Investment Decisions of the Elderly

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Abstract

I build a realistic life-cycle model to explain three main puzzles regarding the investment and consumption behavior of the elderly: 1) very high homeownership rate; 2) very low holdings of risky assets; 3) average consumption almost equal to average retirement income. Households are heterogeneous with respect to age, education, marital status, health, financial assets, and housing. They are subject to longevity risk, disability risk, house price risk, and risk associated to stock return. They choose consumption, housing, and investment in risky assets. I find that households have a strong preference for homeownership, mainly motivated by moral hazard issues. Liquidity constraints drive households' decisions to downsize. Together with the large investment in risky illiquid assets, the event risk appears to be the main driver of financial investment decisions. The model is able to reproduce the main empirical facts: high homeownerhip rate, housing tenure persistence, low mobility rate, low investment in risky assets, and consumption about the same as household income. I also study how consumption and investment choices vary when households buy a longevity insurance, finding a significant increase in consumption and homeownership rate.

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1 Introduction

The aging of the population is remarkable in Italy. In 2012, the number of individuals aged 65 and over was 12.5 million out of a total population of about 59.5 million. Moreover, according to the Istat data, individuals aged 85 and over accounted for 2.9% of the Italian population. The old-age dependency ratio[1] is higher than 30 in 2010 and it is projected to increase dramatically in the future (United Nations, 2011). Given the growing number of seniors in Italy, there is an imminent need to better understand how the wealth is distributed among households and how it is allocated in their portfolio (Draghi, 2007).

Data from the Bank of Italy Survey of Household Income and Wealth (SHIW) show three main puzzles in retirees' investment and consumption choices. Firstly, most retirees have a large share of their wealth in the form of housing, also at very old age. That fact is not only typical of Italy, where the average ownership rate after retirement is about 78% and still remains very high after age 80 (above 75%), but it is also common to other countries (US, UK, France). The home is, potentially, the retirees' major source of finance for retirement. However, retirees choose not to use their home equity to finance consumption in their older ages. The 2010 SHIW data show that about 59.87% of elderly homeowners says to have some financial difficulties to sustain their per-period consumption.[2] Interestingly, about 63.96% of retired homeowners without children answer to have financial difficulties in sustaining their consumption.[3] However, even those households choose not to cash in the equity in their home. This saving behavior departs from the predictions of the standard life-cycle model, according to which households should consume the savings accumulated in their working years to support their consumption in retirement. Not only retirees do not use financial instruments, such as reverse mortgages, to borrow against their home equity (Fornero, Rossi, and Urzi, 2011; Michelangeli, 2010), but they also have the tendency of not moving out of their home. Tatsiramos (2006) estimates Italian retirees' residential mobility to be 1.5 percent per year.

Secondly, almost all retirees' financial wealth is invested in safe assets. The average share of safe assets in portfolio exceeds 90 percent. This investment behavior departs from the predictions of the standard life-cycle model of portfolio choice, according to which retirees' income acts as an implicit holding of safe assets and, therefore, a non-trivial fraction of retirement savings should be invested in risky assets, like equities, characterized by a higher average return.

Thirdly, on average, retirees choose to consume their current income, behaving like liquidity con-

[1] The old-age dependency ratio is measured by the number of individuals aged 65 and over as a percentage of the number of individuals aged 20-64.

[2] Among renters, the percentage of households that says to be in financial difficulty is even larger, equal to 83.44%. Among all the retirees, renters and owners, about 64% say to have some financial difficulties to sustain their per-period consumption, where 14.32% face major difficulties, 18.43% face some difficulties, and 31.90% face a few difficulties.

[3] 16.78% face major difficulties, 16.42% face some difficulties, and 30.75% face a few difficulties.

strained households. Paiella (2007) finds a small wealth effect on consumption. Even though the financial wealth effect on consumption is close to the one observed in the U.S., Italian households have, on average, fewer financial asset holdings. On the other hand, Italian households' marginal propensity to consume out of their real assets is quite small.

This research aims at addressing three questions: Why do the elderly maintain a high level of homeownership? Why do the elderly not invest in risky financial assets? Is there any financial instrument that could provide an answer to the health and income challenges faced by the elderly? With the aim of understanding retirees' behavior[4], I build a realistic life-cycle model where households are heterogeneous with respect to age, education, marital status, financial assets, health, housing tenure and size. Households face several risks: longevity risk (risk of outliving the resources), disability risk (risk of requiring long-term care), house price risk, and equity risk (risk associated to stock return). Retirees choose consumption, housing, and investment in risky assets. They sustain health-related medical expenses and per-period housing costs. When retirees change home, some transaction costs are incurred. To my knowledge, this is the first paper that solves a realistic life-cycle model for retirees, which accounts for the main sources of heterogeneity and risk faced by those households and includes the joint decision to invest both in financial and real assets.

In the model, the house plays the dual role of consumption good and investment asset. Households display a strong preference for homeownership, which is mostly motivated by moral hazard considerations, as homeowners have better control over the actions taken to their house. Furthermore, the house can be liquidated only after the payment of some transaction costs. Because of its illiquid nature, the house acts as a store of value that prevents households from completely consuming it. Finally, the house is considered quite an attractive investment for the elderly, since it is characterized by an average positive return, due to the historic house price appreciation, and low risk, due to the low volatility in the shocks to house prices.[5]

The financial investment choices, as observed in the data, are in contrast with the predictions of the standard portfolio theory. Many papers in the related literature introduce participation costs to explain the low stock market participation. However, in practice, the participation costs are too low to prevent households from investing in risky assets[6] and, therefore, I set them to zero in the parameterization

[4]Even though it is not explicitly analyzed in this paper, understanding retirees' investment behavior is increasingly important for its implications on the housing and financial markets, while understanding retirees' consumption choices is relevant for studying their impact on the Italian GDP.

[5]In addition to households' preferences, the peculiarities of the Italian welfare state can explain, at least partially, the high homeownership rate among the elderly. First, the Italian old-age pensions as a percentage of salaries are quite high, on average, in the international comparison.According to the Statistical Office Of the European Communities, Greece, Spain, Portugal and Italy have the highest replacement ratios and about 59% of social protection expenditure is spent on old-age pensions (Ferrera, Jessoula, and Fargion, 2013). Second, health care expenses are mostly covered by the public system. Because of the architecture of the Italian welfare state, a few households face binding liquidity constraints and find it optimal to liquidate their house to sustain their expenses and consumption. Only after a major change in the economic or financial conditions that causes the budget constraint to become binding, households may choose to use their housing equity to sustain retirement consumption.

[6]Even though different banks apply different fees, those fees could be very low. That is particularly true after the

of the model. To understand the elderly's financial choices, the major risks to which households are exposed should be accounted for. Interestingly, while the disability risk is important among the elderly in Italy, the average medical expenses are quite low. Specifically, the risk of sustaining out-of-pocket medical expenses does not represent a source of background risk large enough to prevent an investment in risky assets, at least for the youngest retirees.[7] I find that two main facts could explain retirees' financial investment decision: the investment in housing and the event risk. Retirees have a large share of the portfolio invested in the house, which is like a long-term bond that provides a stream of housing services. However, due to its illiquid nature, it is costly for households to adjust both non-housing consumption and housing consumption in response to individual shocks. Therefore, with respect to their financial portfolio, households optimally choose to take a highly liquid position, which guarantees that household holdings can be easily sold or converted to cash. Furthermore, as house prices can fluctuate over time, housing represents a risky investment – even if the risk has been historically quite low. As a consequence of the exposition to risks in the housing market, households optimally choose to reduce their exposure to risks in the financial markets by reducing their investment in equity. However, the large investment in housing alone does not appear to prevent households from investing in risky assets. To replicate the financial investment behavior of the elderly, I include the event risk[8], which acts as a liquidity risk. Households, facing the risk of a major negative shock to the return on risky assets, prefer not to reallocate their investment portfolio when that shock occurs and, consequently, behave like if that were investing in a buy-and-hold portfolio. In light of a possible need for liquidity, due to unexpected changes in their current income or medical expenses, households choose to reduce their exposure to financial risk by investing in safe assets.

I also find that the bequest motive plays a positive, but minor role in explaining retirees' housing and saving choices. That is consistent with the data, according to which also households without children maintain a high homeownership rate. The role of the bequest motive[9], together with the precautionary saving motive against risks in retirement, provides a further incentive to hold real and financial assets, when liquidity constraints are still somehow loose.

Given the elderly's large investment in housing and low holdings of financial assets, the average consumption tracks the average per-period income. Therefore, taking into account the joint decision over real and financial investment appears important to generate accurate and realistic consumption profiles over the life-cycle.

introduction of trading online.

[7] According to the classical model, the investment in risky assets should then decrease over time, as the risk of incurring out-of-pocket medical expenses increases and the loss in the financial markets cannot be offset by labor income. That pattern of optimal investment in risky assets is also recommended by some financial advisors. The SHIW data show that, on average, the Italian elderly invest in risky assets less than 10 percent of their retirement saving, which is noticeably less than the amount considered optimal according to the standard model.

[8] The event risk is modeled as a small age-invariant probability of a large negative shock to the return on risky assets.

[9] For instance, Bernheim (1991), Sheiner and Weil (1993), and Megbolugbe, Sa-Aadu, and Shilling (1997) studied the role of the bequest motive.

The model is able to replicate some main empirical facts:
1) high homeownership rate, equal to about 78%;
2) tenure persistence, as households rarely change their housing tenure;
3) low mobility, consistently with Tatsiramos (2006): about 1.79% of the elderly move every period;
4) limited investment in risky assets: more than 90% of the retirees' financial portfolio is invested in safe assets;
5) average consumption equal to about €17,500, which is about the same as the average retirement income;
6) renters consume, on average, less than homeowners;
7) house value and consumption are positively correlated with education.

Given that the model is able to reproduce some of the main features of households' behavior in retirement, it could be used as a framework to evaluate alternative economic and financial scenarios. I find that, in response to an increase in the medical costs, a decrease in per-period income, or an increase in the maintenance costs for homeowners, some households choose to use their housing equity, in addition to their liquid financial assets, to finance the retirement expenses. A change in the moving costs has almost no effect on households' investment and consumption choices. A change in the return on risky assets affects households' financial investment choices, but not their housing choices. A change in the house price process induces households to modify housing, financial investment, and consumption.

