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

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**Abstract**

It is a well-established fact that many retirees do not utilize their accumulated housing equity to help smooth and increase consumption in retirement as is predicted by the Life-Cycle Hypothesis. In this paper, I explore how older Americans may retain their housing equity to help pay off medical bills in the future, treating their house as precautionary savings. 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. Additionally, I find that if retirees had all of their medical expenses covered by insurance, some retirees would be willing to forego homeownership, allowing them to use their housing equity to smooth and increase consumption.

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# 1 Introduction

Housing equity accounts for a large portion of retired Americans wealth (Begley and Chan, 2018; Moulton et al., 2016) and nearly 80 percent of retirees own a home (US Census Bureau, 2018). This accumulated housing equity could be used to help smooth consumption in retirement. However, retirees have a strong preference to remain in their home throughout retirement (Munnell, Soto and Aubry, 2007; Venti and Wise, 2004) with less than 10 percent of older homeowners moving each year (Munnell et al., 2020; Murray, 2019; Venti and Wise, 1989, 1990, 2000, 2004). Additionally, few households take-up a reverse mortgage (Davidoff, Gerhard and Post, 2017; Kaul and Goodman, 2017; Nakajima and Telyukova, 2017). While there are options available to do so, most retirees do not fully use their housing equity to smooth consumption, a contradiction of the Life-Cycle Hypothesis (LCH) (Modigliani and Brumberg, 1954).

As homeowners age, it becomes more difficult to borrow money. Therefore, it has been hypothesized that retirees may choose to engage in precautionary savings using their home and sell it to cover unexpected medical bills (Fisher et al., 2007; Nakajima and Telyukova, 2019; Poterba, Venti and Wise, 2011; Stucki, 2005; Venti and Wise, 2000). 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.

Building off the model used in İmrohoroğlu, Matoba and Tüzel (2018), 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 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., 2016). 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 builds on the existing literature that addresses the question of why so many Americans do not use their housing equity toward consumption in retirement, or the *housing-equity puzzle (HEP)*. Empirical studies, such as Borsch-Supan, Hajivassiliou and Kotlikoff (1992); Fisher et al. (2007); Hurd (1992); Munnell et al. (2020); Murray (2019); Murray and Dunn (2020); Nakajima and Telyukova (2017, 2019); Poterba, Venti and Wise (2011); Suari-Andreu, Alessie and Angelini (2019); Venti and Wise (1989, 1990, 2000, 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, deferred maintenance, and high transaction costs. I use an overlapping generations model of housing and consumption to explore how households may engage in precautionary savings using their house and how this partially explain the HEP. I also show that older Americans would be more willing to downsize and forgo homeownership if they had more comprehensive health insurance.

This paper proceeds with an overview of the data, a discussion on health insurance and spending for retirees, a model of homeownership, model calibration, results, sensitivity analysis, and concluding remarks.

# 2 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 1996-2016. 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 [1].

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. In 2010, those born between 1954-1959 (Mid-Baby Boomers Cohort) were added and in 2016 those born between 1960-1965 (Late-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.

# 3 Health Spending and Insurance for Retirees

Medicare provides health insurance to adults age 65 and older in the United States and has several components [2]. 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 [3]. 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 [4]. Medicare Part D covers prescription drugs and comes with a monthly premium paid in addition to the premium for

[1] For more information on the HRS and its sample selection, see https://hrs.isr.umich.edu/publications/biblio/9047 (HRS Staff, 2008)

[2] Information on what Medicare covers and its various parts are available at: https://www.medicare.gov/what-medicare-covers.

[3] More information on costs for Medicare Part A is available at: https://www.medicare.gov/your-medicare-costs/part-a-costs.

[4] More information on costs for Medicare Part B is available at: https://www.medicare.gov/your-medicare-costs/part-b-costs.

Part B [5]. These are private health insurance plans, typically HMOs, that provide the same benefits covered by Part A and Part B [6] 30 percent of Medicare beneficiaries were enrolled in Medicare Advantage plans in 2014 (Cubanski et al., 2018).

Medicare covers 65 percent of the medical expenses of retirees (De Nardi et al., 2016). 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., 2016; Cubanski et al., 2015). Figure 1 shows that nearly half of older households believe there is a greater than 50 percent chance they will spend more than $1,500 in the coming year in medical bills and just under a third of older households believe there is a greater than 50 percent chance they will spend more than $3,000.

