Wealth-Age Dynamics, the Housing Cycle and the Recession in Spain

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Abstract

Between 1999 and 2007, Spain experienced a massive housing bubble, with real house prices peaking at double the 1999 ones. It burst in 2007, igniting a 5-year recession. During the same period, the wealth-age profile shifted dramatically in favor of the old and the middle-aged. To examine the heterogeneous effects of the housing cycle and the recession on wealth and welfare of different cohorts, I build a quantitative OLG heterogeneous agents model with portfolio choice between housing and a financial asset and house price uncertainty. The model can explain a considerable part of the changes in the wealth-age profile (between 15% and 33%) in those years. It also demonstrates that the housing cycle incited losses for the young while it benefited the old.

1 Introduction

The turn of the millennium found Spain at the beginning of an exceptionally large housing cycle, during which housing prices experienced an increase of about 100% in the period 1999-2008 and then rapidly reverted to the trend in 2008-2014. The burst of the housing cycle was accompanied by a prolonged recession, which also lasted until 2013 and drove working-age households' income about 38% below the pre-recession trend. During this period of the housing cycle and the recession, a striking shift occurred in the wealth-age profile in Spain: in 2002, the median household of 70-74 years old used to hold 20% less wealth than a household in its 40 & the median household of 60-65 years old used to be as rich as the median 40-44, but in 2014 both the median 70-74s and the median 60-64 had become more than twice as rich than the median 40-44s. This paper attempts to draw a link between the two phenomena and examine how and to what extent the housing cycle and the recession have contributed to the changes in the wealth-age profile.

The paper demonstrates that both the recession and the housing cycle have affected young and old households heterogeneously. First, I find that while workers' income fell about 31% below trend during the recession, retirees' income was not affected in that period. Second, I point to two ways young households are particularly exposed to housing cycles. The first channel is that young households tend to be house buyers, while older households are sellers, implying that the first ones lose from buying an overpriced house while the second ones profit from selling the same asset. The second channel is that young households finance their house purchase using mortgage debt, which generates a heterogeneous portfolio composition across ages, with young households being more invested in housing. As young households are more invested in housing, their total wealth is also more exposed to house price fluctuations. A particularly nightmarish scenario that young households face in housing bubbles is the danger of taking a mortgage to acquire an expensive house, only to find few years late that its price has collapsed, but they still have to repay the debt.

To evaluate to what extent the housing cycle and the recession have contributed to the

rise in inter-generational wealth inequality, I build an OLG heterogeneous agents model with portfolio choice among two assets, a financial asset and housing, as well as income and house price uncertainty. I calibrate the model to moments from the wealth-age profile in 2002, i.e. the first year for which the wealth survey data are available, assuming that the economy was at a steady state before the house price boom, i.e. in 1996. The model can generate 33%,24% and 15% of the observed changes in the ratios of median wealth between the aged 50-59, 60-69 & 70-79 households over the median wealth of the aged 40-49 households between 2002 and 2014.

To examine whether the changes are driven by the housing cycle or the recession, I compare the baseline model and two counterfactuals, one where only the housing cycle has occurred and one where only the recession has occurred, with a world in which nor the housing cycle nor the recession has occurred. The outcome of this exercise is that the housing cycle is the major driver of the rise in wealth inequality between young (40-49 years old) and middle-aged households (50-59 & 60-69), while the recession and the housing cycle are of equal importance for the rise in inequality between the young and the old (70-79).

Finally, the model enables a welfare analysis of the effects of the housing cycle and the recession on the different cohorts. I compute the consumption equivalent for both expected lifetime utility and "realized" utility (i.e. utility derived in the period 1997-2014) that would make an average household of each cohort indifferent between living in a counterfactual world with neither a housing cycle nor a recession and a world with only one of the two or both. The welfare analysis yields a second set of results revealing that (i) elders experienced moderate welfare gains from the housing cycle, while young households experienced welfare losses, (ii) that for the lifetime utility of the young, the recession had a much higher impact (losses of up to 20% losses in consumption equivalent from recession vs up to 3.8% from the housing cycle) and (iii) that for some young cohorts the realized welfare losses from the housing cycle have been as important as the ones from the recession.