The model predictions, obtained under a variety of alternative scenarios, support the empirical evidence that households aged 80 and over are the most financial fragile age class among retirees.[10] However, the financial markets do not seem to be able to attract the retirees' investment. In the presence of a reduction in the long-term interest rates, political uncertainty, and unpredictability in the financial markets, households' expectations of an event risk could increase while their willingness to invest in risky assets could further decrease. At the same time, the growing budgetary pressure, resulting also from the demographic change, may induce the government to lower per-period retirement income. I study the housing and consumption decisions when households buy a longevity insurance at age 65. I find that, relative to the baseline scenario without longevity insurance, average consumption significantly increases after age 85 and the homeownership rate does not decrease.

The paper is organized as follows. Section 2 present the related literature. Section 3 introduces the model, section 4 the solution method, and section 5 the parameterization. Section 6 presents the baseline results. Section 7 and 8 presents the results associated with alternative economic and financial scenarios. Section 9 analyzes the longevity insurance. Section 10 concludes.

[10] About 70% of retirees aged 80 and over answer to be in financial difficulty, relative to about 63% of those aged 64 to 79.

2 Related Literature

This paper relates to a few strands of economic literature.

First, it relates to other studies aimed at understanding the empirical behavior of Italian households. Brunetti and Torricelli (2010) study the effects of the aging of the population on financial markets. Using the SHIIW data, they conduct a descriptive analysis of Italian households' portfolio by age and net worth. Using the same database, Guiso and Jappelli (2000) present a detailed description of Italian households' asset allocation over the lifetime. They study the decisions over portfolio diversification and investment in risky assets. Christelis, Jappelli, and Padula (2005) use the Survey of Health, Ageing and Retirement in Europe (SHARE), which contains information on health, socio-economic status, and social and family networks for individuals aged 50 and over in ten European countries. They find that the choice to invest in stocks depends positively on social interactions, financial literacy, and desire to leave a bequest. Bad health is associated to a reduction of the propensity to invest in risky assets. Transaction and participation costs also affect individual investment decision.

Second, this paper builds on the literature on life-cycle behavior (Kotlikoff and Summers (1981), Kotlikoff (1989), Carroll and Summers (1991), Kotlikoff et al. (2001), and Carroll (1997)). Gourinchas and Parker (2002), Cagetti (2003), and Skinner and Zeldes (2002) study optimal consumption and saving behavior. Hubbard et al. (1994), Palumbo (1999), and Hurd (1989) model consumer behavior after retirement. De Nardi, French, and Jones (2010) study the saving behavior of American elderly by focusing on bequest motive, longevity and medical expenditure risks. Nakajima and Telyukova (2011) build a model to explain housing choices in retirement, but do not consider retirees' financial investment. Telyukova and Nakajima (2012) extend the previous analysis to many European countries.

Third, I also follow the literature on housing and on portfolio choice (Campbell and Cocco (2003), Cocco (2005), Gomes and Michaelides (2005), Cocco, Gomes, and Maenhout (2005), Yogo (2009), and Michelangeli (2011), among others).

Finally, Barro (2006) study the 20th century rare disasters and Alan (2012) and Liu, Longstaff and Pan (2003) solve asset allocation problems in the presence of "tail risks."

3 The Model

Let $S_t = \{X_t, H_{t-1}, P_t, Z_t, N_t, E\}$ denote the household vector of state variables, where $t = 65, ..., T$ is household's age with T set exogenously to 100; $X_t = W_t + Y_t$ is its cash-on-hand which includes wealth at the beginning of period t and retirement income; P_t is the house price; H_{t-1} is the previous period housing choice; Z_t is household's health status; N_t is its marital status; and E is its education.

The timing of the event is as follows. The household enters period t and it observes its cash-on-hand, previous period housing choice, current house price, current health status, current marital status, and education. Afterwords, it makes the housing choice H_t, pays the housing expenses ψ_t and moving costs M_t and sustains the medical expenditure Q_t. Simultaneously the household chooses consumption C_t and the fraction of the remaining cash-on-hand to invest in risky assets α_t. After those decisions are made, the shock to the return on risky assets is realized and next period available wealth is determined. Moreover shocks to house prices, survival probability, health status, and marital status occur.

3.1 Preferences

The household's plan is to maximize its expected lifetime utility. In each period the household receives utility from non-durable consumption C_t and from housing H_t. Following Attanasio et al. (2012), the housing preferences explicitly value the benefits associated to homeownership, in addition to accounting for the housing size. Let $H_t \in \{0, 1, 2\}$, where $H_t = 0$ indicates that the household rents a small size house, $H_t = 1$ that the household owns a small size house, and $H_t = 2$ that the household owns a large size house.

Household preferences are described by a utility function in consumption and housing:

$$U(C_t, H_t) = \frac{\frac{C_t}{g(N_t)}^{1-\gamma}}{1-\gamma} exp(\theta\phi(H_t)) + \mu\phi(H_t) \tag{1}$$

where γ is the coefficient of relative risk aversion. The CRRA utility in current consumption is adjusted by a factor $g(N_t)$, to account for the number of household components. The utility from consumption is modified by including a multiplicative term $exp(\theta\phi(H_t))$, that acts as a scaling factor, and an additive term $\mu\phi(H_t)$. The parameter θ set whether consumption and homeownership are complement or substitute in the utility. The additive term includes the parameter μ that implies that housing is a luxury good if $\mu > 0$ or a necessity good is $\mu < 0$. The parameter $\phi(H_t)$ defines the relative utility from owning a large size house versus a small size house. When $H_t = 0$, that is when the household rents a home, $\phi(H_t)$ equals 0 and the household only receives utility from consumption. When $H_t = 2$, $\phi(H_t)$ takes value 1. When $H_t = 1$, $\phi(H_t)$ could take any value in between 0 and 1, implying that $\phi(H_t = 1)$ defines the value associated to the type of house. Using this specification for household's preferences, I abstract from imposing a proportionality between housing and consumption and I can capture the utility associated specifically to homeownership. That utility is mostly driven by moral hazard issues, according to which owners receive a higher utility from housing services than renters because they have full control over the actions taken to their home.[11]

[11] I choose to use this specific utility function, following Attanasio et al. (2012) because it captures the main features about housing preferences. As empirically shown the elderly tend not to move out of their home. Having a Cobb-Douglas

3.2 Bequest function

The household receives some utility from leaving a bequest to its heirs. The bequest consists of financial assets W_t and house value $P_t D(H_t)$. The bequest function takes the following specification:

$$TW(W_t, H_t, P_t) = \eta \frac{(W_t + P_t D(H_t))^{1-\gamma}}{1-\gamma} \tag{2}$$

The parameter η captures the intensity of the utility from leaving a bequest.

3.3 Household's marital status

Marital status is a basic demographic factor that drives retirees' consumption and investment choices. Households can be single or married. Let N denote the number of household components, which equals 1 for single households and 2 for married households. Marital status evolves over time according to a transition matrix Π_N, whose elements are $\pi(N_t) = Pr(N_{t+1}|N_t)$.

3.4 Household's income

In each period, the household receives a constant stream of income, which only depends on her marital status N_t and level of education E, $Y(N_t, E)$. The level of education does not change over time. I assume that the retirement income is deterministic and not affected by random shocks. The retiree's income accounts for after-tax Social Security Income income and other net transfers.[12] With the aim of studying the investment and consumption decision after retirement, I do not consider working households and, consequently, I abstract from including job-related earnings.

3.5 Health

Retirees differ by their health status Z, which evolves according to a Markov process.

Figure 1 shows that the number of individuals affected by some disability increases with age. The percentage of individuals affected by disability raises from 5.5 for individuals aged 65-69 to 44.5 for those older than 80.

Given the importance of the disability risk among retirees, I consider the following three health

utility in housing services and consumption could be computationally quite costly if the number of housing sizes considered is large. However the associated benefits is lower. Instead, considering only three possible choices over housing allows to increase the number of other relevant state variables.

[12] Less than 5% of the sample receive those net transfers, therefore the 'pension income' represents the main form of retirement income.

states: good, bad without limited ability, and bad with limited ability. The health status evolves over time according to a transition matrix Π_Z, whose elements are $\pi(Z_t) = Pr(Z_{t+1}|Z_t)$. Households incur out-of-pocket medical expenses $Q(Z_t, N_t, t)$, which are function of the health status, number of household components, and age.

3.6 Financial assets

There are two financial assets. The first is a riskless asset with gross real return $R_F = 1 + r_F$. The second is a risky asset with gross real return $R_t = 1 + r_t$. As in Cocco, Gomes, and Maenhout (2005), the excess premium, defined as the difference between the gross real return on risky assets and the gross real return on safe assets, is:

$$R_{t+1} - R_F = \mu_r + \iota_{t+1} \tag{3}$$

where μ_r is the mean excess premium and ι_{t+1} is the innovation to the excess premium distributed as $N(0, \sigma_\iota^2)$. B_t and S_t denote the amount of safe and risky assets hold by the household at time t, such that

$$S_t \geq 0, B_t \geq 0, \forall t. \tag{4}$$

This implies that the household cannot short-sell any of these financial assets.

3.7 House prices and costs

Real house prices are assumed to follow an AR(1) process, defined as follows:

$$\log(P_t) = \mu_p + \rho \log(P_{t-1}) + \epsilon_t \tag{5}$$

where μ_p is the mean, ρ is the autoregressive parameter, and ϵ_t is the error distributed as a $N(0, \sigma_\epsilon^2)$.

Per period housing expenses $\psi(H_t)$ are assumed to be function of the house size, deterministic and constant over time. For homeowners, they correspond to a maintenance cost, incurred to keep the house at a constant quality level. For renters, they represent the rental cost.

I assume that the retired homeowners cannot buy a larger house that the one currently owned. If they sell their house, they can only buy a smaller size house or rent. If they are currently renting their home, they can only continue renting and they are not allowed to become homeowners.[13]

[13]This assumption is reasonable as a very small percentage of renters become homeowners.