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., 2016; Fisher et al., 2007). Retirees have the option to purchase additional long-term care insurance, but as shown in Figure 2, fewer than 20 percent of older Americans have it, meaning they would need to bear these costs out-of-pocket. Given the uncertainty of when long-term care will be necessary and the lack of long-term care insurance for most retirees, this is a possibility why households hold on to excess housing equity as a form of precautionary savings where they would sell their house to pay off high medical bills. In this paper, I explore this possibility and how their behavior would change if they had more comprehensive health insurance

[5] 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.

[6] 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.

coverage.

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

## 4.1 Demographics and Income

In a framework that is similar in nature to İmrohoroğlu, Matoba and Tüzel (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 the next with probability $\pi_s$ 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 $log(y_t^s) = log(w^s) + e_t$. 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 $e_t = \Theta e_{t-1} + \varepsilon_t$. $\varepsilon_t$ is normally distributed with mean zero and variance $\sigma_\varepsilon^2$ 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, $\lambda_t$, 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 $\pi_3$ 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).

## 4.2 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 $\tau_t^p$ is the property tax rate, $p_t$ is the price per unit of housing, and $h_t$ is the exogenous quantity of housing an agent has at time $t$. 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 [7].

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 $\bar{H}$. 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.

## 4.3 Individuals Problem

Homeowners must pay a transaction cost if they choose to sell their home. 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:

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

where $\varphi$ 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 transaction costs. I assume that a household who remains in the same size house did not move. All renters

[7] 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. (2016) for more information.

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 $\eta$, given by:

$$a_{t+1} \leq \eta p_t h_{t+1} \text{ if } h_t \in \{h^{own}\} \tag{2}$$

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 $r^d$

$$r = \begin{cases} r^m & \text{if } a_{t+1} > 0 \\ r^d & \text{if } a_{t+1} > 0 \end{cases} \tag{3}$$

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

$$T_t^i(\tilde{y}) = \left[\tilde{y} - (\tilde{y}^{-\tau_{\eta 0}} + \tau_{\eta_2})^{-\frac{1}{\tau_{\eta_1}}}\right] \tag{4}$$

where $\tilde{y}$ is taxable income, and $(\tau_{\eta_0}, \tau_{\eta_1}, \tau_{\eta_2})$ 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:

$$\tilde{y} = max(0, [y_t - ra_t - T_t^p]) \tag{5}$$

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:

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

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 $\delta$. 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:

$$maxu(c_t, h_t) = \frac{\left[c_t^{\chi} h_t^{1-\chi}\right]^{1-\sigma^s}}{1-\sigma^s} \tag{7}$$

where $\chi$ is the relative weight of housing and consumption and $\sigma^2$ is relative risk aversion.

#### 4.3.1 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:

$$c_t + \hat{h}_{t+1} - a_{t+1} = y_t^1 + \hat{h}_t - T_t^i - T_t^p + q_t - F_t \tag{8}$$

$$\hat{h}_t = \begin{cases} (1-\delta)p_t h_t & \text{if } h_t \in h^{own} \\ 0 & \text{if } h_t \in h^{rent} \end{cases} \tag{9}$$

$$\hat{h}_{t+1} = \begin{cases} p_t h_{t+1} & \text{if } h_t \in h^{own} \\ rent_t h_{t+1} & \text{if } h_t \in h^{rent} \end{cases} \tag{10}$$

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:

$$rent_t = (r^m + \delta + \tau_t^p) p_t \tag{11}$$

#### 4.3.2 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:

$$c_t + \hat{h}_{t+1} - a_{t+1} = y_t^2 + \hat{h}_t + (1+r)a_t - T_t^i - T_t^p - F_t \tag{12}$$

#### 4.3.3 The Third Stage

At the beginning of each period in this stage, agents observe their income, $y_t^3$ unexpected medical bills as a result of a health shock, $\lambda_t$. $\lambda_t$ 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:

$$c_t + \hat{h}_{t+1} - a_{t+1} = y_t^4 - d_{tt} + \hat{h}_t + (1+r)a_t - T_t^i - T_t^p - F_t \tag{13}$$

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.

