3
	Percent Bought Insurance	0.0	12.8

Notes: Price of insurance policy is 4.0% of household income

Table 5. Sensitivity Analysis

	Percent	Benchmark	Low λ_t	High λ_t	No Transaction Costs
Stage 1	Own	79.2	73.9	94.7	79.6
	Move	11.2	12.2	9.6	14.4
	Move Own to Rent	1.6	2.2	0.7	1.6
	Move and Downsize	3.5	3.7	3.2	6.7
Stage 2	Own	81.3	77.6	95.5	82.0
	Move	7.4	8.2	6.8	11.1
	Move Own to Rent	1.0	0.9	0.3	0.7
	Move and Downsize	2.8	3.6	3.4	6.3
Stage 3	Own	72.8	61.8	96.0	73.0
	Move	7.2	8.8	5.3	11.0
	Move Own to Rent	1.8	3.2	0.1	1.9
	Move and Downsize	3.1	3.0	3.9	6.3
Overall	Own	78.1	71.6	95.3	78.4
	Move	9.1	10.2	7.6	12.6

Notes: λ_t = 0.75 in the benchmark economy, 0.25 for low λ_t, and 1.25 for high λ_t