If the household decides to sell its house at time t and move to another house, it receives the difference in the owner-occupied housing wealth. In addition, it sustains a one-time transaction cost, $\lambda(H_{t-1}, H_t, P_t)$, which is a function of house size, housing tenure, and house prices. It is given by the sum of the transaction costs sustained by the seller λ_s (if the household sells its home), by the buyer λ_b (if the household buys a new home), and by the renters λ_r (if the household becomes a renter). Let $M(H_t, H_{t-1}, P_t)$ be the moving cost defined as:

$$M(H_t, H_{t-1}, P_t) = P_t D(H_t) - P_t D(H_{t-1}) + I_D \lambda(H_{t-1}, H_t, P_t) \tag{6}$$

where I_D is an indicator function taking value 1 if $H_{t-1} > H_t$ and 0 otherwise.

3.8 The retiree's optimization problem

The Bellman equation for the household problem is:
$V(S_t) = \max_{C_t, \alpha_t, H_t} U(C_t, H_t) +$

$$\beta[sp(N_{t+1}) E_t V(S_{t+1}) + (1 - sp(N_{t+1})) TW(W_t, H_t, P_t)] \tag{7}$$

where next period wealth is given by:

$$W_{t+1} = R_{t+1}(W_t + Y(N_t, E) - C_t - M(H_t, H_{t-1}, P_t) - \psi(H_t) - Q(Z_t, N_t, t)) \tag{8}$$

The return on the portfolio is:

$$R_{t+1} = \alpha_t(1 + r_{t+1}(1 - \tau_S)) + (1 - \alpha_t)(1 + r_F(1 - \tau_F)) \tag{9}$$

and

$$C_t \geq C_{min}, 0 \leq \alpha_t \leq 1 \tag{10}$$

where τ_S is the tax rate applied to the interests on risky assets and τ_F is the tax rate applied to interests on the safe assets.

4 Solution Method

The model is solved using numerical techniques (Judd, 1998). As households make both discrete and continuous choices and face fixed housing transaction costs, the model is solved using value function iteration (instead of relying on the first order conditions), starting from the last period of life and moving backward until age 65. In the last period, a terminal value function is obtained for each combination of the state variables. That function acts as a continuation value function. In each previous periods, for each vector of state variables, the household first makes a discrete choice over housing. Given that housing choice, the household chooses her consumption and share of risky assets. As consumption and portfolio choice are continuous choices, I use cubic spline interpolation to evaluate the function outside the grid. I compute the optimal consumption and portfolio choice for each possible choice over housing and I obtain all of the possible value functions associated with a vector of state variables. I use grid search to select over the possible choices. I use the quadrature based method (Tauchen and Hussey (1991)) to approximate the house price process and the return on risky assets. I also include a small probability for the event risk. Once the model is solved and the policy functions obtained, I simulate 10,000 households of age 65 and I use the computed policy functions to obtain households' choices over time.

5 Parameterization

I drew from several sources of data to select some parameter values used in the model (see Table 1). Specifically, I used the Bank of Italy SHIW data for marital status, financial assets, house value, education, income, and minimum consumption; the SHARE data for health status and medical expenses; the ISTAT data for survival probabilities; the OECD equivalence scale and OECD data for moving costs; "Il Consulente Immobiliare" and "Agenzia del Territorio" for house prices; data from Mediobanca for return on risky assets. The year of reference for the baseline parameterization is 2010.

Given the focus on retirement behavior, I restrict the sample to households born before 1946 (older than 64 in 2010). I considered only households that are fully retired, who do not perceive any income from self-employment or as employees. I also drop households that declare to have house value greater than €800,000 or financial assets greater than €150,000.[14] Those choices are motivated by the aim of studying the investment decisions of an average retiree with a fixed retirement income. I focus on households and, when the variable of interest differ among household components, I choose to use the data for the household reference person. The final sample consists of about 2,500 households and I use that sample to compare the empirical choices with the predictions of the model.

[14] 160 observations are lost from imposing a restriction on financial assets and house value.

5.1 Risk aversion and discount factor

The risk aversion parameter γ takes a value of 5 and the discount factor takes a value of 0.96, as those parameter values are considered standard in the literature of portfolio choice.

5.2 Marital status

Marital status is an important determinant of the elderly's investment decision. Married households consist of two individuals. Single households consist of one individual and include single, widowed, or divorced. As shown by the SHIW data, the household marital status is subject to dramatic changes in the retirement period, mostly due to the death of one of the partners. About 60 percent of households younger than 70 are married and only about 29 percent of households older than 80 are married. As the fraction of singles tends to increase with age, I model transition matrices for the marital status dependent on age.

I obtain the transition matrices for marital status using the SHIW 2008 and the 2010 waves.[15] I follow the counting method that consists of counting the number of married and single households in both waves and computing the changes. Since the model is annual, while the SHIW is biannual, I converted the transition matrices from biannual to annual. The marital status transition matrices are reported in Table 2.

5.3 Retirement income

I parameterize household retirement income using the 2010 SHIW data on after-tax pension and net transfers. Retirement income is assumed to be function of both marital status and level of education. I distinguish two levels of education: low and high. The low level of education includes households without education or with only elementary education. The high level of education includes households with middle school, high school, bachelor degree, master, Ph.D., or other post-bachelor degrees. Those two groups include about the same number of households. I assume that the level of education remains constant over time. I calculate a weighted average of the retirement income for households with low and high education according to their marital status. The average retirement income for single with low education $Y(N = 1, E = 1)$ is €11,100, for single with high education $Y(N = 1, E = 2)$ is €15,930, and for married with low education $Y(N = 2, E = 1)$ is €16,650, for married with high education $Y(N = 2, E = 2)$ is €23,340.

[15] To parameterize the marital status in retirement I include all the households aged 65 and over, under the assumption that the financial situation does not cause a change in marital status.

5.4 Survival probabilities

The survival probabilities are taken from the ISTAT statistics. The survival probability for a married couple is given by the product of the male and female survival probabilities. The survival probability for a single household equals the weighted average survival probabilities of male and female, using the percentage of male and female for each age class in 2010 as a weight.

5.5 Equivalence scale

Household consumption is adjusted using the OECD equivalence scale, according to which the consumption of a two people is equal to the consumption of a person multiplied by the square root of 2. Therefore I set the adjustment factor $g(N_t)$ equal to square root of 2. This is consistent with the SHIW data, where a retired household composed by two individuals consumes on average 1.5 as much as an household composed by a single individual.

5.6 Consumption floor

According to the ISTAT data, the level of absolute poverty varies according to the number of household components and to the geographic area. Specifically, it varies from a minimum of about €490 per month for a single household living in the South and a maximum of about €1000 per month for a married couple living in the North.[16] I assume a minimum consumption floor C_{min} lower than the absolute poverty rate and equal to the minimum household consumption observed in the SHIW, corresponding to €3000. This implies that if, a households have decumulated all its real and financial assets, its consumption will not follow below that minimum amount. This captures the fact that Government, religious associations, or charity groups may help the household in sustaining its consumption when it has exhausted her assets.

5.7 Medical expenses

The Bank of Italy SHIW data does not contain detailed data on household medical expenses for the year 2010. A supplementary database, which samples households aged 50 and over, that could be useful for the parameterization is the SHARE. The SHARE is constructed to mirror the US Health and Retirement Study (HRS) and contains questions about the individual health status and medical expenditures, wealth, income, and job status (Brugiavini, Jappelli and Weber, 2002). I use the 2004 and

[16] Data from "La misura della povertá assoluta," ISTAT 2009, adjusted for inflation.

2006 SHARE data to parameterize the health status transition matrix and related medical expenses, as those waves contain the major number of details about medical expenditure and health.

I select a sample of households aged 65 and over. Households can be in a good health status, bad health status without limited ability, or bad health status with limited ability. The health status is subjective as it results from individuals' answers to the survey. I use two questions to identify households' health status. The first question is "how is your health?"[17] The good health status corresponds to the answers "very good," "good," and "so and so." The bad health status corresponds to the answers "very bad" and "bad." The second question concerns limited activities.[18] An household is defined to be in bad health with limited ability if the household answered to have a "bad" or "very bad health" and to be "severely limited in doing normal activities because of its health." An household is defined to be in bad health without limited ability it answered to have a "bad" or "very bad" health and but also answered not to be "severely limited in doing normal activities because of its health." The number of households to have limitations in doing normal activities increases with age. Consistent with the Multiscopo Analysis, the SHARE data show that about 4 percent of the population aged 65-66 is characterized by limited ability to carry on normal activities, while, on average, more than 40 percent of seniors 80 and over are characterized by having limited ability in conducting normal activities. Given that the health status changes as households age, I compute health transition matrices by age. The health status, especially the bad health status with limited ability, is very persistent. Since the SHARE is a biannual survey, I converted the two years transition matrices into one-year transition matrices. The health status transition matrices are reported in Table 3.

Out-of-pocket medical expenses include paid out-of-pocket for inpatient care[19], paid out-of-pocket for outpatient care[20], paid out-of-pocket for prescribed drugs[21], paid out-of-pocket for day care, nursing home and home based care[22]. I computed the total out-of-pocket expenses for year 2004 and 2006. I adjusted those values to 2010 euro using the Italian consumer price index and I took the average of the medical expenses of both years to obtain the average medical expenses by health status in 2010. Table 4 shows that the medical expenses are larger for households in a bad health status with limited ability

[17] "Health in general question 1: Direbbe che la sua salute è: 1. Molto buona; 2. Buona; 3. Discreta; 4. Cattiva; 5. Molto cattiva."

[18] "Question on Limited Activities: Pensando almeno agli ultimi sei mesi, quanto sei stato/a limitato/a nelle normali attività causa di un problema di salute? 1. Notevolmente limitato/a; 2. Limitato/a, ma non in modo notevole; 3. Non limitato/a."

[19] "Paid out-of-pocket for inpatient care: Senza considerare i premi delle assicurazioni sanitarie o i rimborsi pagati dai datori di lavoro, all'incirca quanto ha speso di tasca propria per tutti i suoi ricoveri ospedalieri negli ultimi dodici mesi?"

[20] "Paid out-of-pocket for outpatient care: Senza considerare i premi delle assicurazioni sanitarie o i rimborsi pagati dai datori di lavoro, all'incirca quanto ha speso di tasca propria per tutte le cure senza pernottamento in ospedale o clinica, negli ultimi dodici mesi?"

[21] "Paid out-of-pocket for prescribed drugs: Senza considerare i premi delle assicurazioni sanitarie o i rimborsi pagati dai datori di lavoro, all'incirca quanto ha speso di tasca propria per tutti i farmaci che le sono stati prescritti, negli ultimi dodici mesi?"