#### 4.3.4 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.

## 4.4 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; $\Omega_t$ 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 $\Omega_t$. The dynamic programming problem faced by individuals is given by:

$$V_t(\Omega) = \max_{c,h',m'} u(c,h) + \beta \sum_{s'} \sum_{e'} \sum_{\vartheta^s} \Lambda(s,s') \vartheta^s(\lambda') V_{t+1}(\Omega') \tag{14}$$

subject to the constraints of (1)-(13).

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 $\prod_t(\Omega)$; and the price of housing $p_t$ - assuming assuming the sequence government policy $\{\tau_{\eta_0}, \tau_{\eta_1}, \tau_{\eta_2}, \tau_t^p\}_{t=0}^{\infty}$ and mortgage and deposit rates $\{r^m, r^d\}_{t=0}^{\infty}$ are igven - 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, $\sum_\Omega \prod_t(\Omega) h_t(\Omega) = \bar{H}$, where $h_t(\Omega)$ is the optimal housing

allocation resulting from the dynamic programming problem of the household.

- Accidental bequests are given by

$$q_t = \frac{\pi_t \sum_{m,h;a} \prod_t(\Omega)[(1-\delta)(p_t(\Omega)h_t(\Omega)) - (1+r)(a_t(\Omega))]}{\sum_\Omega \prod_t(\Omega) y_t^s} \tag{15}$$

Death occurs (with probability $\pi_3$ after agents in the third stage have made their homeownership, mortgage, and savings decisions.

# 5 Calibration [8]

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.

In each life stage, $s$, agents face a probability $\pi_s$ of moving to life stage $s+1$. $\pi_s$ 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:

$$\Lambda(s,s') = \begin{bmatrix} .90 & .10 & .00 \\ .00 & .83 & .17 \\ .00 & .00 & .83 \end{bmatrix} \tag{16}$$

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 İmrohoroğlu, Matoba and Tüzel (2018). The values of $e_t$ are $(-0.41, -0.10, 0.10, 0.41)$ and the transition matrix is:

[8] The MATLAB code used by İmrohoroğlu, Matoba and Tüzel (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

$$\Gamma(e,e') = \begin{bmatrix} .84 & .16 & .00 & .00 \\ .16 & .64 & .20 & .00 \\ .00 & .20 & .64 & .16 \\ .00 & .00 & .16 & .84 \end{bmatrix} \tag{17}$$

The tax function in equation 4 is calibrated to the US federal tax code. $\tau_{\eta_1}$ determines the progressivity of taxes and is estimated by Gouveia and Strauss (1994) to take the value of 0.768. The also estimate $\tau_{\eta_0}$ to be 0.258. $\tau_{\eta_2}$ 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 $\tau^p$ is set in the middle at 1.0 percent.

The interest rate on mortgages, $r^m$ is set to 4.05 percent[9] and the interest rate on deposits, $r^d$, is set to 1.7 percent[10]. The transaction cost of selling a home, $\varphi$, 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 (Ai et al., 1990; Borsch-Supan, Hajivassiliou and Kotlikoff, 1992; Feinstein and McFadden, 1989; Venti and Wise, 1990). Following İmrohoroğlu, Matoba and Tüzel (2018), the maximum loan-to-value parameter, $\eta$, is set to 80 percent. The depreciation rate, $\delta$, is set to 1.7 percent[11].

The time period, $t$, is one year. The subjective time discount factor, $\beta$, 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, $\chi$, 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, $\sigma^s$, takes the

9 The average rate on a 30-year fixed mortgage is 4.05 percent between 2010-2017 Freddie Mac (2018)

10 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 İmrohoroğlu, Matoba and Tüzel (2018), the expected standard as QE ends

11 The range of is between 1.5 and 2.0 percent in De Nardi (2004), İmrohoroğlu, Matoba and Tüzel (2018), and Nakajima and Telyukova (2017).

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; Albert and Duffy, 2012).

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, $\lambda_t$, is set to 0.75. A sensitivity analysis in section 7 explores what happens to the model with higher and lower values $\lambda_t$.

The housing grid is based on the square footage for homeowners and renters from the 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.

# 6 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.

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 2 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.

## 6.1 Economies with and without a Potential Health Shock

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.