Overall, the paper makes the case that cohort (un)luck has gravely impacted Spain's

young households in terms of both accumulated wealth and welfare. Specifically, it shows that housing is key when thinking about cohort luck, as housing cycles (a) predominantly hit the young while benefiting the old and (b) amplify the well-studied effects of recessions, which often follow the burst of the cycle.

2   Literature Review

The paper contributes to 3 strands of the literature. First, it complements the literature that examines cohort effects of house price movements such that Glover et al. (2020), Fagereng et al. (2022),Kaplan et al. (2020). Fagereng et al. (2022) use administrative data of housing transactions from Norway and employ a sufficient statistic approach to uncover welfare gains and losses from the rise of house prices. Among their findings, it is that the young mostly lose in terms of welfare gains from rising house prices, while the old benefit. The closest paper is perhaps Glover et al. (2020) who employ a heterogenous agents model to quantify welfare effects from the house price collapse in and the great recession that ensued in the US in 2007. They find that older households lose the most from collapsing house prices movement, why young benefit as they will buy cheaper in the future. Young households, however, take a big hit from the recession. I contribute to this literature by evaluating the welfare effects of an entire housing cycle and not only of one-directional house price movements. It turns out that housing cycles yield losses for the young and benefit the elders. On top of that, I provide a mechanism through which the housing cycle in Spain can be associated with the significant and rapid changes in the wealth-age profile, leading to elders becoming richer relative to the young. Kaplan et al. (2020) also employ an OLG heterogeneous agents model to build a theory of a sentiment-driven housing cycle in the US, but they do not evaluate the effects of the cycle on the wealth-age profile and the welfare of the agents. Notice that a dimension distinguishing Spain from the US is that homeownership is much more widespread in Spain (about 80% in Spain in 2002 vs 60% in US in 2001,

(SCF)), potentially amplifying the welfare effects.

Second. the paper adds to the literature that examines the heterogeneous effects of the housing cycle and the recession in Spain, which includes Ferreira et al. (2023), Martínez-Toledano (2020),Martinez-Toledano et al. (2019), Arellano et al. (2022), Erosa et al. (2023). Ferreira et al. (2023) employ an OLG model with non-linear income dynamics and a credit tightening shock to account for changes in consumption, debt and tenure changes after the housing burst in Spain. Martínez-Toledano (2020) finds that rich households were able to adjust their portfolio more than poorer households when the housing bubble burst, and Martinez-Toledano et al. (2019) report, among other results, that during the crisis inter-generational income and wealth inequality increased. Arellano et al. (2022), using administrative data, document that young workers were more exposed to income risk during the period 2005-2017. Erosa et al. (2023) also look at the recession in Spain and build a heterogeneous agents model with human capital accumulation to evaluate the income and welfare losses of young workers. The current paper adds to this literature by examining the entire housing cycle and the recession in Spain simultaneously & evaluating their contributions to the wealth-age profile & and on welfare of cohorts.

Lastly, there is a nascent literature that documents that households and individuals face heterogenous returns on wealth and documents their role in shaping wealth inequality and wealth dynamics, including Gabaix et al. (2016), Gabaix et al. (2016), Cioffi (2021). Gabaix et al. (2016) shows that returns heterogeneity is necessary to induce movements in wealth as fast as in the data, and ? & ? show that models featuring heterogeneous returns can match the extreme concentration of wealth observed in the US. Cioffi (2021) argues that the rise of wealth concentration could well be an effect of mere luck in asset returns realizations, like stock market returns. In this paper, although I abstract from idiosyncratic returns risk within each asset class, returns heterogeneity is generated through differences in the portfolio composition. It has a particular age dimension because young people take mortgages to finance their home purchases and have to repay these mortgages before retirement.

3   Data

Most of the analysis is based on the cross-sectional dimension of the household wealth survey Encuesta Financiera de las Familias (EFF). The survey is similar to the SCF and forms part of the HFCS (Household Finance and Consumption Survey) in Europe. The first wave was in 2002, and the survey is triennial, with the last wave having been conducted in 2020. As the SCF does, the EFF provides detailed information on the households' financial position and income. The micro-level data will be supplemented by aggregate data on GDP and interest rates available from the Bank of Spain, as well as the house price index provided by Taylor et al. (2018).