[22] "Paid out-of-pocket for day care, nursing home and home-based care: Senza considerare i premi delle assicurazioni sanitarie o i rimborsi pagati dai datori di lavoro, all'incirca quanto ha speso di tasca propria per assistenza in casa di riposo o residenza assistenziale, in centri di assistenza diurna e per tutti i servizi di assistenza a domicilio, negli ultimi dodici mesi?"

and increase with age.

5.8 Financial markets

I define as safe assets the sum of deposits and short-term government bonds[23] and I define as risky assets other bonds, stocks, managed assets, foreign bonds, and others assets.[24]

To compute the return on risky assets, I used Mediobanca data, starting in 1950. The real stock return has been computed starting from the index of total stock return (deflated by the consumer price index)[25]. The return on safe assets has been computed using the nominal return on Italian one-period bonds (BOT) deflated by the consumer price index to obtain real returns. The excess premium is given by the difference between the real return on risky assets and the real return on safe assets in each period. The mean return on safe assets is $r_F = 0.012$, the mean excess premium μ is 0.049, and the standard deviation of the innovation to excess premium σ_ι is 0.26. I define as an event risk a rare event, that has a low probability of happening, to which is associated a significant reduction in the return of risky assets. I assume that an event risk implies that the stock return equals its mean minus two-standard-deviation, which implies a stock return lower than -40 percent. To assess the validity of this assumption, I consider two datasets, covering the years between 1950 and 2010, "Indice Annuale dei corsi della Borsa Italiana" by Mediobanca and the "Milan Comit Global - DS Total Return Index (DSRI)." Data about the event risk are reported in Table 5. The probability of an event risk is assumed to be equal to 0.05.

5.9 House value, housing expenses, and house prices

House values are parameterized using the 2010 SHIW data.

To obtain the values associated to large and small size houses, I first computed the weighted average house value for the entire sample, assuming a minimum house value of €30,000 to eliminate outliers. The average weighted house value equals about €200,000. I then computed the weighted median house value for those households living in a house of value greater than €200,000, which equals €300,000. That is the house value assigned to the large size house, $D(H = 2)$. Similarly, I computed the weighted median house value of those households living in a house of value lower than €200,000, which equals €135,000. That is the value assigned to the small size house, $D(H = 1)$. The value of a rental house, $D(H = 0)$, equals €0.0.

[23] "Depositi e titoli di stato."
[24] "Obbligazioni, azioni, gestioni patrimoniali, titoli esteri, prestiti alle cooperative, altro."
[25] "Indice dei corsi azionari deflazionato con l'indice dei prezzi al consumo."

For homeowners, per-period housing expenses include ordinary maintenance that equals 1.5% of the house value. For renters, per-period housing expenses involve the rent, that is parameterized using the 2010 SHIW data and is equal to about €3,600 annually.

If households decide to move out of their house, they pay some moving costs. Those costs equal 3.5% of the house value for sellers and 8.5% of the new house value for buyers.[26] Those fees include notary fees, typical real estate agent fees, legal fees, registration fees, and transfer taxes. The housing moving cost is higher for buyers because only they are charged with notary fees, taxes, and registration fees.Instead, for renters, the cost associated to entering the rented house equals one-month of rent.

The sources used to parameterize the house price process are "Indici Quotazioni Compravendite per Macro Aree Geografice e Totale; prezzi costanti" by "Il Consulente Immobiliare"(until 2007, second semester) and "Agenzia del Territorio" (from 2008, first semester). I used house price data from the first semester of 1967 until the second semester of 2011. To obtain the real house price for each year, I took an average of the two semesters. I estimate an AR(1) process with intercept for the log of real house prices. I found that the autoregressive parameter ρ_p takes a value of 0.95, the intercept μ_p equals 2.36%, and the standard deviation of the shock σ_ϵ is 0.04.

5.10 Calibrated parameters

I calibrate five parameters, μ, $\phi(H = 1)$, θ, η, G_{FA} to match five moments: the weighted average homeownership rate for households aged 65 and over equal to 78.5%, the percentage of households owning a small size house equal to 52.1% of the sample, the mean ratio consumption/house value for homeowners equal to 9.55%, the mean financial assets equal to €15,888, and the mean financial assets for age class 65-70 equal to €19,491. In the interpretation of the definition of the calibrated parameters I follow Attanasio et al. (2012). However, those authors explicitly mention that in their paper the end-of-life behavior and bequests are not modeled, causing an overestimation of sales of homes at old ages. Furthermore, in Attanasio et al. (2012) the health expenses motive for saving after retirement is not considered. It follows that, ex-ante, I do not have a strong prior for the value taken by the calibrated parameters. Table 6 presents the calibrated parameters.

The parameter μ takes a positive values, equal to 0.44, implying that homeownership is a luxury in the utility as defined by Attanasio et al. (2012): The additive term is positive and constant, implying a shift in the utility function at high levels of non-durable consumption.

The parameter θ takes a positive value of 2.33 which indicates that non-durable consumption and homeownership are complements in the utility, following from the positive cross-partial derivative of

[26]Source: 2012 OECD report, OECD calculations based on OECD Housing Market questionnaire.

the utility function with respect to consumption and housing. The additional additional utility from homeowneship could be associated with moral hazard issues, according to which homeowners have more control than renters over actions that influence the value of housing services.

The parameter ϕ represents the preference for the house type. For renters, $\phi(H = 0)$ takes value 0, meaning that renters only derive utility from non-durable consumption goods. For owners of a large size house, $\phi(H = 2)$ takes value 1. For owners of a small size house, $\phi(H = 1)$ takes a value in between 0 and 1. The calibrated parameter $\phi(H = 1)$ takes then a value of 0.85, implying that the extra utility from owning a large size house versus a small size house is about 15%.

The parameter η, which, as mentioned earlier, captures the utility from leaving a bequest, takes a positive value, equal to 0.02. As a consequence, retirees benefit from leaving some bequest to their heirs. The parameter G_{FA} is used to match the initial distribution of financial assets for the age class 65-70.

6 Results

In this section, I compare the model predictions with the data. First, I present the macroeconomic variables and, then, the life-cycle profiles.

Table 7 presents the average value of some macroeconomic aggregates both in the model and in the data. I use the 2010 SHIW data to compute a weighted average of homeownership rate, percentage of owners of small size house, financial assets, share of safe assets, and consumption. The model captures quite well the retirees' behavior, being also able to reproduce some moments that are not targeted in the calibration. The average homeownership rate is about 78 percent, about 50 percent of homeowners own a small size house, the average house value is about €200,000. The fact that households have an average stock of liquid financial assets equal to about 9 percent of the average house value highlights the fact that the amount of liquid assets in portfolio represents just a minor fraction of the total portfolio. Retirees keep more than 90 percent of their financial wealth in safe assets and consume on average about €18,000 yearly, which is financed almost entirely with their current income. Tatsiramos (2006) estimates Italian retirees residential mobility to be 1.5 percent per year. The model is also able to capture that empirical fact, since it predicts that about 1.79% of households choose to move out of their house.

To deepen the study of retirement behavior and to assess the validity of the model, I construct four groups of households that differ by their age and consist of about the same number of households. The first group includes households aged 65 to 69 (19% of the sample), the second group includes households aged 70 to 74 (26% of share sample), the third group includes households aged 75 to 79 (22% of share

sample), the fourth group includes households aged 80 to 100 (33% of share sample). Given the limited number of observations for retired households, analyzing the households' behavior for four age classes allows to have a smoother behavior.

Figure 2 shows the homeownership rate by age. Overall, in the data, the homeownership rate remains quite high (about 80%) and almost constant until the end of life. The model is able to capture quite well that data profile, as it predicts that households choose to remain homeowners also very late in life. As households choose not to sell their house to cash in some of the equity locked in it, one could conclude that also the very old households prefer to maintain a high level of housing consumption at the cost of a possible reduction in non-housing consumption.

Figure 3 shows the average house value in 2010 euro, both in the data and in the model. The average house value tends to slightly decrease with age as some older households choose to live in a smaller house, while remaining homeowners. Households, who choose to downsize, benefit from liquidating some of the equity held in their house as well as from the lower per-period maintenance costs associated with the smaller houses. The figure also captures the fact that the fraction of homeowners that live in a small size home increases with age, moving from about 40% of households younger than 70 to more than 60% of households older than 79.

Figure 4 displays the average financial assets over the retirement period. The liquid assets, even though considerably lower than the average holdings of illiquid assets, tend to remain at a positive level also at very old age. That means that households choose to maintain a buffer of savings that could either be used to pay for their age-related medical expenses or left as a bequest. As average consumption is slightly greater than average per-period income, some households use a small fraction of their liquid wealth to finance their per-period consumption.

Retirees, on average, choose to invest their liquidity in assets characterized by a low, but safe return. As shown in Figure 5, the average share of financial assets invested in safe assets is almost constant after age 65 and does not drop below 90%. Retirees, who face medical expenditure risk, house price risk, and event risk, choose to avoid taking other risks from investing in the financial markets.

Figure 6 displays the average consumption, inclusive of housing costs, both in the model and in the data. Average consumption is about stable in retirement, averaging around €18,000 and slightly decreasing.

The model delivers also some other results. For instance, it predicts that housing tenure has a major effect on households' consumption level. Renters on average have a lower consumption than homeowners (see Figure 7).

Furthermore, the education level, which affects the retirement income, is a major determinant of

different economic behaviors among retirees. More educated households display a higher homeownership rate and live in houses of value about 15 percent higher than less educated households. The difference between average house values shrinks with age, but it remains significant after age 80. Also the average consumption is higher for more educated households by about 30 percent. The higher per-period retirement income allows more educated households to sustain larger per-period maintenance costs and consumption. With respect to investment in risky assets, households' behavior does not display significant differences, even though households with higher education have a slightly larger fraction of their portfolio invested in risky assets.

7 Alternative Economic Scenarios

In this section, I evaluate how households' economic behavior changes relative to the baseline scenario when alternative economic scenarios are considered. Table 8 presents the percentage changes in the aggregate variables relative to the baseline scenario. In the Appendix, I report the percentage changes by age, education, and housing tenure.