## 6.2 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 $\alpha$, 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:

$$c_t + \hat{h}_{t+1} - a_{t+1} = y_t^s - d_t \lambda_t \kappa_t - \kappa_t I_t + \hat{h}_t + (1+r)a_t - T_t^i - T_t^p - F_t \qquad (18)$$

where,

$$
I_t = \begin{cases} 0 & \text{if } \kappa_t = 0 \\ \alpha y_t^s & \text{if } \kappa_t = 1 \end{cases} \tag{19}
$$

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 $\lambda_t$ becomes:

$$
\lambda_t \kappa_t = \begin{cases} \lambda_t & \text{if } \kappa_t = 0 \\ 0 & \text{if } \kappa_t = 1 \end{cases} \tag{20}
$$

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.

# 7 Sensitivity Analysis

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, $_t$. Lowering $\lambda_t$ 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 $\lambda_t$ 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, $\lambda_t$, 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 (Ai et al., 1990; Borsch-Supan, Hajivassiliou and Kotlikoff, 1992; Feinstein and McFadden, 1989; Venti and Wise, 1990). 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.

# 8 Conclusions

Many retirees spend and anticipate spending on out-of-pocket medical expenses, despite coverage from Medicare and supplemental insurance. In this paper, I show that this causes some older individuals remain in their home throughout retirement and engage in precautionary savings using their home to sell in the event of high unexpected medical bills. Most Americans own a house in retirement, and this paper shows that were it not for gaps in current health insurance coverage, more retirees would be willing to forgo homeownership.

Using a mode of overlapping generations with heterogeneous agents, I show that 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 and households may incur out-of-pocket medical expenses. 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 households would 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 this policy. 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 comprehensive 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 LCH. As policymakers in the United States seek health insurance and Medicare reform, this is an additional benefit of reform that should be considered.

The model I present shows that on average in the United States, some older homeowners would be willing to forgo homeownership if they has more health insurance coverage, this model does not capture important factors that could influence this decision. First, this model does not distinguish between married and single households and it is likely the behavior and savings portfolios are different between these two groups. Second, local and state policies regarding housing, taxation, and other programs the benefit seniors could influence this decision (e.g., Proposition 13 in California, home-repair assistance programs, and in-home health care assistance) are not able to be included in this model. Future empirical research should look at these differences and evaluate medical care and insurance reforms on homeownership. Finally, extending this model to include altruism and bequeathing housing wealth would provide additional insights as to why older Americans are not using their housing equity to increase consumption in retirement as a reason many households do stay in their house is a desire to leave it as a bequest.