7.1 1 percent increase in medical expenses

One of the driving force of savings after retirement is the medical expense risk. In order to quantify how much that risk affects retirees' economic behavior, I assume that medical expenses are increased by 1 percent. That increase could result from a restriction in public medical coverage or from an increase in the unit cost of medical services or drugs. As displayed in the first column of Table 8, the model predicts a decrease in the homeownership rate, which is mostly driven by a decrease in the fraction of small size house owners. Households also reduce their average financial assets, without changing their average consumption. As an increase in the medical expenses represents an increase in the risks faced by retirees, the share of safe financial assets in portfolio increases, averting an increase in the overall exposure to risk.

In Table 10 in the Appendix, the effects associated with a 1 percent increase in medical expenses are disentangled by age, education, and housing tenure. With respect to age, the behavior is different for households aged 65 to 79 and for households aged 80 and over. Households aged 65 to 79 choose to downsize while remaining homeowners. Downsizing allows young retirees to increase their available financial assets and consumption. The average share invested in safe assets does not change significantly, as the medical risk is relatively low until age 80. Households aged 80 and over face a larger disability risk and larger expected medical expenses. More than 1% of retirees older than 80 choose to sell the house and become renters. The average house value among the remaining owners is slightly larger

relative to the baseline, as the poorest retirees have chosen to change their housing tenure. To finance their consumption, some retirees use their proceeds from the sale of the house, while others choose to use their accumulated financial assets. As the overall exposure to risk increases, the share invested in safe assets increases.

The second and third columns of Table 10 show the effects by education level. On the one hand, the impact of the policy on retirees with a high level of education is limited. Those retirees do not chose to sell their house and only few move to a smaller house. They slightly reduce their financial assets and their consumption. They also reallocate their portfolio towards more safe assets. On the other hand, the impact of the policy on retirees with a low level of education (and a lower income) is quite strong. Low educated households younger than 80 choose to downsize, while those older than 80 choose to sell their house. The financial resources made available after the change in housing size or tenure are used to sustain household consumption.

The fourth and fifth columns of Table 10 show the effects by housing tenure. The model predicts that owners choose not reduce their average consumption, as young owners choose to downsize and old owners choose to sell the house to cash in some of their housing equity. Instead, young renters reduce their financial resources to sustain their consumption, while old renters are forced to reduce their consumption.

7.2 1 percent cut in retirement income

A cut in retirement income has an impact on the household budget, but, differently from the previous experiment, it does not affect the household exposure to risk. As shown in the second column of Table 8, the reduction in the homeownerhip rate is smaller and a larger fraction of households choose to downsize, while remaining owners. As a result, the fraction of small size house owners increases and the average house value reduces. The change in housing allows to cash in some of the housing equity and, as a consequence, average financial assets increase. In response to a budget effect, households choose to reduce their consumption. However, as the policy in itself does not generate an increase in the household exposure to risk, the share of risky assets increases. That increase is mostly driven by high educated households older than 80, who are willing to invest in the financial markets, while the low educated ones choose to leave almost unchanged their financial portfolio composition.

Table 11 in the Appendix presents the effects as disentangled by age, education, and housing tenure. As shown in the first column, households younger than 80, optimally choose to downsize to increase their financial resources and to sustain their consumption. On the other hand, households older than 80 are those that suffer the most. They use both the proceeds from the sale of the house or from downsizing and their financial assets to sustain their consumption, which, nevertheless, decreases on

average as a result of the budget effect.

The second and third columns present the effects of the policy disentangled by education level. The model predicts that that low educated households older than 80 suffer the most. As a matter of fact, that group of households displays the largest change in homeownership rate, use the largest fraction of financial savings, and reduce by the largest amount its consumption.

The fourth and fifth columns show the effects by housing tenure. Renters are those who suffer more from the policy as any age group chooses to reduce its consumption.

7.3 Change in moving costs

To study the role played by the housing moving costs in preventing households from liquidating their house, I considered two alternative policy scenarios: no moving costs and a 1 percent increase in the moving costs. As shown in the third and fourth columns of Table 8, the aggregates remain basically unchanged relative to the baseline scenario. That prediction could be motivated by the fact that households, who are not facing binding liquidity constraints, choose to keep unchanged their housing status, consumption, and investment choices.

The two policy experiments show that the housing transaction costs are not the main explanation for the observed persistence in households' housing tenure. The minor difference between the two experiments, as showed in Table 12 and Table 13 of the Appendix, is that in the first scenario a small fraction of low educated households older than 80 optimally chooses to remain owner instead of becoming renter, while in the second scenario there are not relevant changes relative to baseline.

7.4 1 percent increase in maintenance costs for homeowners

In this experiment, I study how an increase in the maintenance costs faced by homeowners affects households' economic behavior. For istance, such a case could mimic the effects of a generic increase in the taxes levied on real estate properties (when no provisions for poor households are made and the tax is simply proportional to the house value). As shown in the fifth column of Table 8, the homeownerhip rate slightly drops. Moreover, among homeowners, there is an increase in those that opt for a smaller size house and the average house value decreases. Households use the new available financial resources to sustain their consumption, which, nevertheless, slightly reduces. The increase in the share of safe assets is driven by high educated households older than 80, who substitute their investment in housing with an investment in safe assets.

As shown in the first column of Table 14 in the Appendix, the effects of the policy are different by

age. The youngest retirees experience an increase in their financial assets, because, at the announcement of the increase in maintenance costs, they immediately choose to downsize, cashing in some of their housing equity. They use those financial assets to sustain their consumption. Instead, some of the older retirees choose to sell-and-rent, downsize, or use their financial assets to support their consumption, which, however, slightly decreases on average.

As displayed in the second and third columns, the low educated households older than 80 suffer the most. That group of households experience the largest drop in homeownership rate, financial assets, and consumption.

The last two columns show that the policy only affects the choices of owners, without almost any impact on the renters' choices.

8 Alternative Financial Scenarios

In this section, I evaluate how households' choices change relative to the baseline scenario when alternative financial scenarios are considered. Table 9 presents the percentage changes in the aggregate variables relative to the baseline scenario. In the Appendix, I report percentage changes by age, education, and housing tenure.

8.1 Increase in the mean of excess premium by 1 percentage point

An increase in the mean of excess premium implies that the expected real return from an investment in risky assets increases. As displayed in the first column of Table 9, the main effect is an increase in the average share of risky assets in portfolio. In face of a higher expected return from investing in the financial markets, households can slightly increase their investment in housing and reduce their financial assets, while keeping constant their consumption.

Table 15 in the Appendix shows that the main effect is a strong decrease in the share of safe assets for households 80 and over, high educated, that own a house. That group of households is the one that is more willing to modify its investment in the financial markets. Instead, the policy as a minor effect on older households with low education or renters who, on average, keep almost unchanged their investment in safe assets.

8.2 Decrease in the standard deviation of the shock to excess premium by 1 percentage point

A decrease in the standard deviation of the shock to the excess premium implies a reduction in the riskiness of the investment in risky assets. Likewise the previous scenario, the second column of Table 9 shows that some households choose to reallocate their portfolio between risky and safe assets and between liquid and illiquid assets in such a way to leave unchanged their average consumption.

As shown in Table 16 of the Appendix and consistently with the previous scenario, households age 80 and over, high-educated, that own a house display the largest response in term of reallocation of their financial portfolio towards risky assets. The increase in the share of safe assets for renters is the result of a composition effect, as the group of renters includes, on average, under this alternative scenario, less and poorer households.

8.3 Increase in the mean of log real house prices by 1 percentage point

The house is both a consumption and an investment good. It affects households' preferences, which are defined over housing consumption, non-housing consumption, and housing tenure. It is also an investment, characterized by a positive expected return, as a consequence of the historic house price appreciation. But, it is a risky investment, due to the house price volatility. When the mean of the house price process increases, the investment in housing is more profitable and the homeownership rate increases (see the third column of Table 9). However, since it is a risky investment, households choose to increase the share of their financial portfolio invested in safe assets. The average consumption decreases, as the utility resulting from owning a house increases and households substitute housing consumption for non-housing consumption. The increase in the average financial assets is driven by households that sell their house and receive a higher price, relative to the baseline scenario, from that sale.

Table 17 in the Appendix shows that the results are almost completely driven by low educated households. Low educated households with more accumulated savings, choose to increase their house value or homeownership rate, substituting housing consumption for non-housing consumption. Low educated households with less accumulated savings, sell the house benefiting from the higher sale price and, hence, increasing their financial assets.

The increase in consumption for older renters, as shown in the fifth column, results from the fact that low educated households that sell their house have more financial resources after the sale that could be directed to consumption.

8.4 Decrease in the standard deviation of the shock to log real house prices by 1 percentage point

A decrease in the standard deviation of the shock to log real house prices implies that the investment in housing is less risky. To maintain the same overall exposition to risk, households optimally choose to increase their investment in risky financial assets (see the fourth column of Table 9). Furthermore, consistently with the previous scenario, the average homeownership rate and house value increase, while consumption decreases.

Likewise the previous scenario and as shown in Table 18 of the Appendix, low educated households drive all of these results.

8.5 Decrease in the probability of the event risk by 1 percentage point

A reduction in the probability of the event risk implies that the expected return from investing in risky assets is higher. Households optimally choose to increase the share invested in risky assets. Likewise the scenarios with alternative specifications of the excess premium, households choose to sligthly increase their investment in housing and reduce their financial assets, while keeping almost constant their consumption (see the fifth column of Table 9).

Table 19 in the Appendix shows that households age 80 and over, high-educated, that own a house display the largest response in term of reallocation of their financial portfolio towards risky assets. That group of households drives most of the results.

9 Financial Innovation: Longevity Annuity

The data, the baseline model, and policy experiments show that households aged 80 and over are the most financial fragile among the elderly. Specifically, that age group has decumulated mostly of its liquid savings, tends to consume its per-period income, and, if a change in its medical expenses, maintenance costs, or retirement income occurs, its budget constraint could become binding and a sale of the house could be the only available choice to increase its liquid position. However, even after liquidating the house, many households have to reduce their per-period consumption. This is particularly true for the renters, who do not have any housing equity to cash in.

Furthermore, the data and the simulations show that households have a strong preference for homeownership. Even in the absence of moving costs, they do not change their housing status. Households choose to downsize or to sell-and-rent only if they have exhausted their liquid assets and if their per-

period expenditure exceeds their per-period income. Financial restraints are particularly severe for households age 80 and over, whose rate of homeowneship could more easily drop.

Economists and the financial industry have evaluated alternative financial instruments that could alleviate the poverty among the very old and the renters. One financial instrument that did not received the expected success in the US and, similarly, that is not much widespread in Italy is the "reverse mortgage." One of the motivation for the unsuccess could be associated with the strong desire for homeownership, that is preferred to renting. Households that are not facing a binding liquidity constraint seem to prefer to reduce their own non-housing consumption. Households facing a binding liquidity constraint prefer to sell-and-rent. After all, it seems that, on average, households would not be willing to sacrifice their housing consumption to increase their non-housing consumption in retirement.

Also financial markets do not seem to be able to attract retirees' investments. In the presence of a reduction in the long-term interest rates, political uncertainty, and unpredictability in the financial markets, households' expectations of an event risk could increase and their willingness to invest in risky assets may decrease even more.

Visco (2002) and Elmendorf (2000) emphasize the growing budgetary pressure faced by many developed countries, resulting from the demographic change and the increasing spending in retirement programs. Possibly retirees could have to face a reduction in their available per-period liquid resources, with consequences for their consumption choices.

A financial innovation, which possibly could offer an hedge against longevity and disability risks, could be the longevity insurance (see, for example, Horneff et al. (2010) that study the role of deferred annuities within a life-cycle model with portfolio choice). The longevity insurance is a particular kind of annuity that guarantees a stream of payments until death. However, differently from other forms of annuity, it does not start until age 85. By that age, the retirees would have exhausted most of their financial savings and, at the same time, they will possibly start facing an increase in health-related medical costs. That financial instrument could help retirees sustaining their old-age medical expenses and their consumption, without the need to sell the house. The longevity insurance can be offered at a very affordable price relative to the conventional annuity, but the retiree has to buy it at age 65. This would imply that the retiree will not receive any money for the first 20 years of retirement.

The price for a longevity insurance that pays €20,000 yearly after age 84 should be determined under the assumption that the insurance is actuarially fair, namely the insurance company should have zero expected profits. Adverse selection should be limited given that the household sustains the cost at age 65 and it will receive the payment after 20 years. I assume that only one component of the household

buys the insurance. The formula for the total price of the longevity insurance P_L is:

$$P_L = \sum_{t=85}^{T} \left[\prod_{j=85}^{t} sp_j \right] L(1+i)^{-(t-65+1)} \tag{11}$$

where sp_j is the conditional probability of being alive at time j conditional on being alive at time $(j-1)$. L is the per-period cash received by the households, i is the average interest rate over the life of the annuity, assumed equal to 5%. I also assume that there are no associated fees at the time of the purchase.[27] Using the weighted average survival probabilities provided by the ISTAT and assuming that a retiree would die by age 100, I found that a 65-year-old retiree that buys a €20,000-a-year annuity that starts immediately would pay about €235,000; while if it buys the longevity insurance that starts its payments at age 85, it would pay about €21,000.

I assume that all households buy a longevity insurance at age 65 and I evaluate the change in their housing and consumption choices. I compare two scenarios: the baseline scenario and the baseline scenario with longevity insurance. As shown in figure 8, almost all the alive homeowners can afford to maintain their housing tenure. With longevity insurance, households receive a constant and deterministic stream of income at the time in which all other liquid resources are almost exhausted and the medical costs are growing. That stream of income provides such an important source of income for the retirees that almost nobody chooses to change housing tenure. Without longevity insurance, a non-trivial fraction of households has to move out their home to sustain their consumption and medical expenses after age 80.

Figure 9 shows that, in the baseline case, households reduce their consumption as they get older, because they do not have enough financial resources to sustain medical expenses, housing, and non-housing consumption. Instead, households that bought the longevity insurance experience a significant increase in their consumption after age 80. The goal of the longevity insurance would be to reallocate consumption from a period in life when it is relatively high (due to low medical expenses and relatively large buffer stock of savings) to a period when it is low (due to larger medical costs and lower buffer of savings).

10 Conclusion

In this paper, I built a realistic life-cycle model to study the investment and consumption decisions of the elderly. The model features household heterogeneity with respect to age, education, marital status, health, financial assets, housing, and accounts for the interactions of the main risks faced by the elderly: health, survival, risky house prices, and return on risky assets. The model was used to

[27] Alternative parameterization may alter the quantitative results, but qualitatively the results will still hold.

explain three main puzzles regarding the investment and consumption behavior of the elderly: 1) very high homeownership rate; 2) very low holdings of risky assets; 3) average consumption almost equal to average retirement income. I identify some features that could explain these puzzles. First of all, the housing choice is mostly driven by strong preferences for homeownership, peculiarities of the Italian welfare state, and role of liquidity constraints. Second, financial investment decisions are mostly driven by the event risk, in addition to house price risk and health risk. I also find a small positive utility from leaving a bequest. The model replicates some of the main facts observed in the Italian data: high homeownership rate, tenure persistence, low mobility, limited investment in risky assets, and average consumption about equal to average retirement income. Furthermore, the model has been used to study alternative economic and financial scenarios and to evaluate the longevity insurance.

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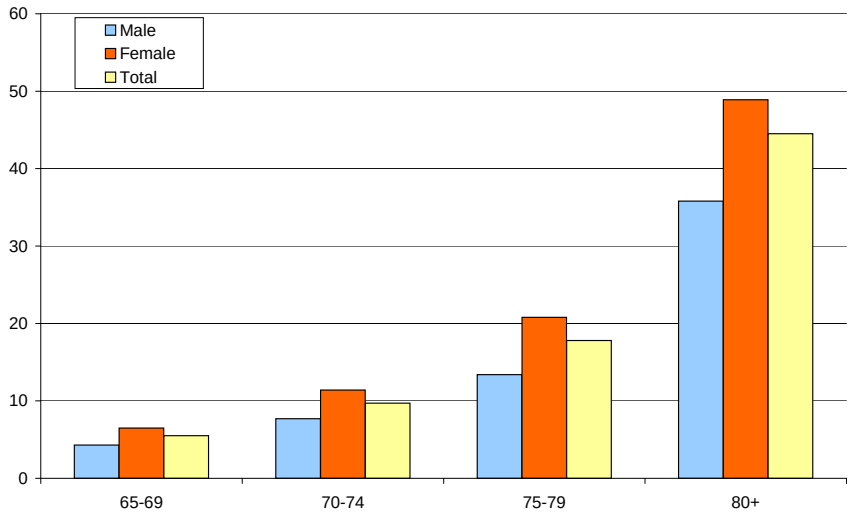
11 Figures

Figure 1: Disability Rate by Age and Gender



Source: Indagine Multiscopo Istat Salute 2005. The figure shows the number of individuals with disabity per 100 people of the same age and gender.