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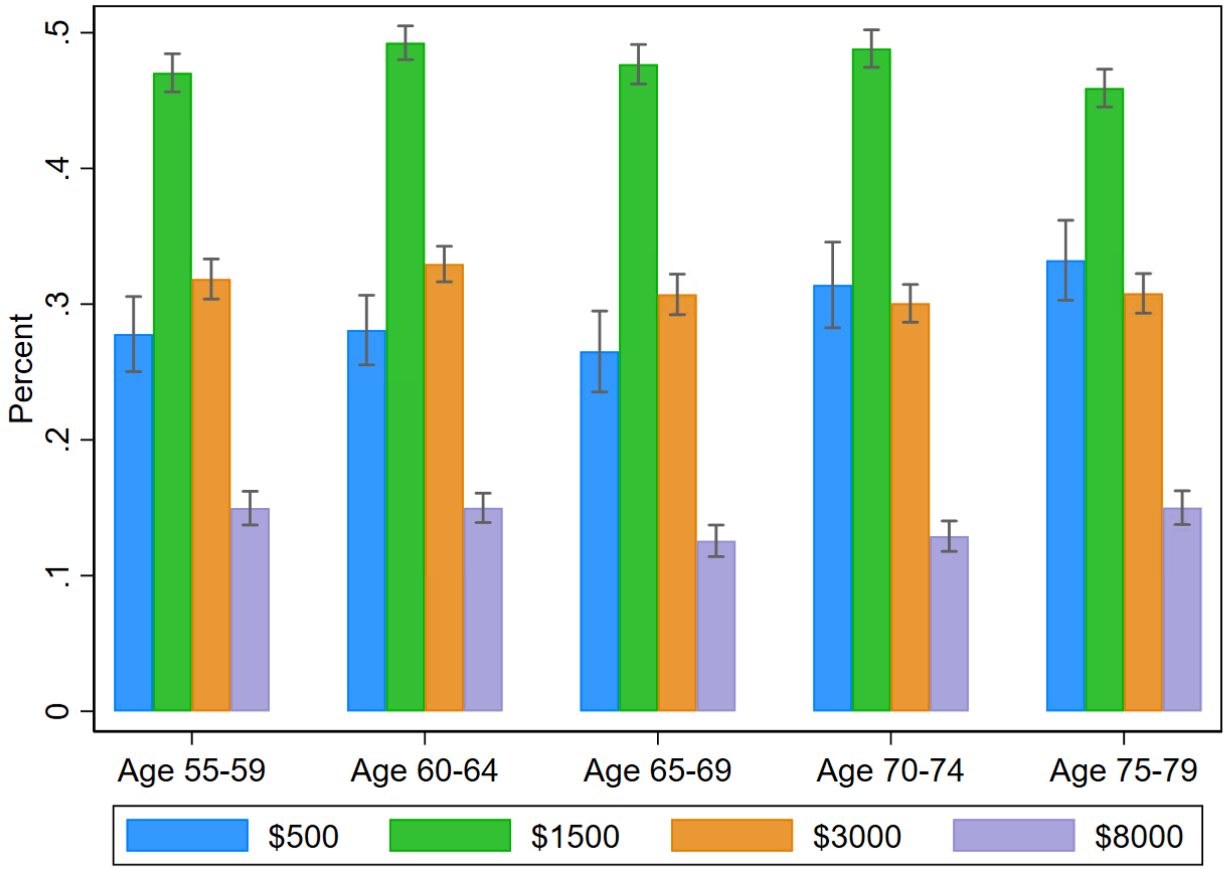
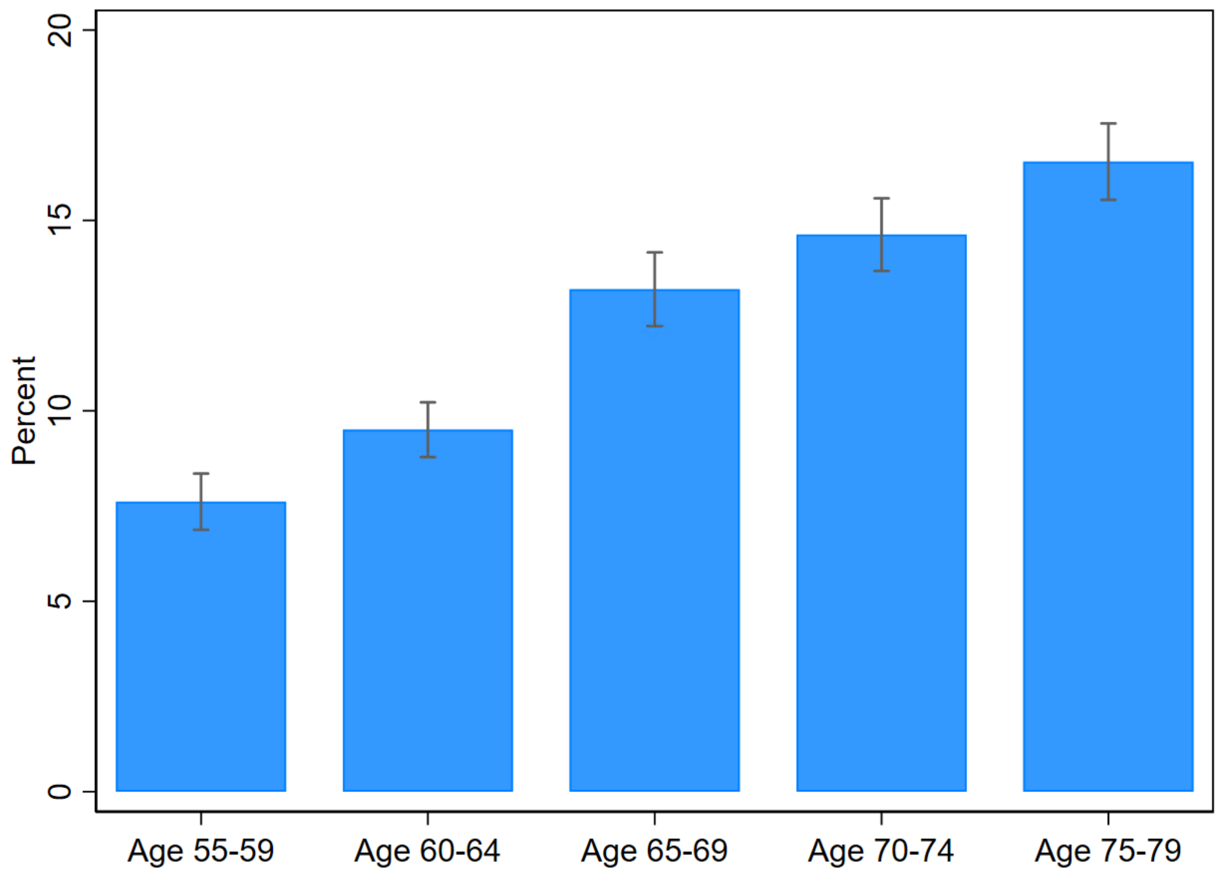
## Tables and Figures