Figure 2: Homeownership Rate by Age

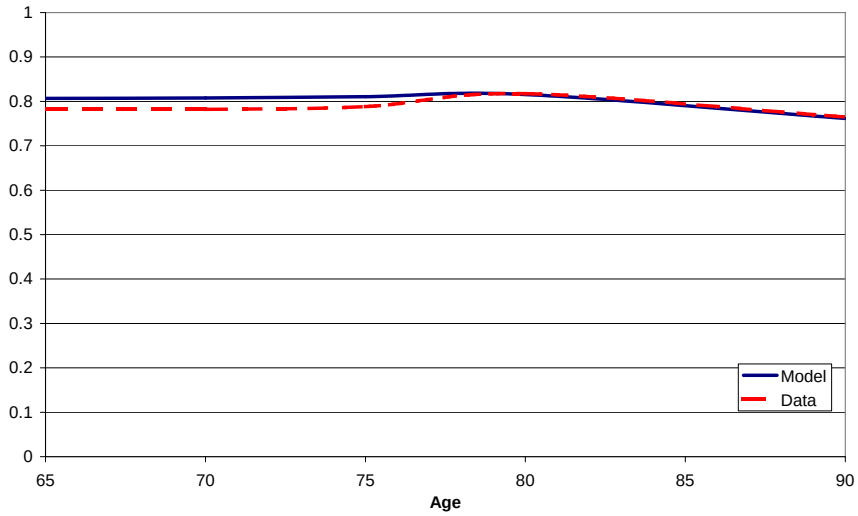


Figure 3: Average House Value by Age

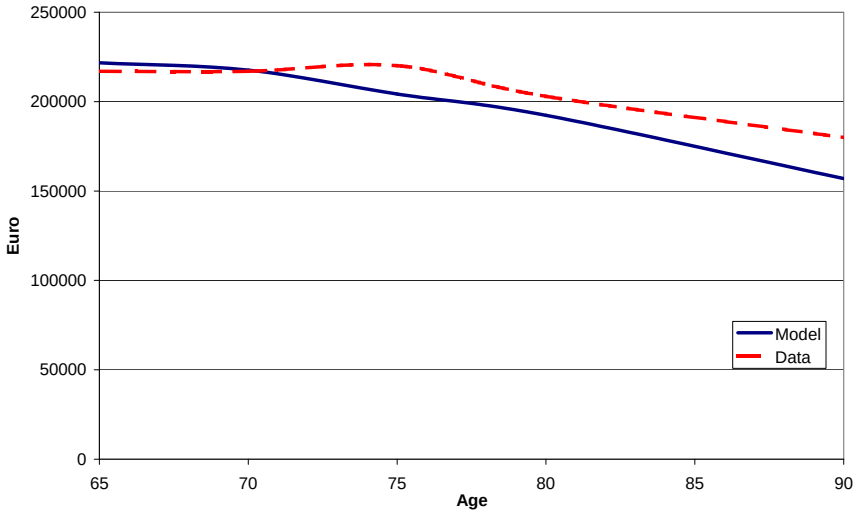


Figure 4: Financial Assets by Age

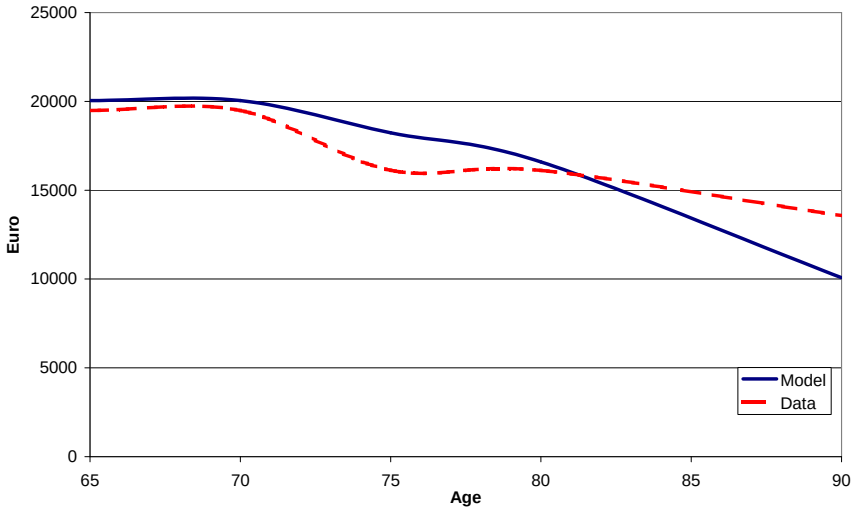


Figure 5: Share of Safe Assets by Age

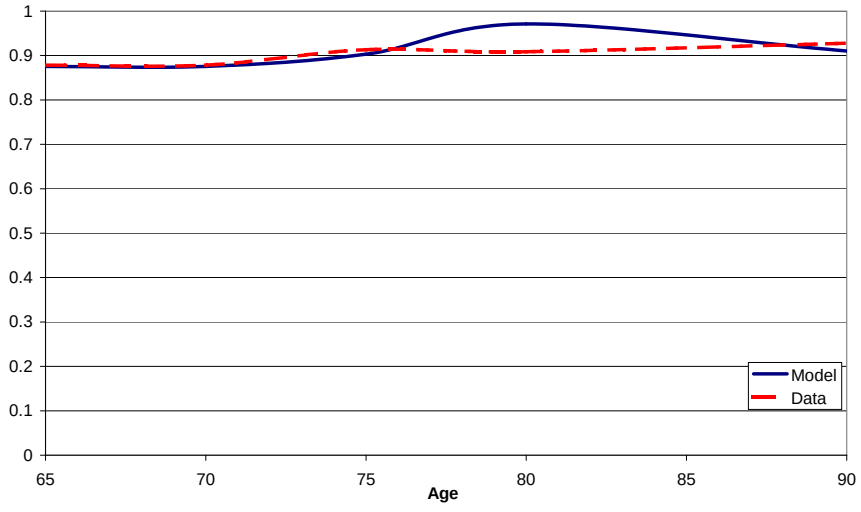


Figure 6: Consumption by Age

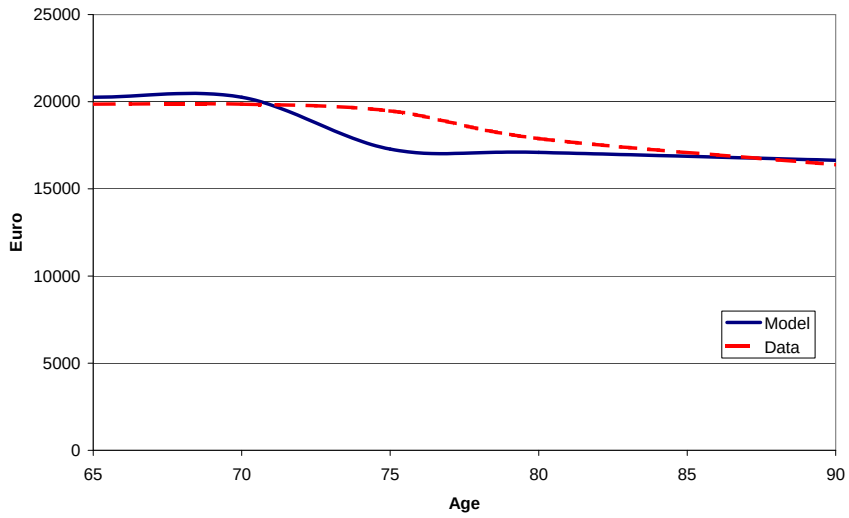


Figure 7: Consumption by Housing Tenure

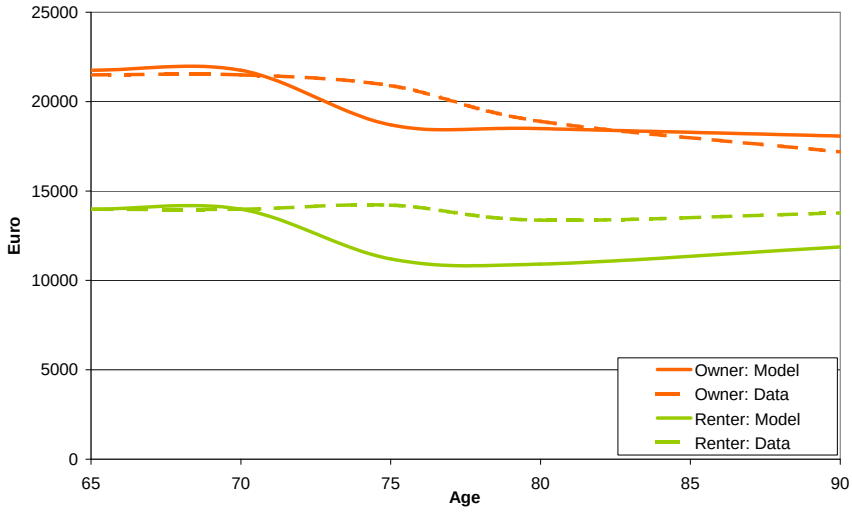


Figure 8: Homeownership with and without Longevity Insurance

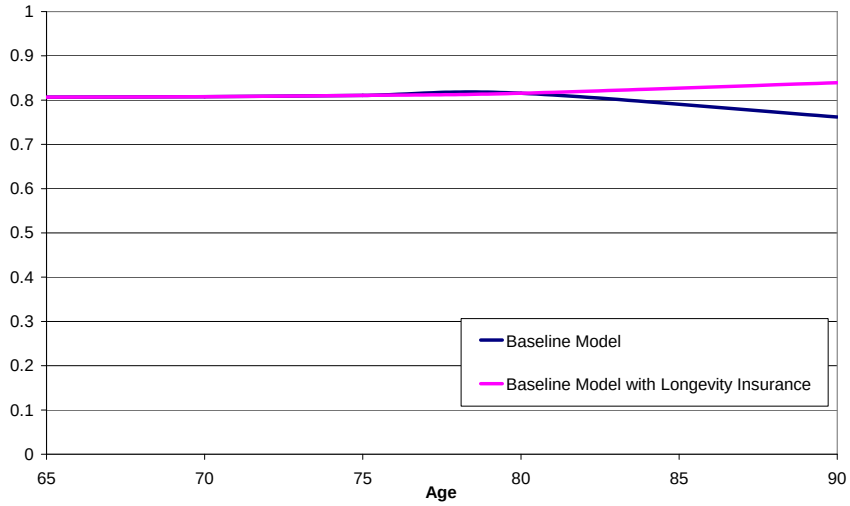
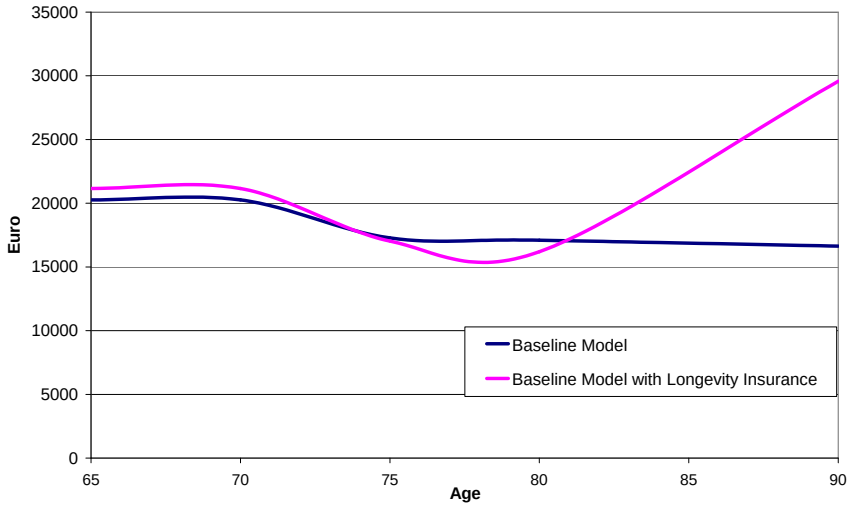


Figure 9: Consumption with and without Longevity Insurance



12 Tables

Table 1: Parameters

Parameter		Value
A. Preference		
γ	Risk aversion	5
β	Discount factor	0.96
$\phi(H=2)$	Preference for "large" house	1.00
$\phi(H=0)$	Preference for renting	0.00
$g(N_t)$	Equivalence scale	$\sqrt{N_t}$
B. Income and Consumption		
$Y(N=1,E=1)$		€11,100
$Y(N=1,E=2)$		€15,930
$Y(N=2,E=1)$		€16,650
$Y(N=2,E=2)$		€23,340
C_{min}	Minimum consumption	€3,000
C. House		
$D(H=2)$	Value of a "large" house	€300,000
$D(H=1)$	Value of a "small" house	€135,000
$D(H=0)$	Value of a rental house	€0.0
D. House Costs and Prices		
$\psi(H=1,2)$	Maintenance cost	1.5%
$\psi(H=0)$	Rent	3.0%
λ_s	Moving cost for the seller	3.5%
λ_b	Moving cost for the buyer	8.5%
λ_r	Moving cost for the center	€300
μ_p	Mean log real house price	2.36%
ρ_p	Autoregressive parameter in log real house price process	0.945
σ_ϵ	Standard deviation to the shock to log real house price	0.040
D. Finance		
r_F	Real return to safe assets	1.20%
μ	Risk premium	4.90%
σ_ι	Standard deviation	0.26
τ_F	Tax rate on safe assets	12.5%
τ_S	Tax rate on risky assets	20.0%

Table 2: Marital Status Transition Matrices from SHIW

	Single	Married
Age 65-69		
Single	0.990	0.010
Married	0.038	0.962
Age 70-74		
Single	0.993	0.007
Married	0.042	0.958
Age 75-79		
Single	0.995	0.005
Married	0.072	0.928
Age 80+		
Single	0.996	0.004
Married	0.088	0.912

Table 3: Health Status Transition Matrices from SHARE 2004-2006

	Good	Bad No limited activities	Bad limited activities
Age 65-79			
Good	0.563	0.111	0.326
Bad - No limited activities	0.134	0.689	0.177
Bad - limited activities	0.300	0.115	0.585
Age 80+			
Good	0.585	0.065	0.350
Bad - No limited activities	0.112	0.635	0.253
Bad - limited activities	0.202	0.077	0.721

Table 4: Average Medical Expenses in 2010 Euro

	Single	Married
Age 65-79		
Good	340	706
Bad - No limited activities	520	1030
Bad - limited activities	700	1140
Age 80+		
Good	510	560
Bad - No limited activities	420	1106
Bad - limited activities	1255	1410

Table 5: Event Risk

Year	Event	Real Return Mediobanca	Real Return Milan Comit Global
1974	First oil shock	-0.47	-0.48
1977	Recession	-0.43	-0.39
1987	Stock market crash	-0.33	-0.35
2008	Great recession	-0.50	-0.49

Table 6: Calibrated Parameters

Parameter	Variable	Value
μ	Housing preference (luxury/necessity)	0.44
θ	Housing preference (complementarity)	2.33
$\phi(H=1)$	Preference for "small" house	0.85
η	Intensity of bequest	0.02
G_{FA}	Distribution of financial assets for age class 65-70	0.55

Table 7: Baseline Statistics

	Model	Data
Homeownership rate (percentage)	78.2	78.5
"Small" house owners (percentage)	58.1	52.1
House value (€)	176,878	202,054
Financial assets (€)	13,498	15,888
Share of safe assets (percentage)	91.3	90.1
Consumption (€)	17,293	18,132
Mobility rate (percentage)	1.79	1.50

Table 8: Percentage Change in Aggregate Variables

	(1)	(2)	(3)	(4)	(5)
Homeownership rate	-0.80	-0.57	0.01	0.00	-0.07
"Small" house owners	-0.77	0.90	0.00	0.00	0.65
House value	-0.02	-1.02	0.01	0.00	-0.49
Financial assets	-0.73	0.25	0.00	0.00	0.22
Share of safe assets	1.62	-4.70	0.02	0.01	2.77
Consumption	-0.01	-0.83	0.00	0.00	-0.10

The experiments are:

(1) 1 percent increase in medical expenses

(2) 1 percent reduction in social security income

(3) No moving costs

(4) 1 percent increase in moving costs

(5) 1 percent increase in maintenance costs for homeowners

Table 9: Percentage Change in Aggregate Variables

	(6)	(7)	(8)	(9)	(10)
Homeownership rate	0.01	0.01	0.10	0.07	0.00
"Small" house owners	0.00	0.00	-0.01	-0.06	-0.01
House value	0.00	0.01	0.09	0.10	0.01
Financial assets	-0.06	-0.04	0.69	0.55	-0.05
Share of safe assets	-4.18	-0.83	0.12	-0.08	-2.37
Consumption	0.00	0.00	-0.11	-0.10	-0.01

The experiments are:

(6) Increase in excess premium mean by 1 p.p.

(7) Reduction in std.dev. of shock to excess premium by 1 p.p.

(8) Increase in the house price mean by 1 p.p.

(9) Reduction in std.dev. of shock to house prices by 1 p.p.

(10) Reduction in the probability of event risk by 1 p.p.

A Appendix

Table 10: 1 Percent Increase in Medical Expenses

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	-1.06	0.00	-7.67	-1.06	-
House value					
65-79	-0.25	0.00	-1.22	-0.25	-
80+	0.15	-0.06	-0.08	0.15	-
Financial Assets					
65-79	1.14	0.14	2.48	1.20	-3.91
80+	-1.76	-0.31	-5.32	-2.06	2.87
Share of safe assets					
65-79	0.07	0.06	0.10	0.05	0.16
80+	2.11	2.22	0.36	2.47	0.70
Consumption					
65-79	0.27	-0.06	1.26	0.31	0.01
80+	-0.10	-0.11	-0.32	0.20	-0.16

Table 11: 1 Percent Cut in Retirement Income

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	-0.76	0.00	-5.51	-0.76	-
House value					
65-79	-1.47	-1.42	-4.04	-1.47	-
80+	-0.44	-0.62	-0.37	-0.44	-
Financial Assets					
65-79	7.74	6.11	8.31	7.58	1.23
80+	-4.14	-2.09	-7.91	-4.54	2.73
Share of safe assets					
65-79	-0.04	-0.04	-0.06	-0.12	0.30
80+	-5.87	-7.14	0.48	-8.27	1.87
Consumption					
65-79	0.50	-0.13	2.95	0.71	-0.87
80+	-1.36	-1.30	-2.00	-1.18	-1.20

Table 12: No Moving Costs

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	0.01	0.00	0.12	0.01	-
House value					
65-79	0.00	0.00	0.00	0.00	-
80+	0.01	0.00	0.08	0.01	-
Financial assets					
65-79	0.00	0.00	-0.01	0.00	0.00
80+	0.00	0.00	0.11	0.03	-0.14
Share of safe assets					
65-79	0.09	0.00	0.27	0.12	0.00
80+	0.00	0.00	0.01	0.00	0.01
Consumption					
65-79	0.01	0.00	0.02	0.01	0.00
80+	-0.01	0.00	-0.03	-0.01	-0.04

Table 13: 1 Percent Increase in the Moving Costs

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	0.00	0.00	0.00	0.00	-
House value					
65-79	0.00	0.00	0.00	0.00	-
80+	0.00	0.00	0.00	0.00	-
Financial assets					
65-79	0.00	0.00	0.00	0.00	0.00
80+	0.00	0.00	0.00	0.00	0.00
Share of safe assets					
65-79	0.00	0.00	0.00	0.00	0.00
80+	0.01	0.00	0.03	0.01	0.00
Consumption					
65-79	0.00	0.00	0.00	0.00	0.00
80+	0.00	0.00	0.00	0.00	0.00

Table 14: 1 Percent Increase in Maintenance Cost for Homeowners

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	-0.09	0.00	-0.61	-0.09	-
House value					
65-79	-0.73	-0.35	-2.42	-0.73	-
80+	-0.20	-0.25	-0.11	-0.20	-
Financial assets					
65-79	3.50	1.64	5.73	3.42	0.00
80+	-1.91	-1.06	-3.08	-2.13	0.43
Share of safe assets					
65-79	-0.25	0.05	-0.87	-0.32	0.00
80+	3.68	4.15	-0.06	4.64	0.00
Consumption					
65-79	0.48	0.10	1.89	0.55	0.00
80+	-0.34	-0.19	-0.76	-0.38	0.01

Table 15: Increase in excess premium mean by 1 percentage point

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	0.01	0.00	0.13	0.01	-
House value					
65-79	0.00	0.00	0.00	0.00	-
80+	0.01	0.00	0.04	0.01	-
Financial assets					
65-79	-0.03	-0.04	-0.01	0.01	-2.38
80+	-0.07	-0.02	-0.24	-0.02	-0.42
Share of safe assets					
65-79	0.10	-0.16	0.58	0.16	-0.14
80+	-5.39	-6.61	0.20	-7.39	0.85
Consumption					
65-79	0.02	0.00	0.06	0.02	-0.02
80+	-0.01	0.00	-0.06	-0.01	-0.02

Table 16: Reduction in the std.dev. of shock to excess premium by 1 percentage point

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	0.01	0.00	0.17	0.01	-
House value					
65-79	0.00	0.00	0.00	0.00	-
80+	0.01	0.00	0.07	0.01	-
Financial assets					
65-79	0.02	-0.02	0.09	0.04	-0.64
80+	-0.07	-0.04	-0.15	0.00	-0.53
Share of safe assets					
65-79	0.31	0.09	0.74	0.27	0.46
80+	-1.15	-1.32	-0.03	-1.83	1.25
Consumption					
65-79	0.01	0.01	0.02	0.02	-0.03
80+	0.00	0.00	-0.05	-0.01	0.01

Table 17: Increase in house price mean by 1 percentage point

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	0.14	0.00	1.47	0.14	-
House value					
65-79	0.05	0.00	0.18	0.05	-
80+	0.09	0.00	0.58	0.09	-
Financial assets					
65-79	0.16	0.00	0.38	0.16	0.00
80+	1.02	0.01	3.18	0.91	0.23
Share of safe assets					
65-79	0.15	0.00	0.45	0.19	0.00
80+	0.11	0.00	0.34	0.17	-0.03
Consumption					
65-79	-0.12	0.00	-0.47	-0.14	0.00
80+	-0.10	0.00	-0.41	-0.28	0.33

Table 18: Reduction in std.dev. of shock to house prices by 1 percentage point

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	0.09	0.00	1.13	0.09	-
House value					
65-79	0.05	0.00	0.18	0.05	-
80+	0.10	0.00	0.59	0.10	-
Financial assets					
65-79	0.13	0.00	0.30	0.12	0.00
80+	0.81	0.01	2.56	0.77	0.19
Share of safe assets					
65-79	-0.05	0.00	-0.14	-0.06	0.00
80+	-0.09	0.00	-0.26	-0.12	-0.01
Consumption					
65-79	-0.11	0.00	-0.43	-0.13	0.00
80+	-0.09	0.00	-0.37	-0.20	0.19

Table 19: Reduction in the probability of event risk by 1 percentage point

	Age	**Education**		**Housing Tenure**	
		High	Low	Own	Rent
Homeownership rate					
65-79	0.00	0.00	0.00	0.00	-
80+	0.00	0.00	-0.01	0.00	-
House value					
65-79	0.00	0.00	0.00	0.00	-
80+	0.01	0.00	0.03	0.01	-
Financial assets					
65-79	-0.09	-0.13	0.01	-0.04	-2.74
80+	-0.02	-0.03	-0.01	0.00	-0.20
Share of safe assets					
65-79	-0.01	-0.06	0.09	0.00	-0.04
80+	-3.05	-3.70	0.17	-4.08	0.34
Consumption					
65-79	-0.01	-0.01	-0.01	0.00	-0.05
80+	-0.02	-0.01	-0.05	-0.02	0.00