Figure 1: Older Americans Expectation of Future Expenditure on Medical Bills




**Source:** Author's calculations from the Health and Retirement Study. **Notes:** Each bar represents the percent of households who report a 50% of greater likelihood of spending more than given dollar amount on medical bills in the next year. 95% confidence interval calculated from the standard deviation is shown with the error bars. *N*: 5,026 (Age 55-59); 6,453 (Age 60-64); 4,748 (Age 65-69); 5,341 (Age 70-74); 5,347 (Age 75-79).

Figure 2: Percent of Older Americans with Long-Term Care Insurance




**Source:** Author's calculations from the Health and Retirement Study. **Notes:** Each bar represents percent of households in that age group that has long-term care insurance. 95% confidence interval calculated from the standard deviation is shown with the error bars. *N*: 5,026 (Age 55-59); 6,453 (Age 60-64); 4,748 (Age 65-69); 5,341 (Age 70-74); 5,347 (Age 75-79).

Table 1: Summary of Model Parameters

| Parameter | Description | Value | Source |
|---|---|---|---|
| $\tau^p$ | Property Tax Rate | 1.0% | Walczak (2015) |
| $r^d$ | Interest Rate for Deposits | 1.7% | İmrohoroğlu, Matoba and Tüzel (2018) |
| $r^m$ | Interest Rate for Mortgages | 4.05% | Freddie Mac (2018) |
| $\varphi$ | Transaction Cost of Selling a Home | 10.0% | Calibrated |
| $\eta$ | Maximum Loan-to-Value | 80% | İmrohoroğlu, Matoba and Tüzel (2018) |
| $\tau_{\eta_0}$ | Income Tax Parameter | 0.258 | Gouveia and Strauss (1994) |
| $\tau_{\eta_1}$ | Income Tax Parameter | 0.768 | Gouveia and Strauss (1994) |
| $\tau_{\eta_2}$ | Income Tax Parameter | 0.50 | Calibrated |
| $\chi$ | Relative Weight of $c$ in Utility | 0.66 | Bureau of Labor Statistics (2018) |
| $\sigma$ | Relative Risk Aversion | 5.0, 8.0, 10.0 | Calibrated - Albert and Duffy (2012); Tymula et al. (2013) |
| $\delta$ | Housing Depreciation Rate | 1.7% | De Nardi (2004); İmrohoroğlu, Matoba and Tüzel (2018) |
| | Time Discount Factor | 0.96 | Common in Literature |
| $w^s$ | Wage Profile | 2.5, 2.2, 1.7 | Calibrated |
| $\lambda_t$ | Health Shock to Income | 0.75 | Calibrated |
| $d_t$ | Probability of a Health Shock | 0.40 | Health and Retirement Study |

Note: the values of calibrated parameters are set up so the output of the 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: Age 55-64** | 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: Age 65-71** | 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: Age 71-77** | 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: Age 55-64** | 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: Age 65-71** | 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: Age 72-77** | 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 $\lambda_t$ | High $\lambda_t$ | No Transaction Costs |
|---|---|---|---|---|---|
| **Stage 1: Age 55-64** | 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: Age 65-71** | 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: Age 71-77** | 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 |

Note: $\lambda_t$ = 0.75 in the benchmark model, 0.25 for low $\lambda_t$, and 1.25 for high $\lambda_t$.