In this section, I briefly review the major economic events that shaped the Spanish economy from the 1990s to 2014 and present some key facts that document that the recession and the housing cycle have had heterogeneous effects across cohorts in Spain. I also document a shift in the wealth-age profile in favor of the old during this period. The evidence will motivate a heterogeneous agent model, which I will use to evaluate the effects of each driver and perform a welfare analysis.

3.1   Heterogeneous exposure to Recession and Housing Cycle across cohorts

Spain faced a prolonged recession that started in 2008 and lasted until 2013, intermitted by breaks of stagnation [1] Figure 1. During this period, the EFF income data reveal that while retirees' income was left unscathed, increasing at the pre-crisis trend, working-age suffered a large hit in their labor income, which stagnated at 17% below trend in 2011 and 31% below the pre-crisis trend in 2014 (Figure 2). From 2014 to the last wave of the survey, workers' incomes never recovered, leading workers' and retirees' incomes to converge. Given

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[1]The exact start and end of the recession is subject to how ones defines a recession. Using the definition of "two consecutive quartes of negative growth in the real gdp", the Spanish economy entered the recession in 2008q4 and exited for last time in 2013q2 (I omit some breaks of stagnation for brevity).
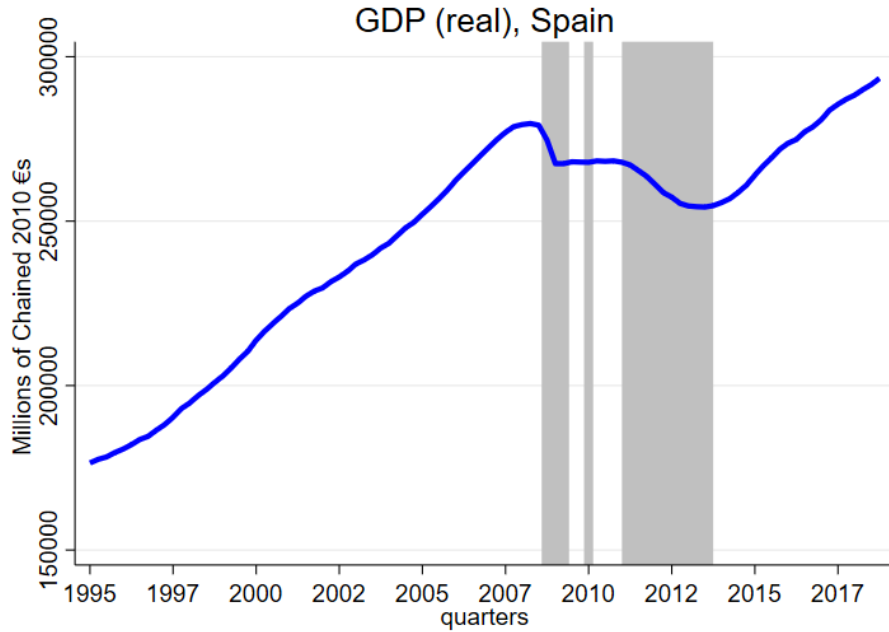
Figure 1: Spain's Real GDP
Spain's real gdp (quarterly, seasonally adjusted) in 2010 constant prices. The shaded areas correspond to recessions defined as "two consecutive quarters of negative growth"

that the recession overwhelmingly hurt working-age households but not retirees, it is a prime potential driver of the observed rise in intergenerational wealth inequality.

The second seismic event during those years was the housing cycle. House prices in Spain experienced a sharp rise from 1999 to 2007, of about 100% in real terms, and then collapsed in the next seven years, in 2007-2014 (Figure 3). Households in Spain are particularly exposed to movements in housing prices, since homeownership is particularly widespread (homwonership rate at $\sim 80\%$ in 2002-2014 [2]) and they allocate an exceptionally large part of their portfolio into real estate. In 2002, the median household held about 85% of their assets in real estate, the figure being relatively stable across the wealth distribution, except for households at the bottom 20% and the top 1% of wealth, and across different survey waves, affected mostly by house prices.

However, house price movements affect young and old households heterogeneously. First,

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[2]The rest 20% is split in about $\sim 11\%$ living in rented main residence and $\sim 7\%$ in usufruct during that period
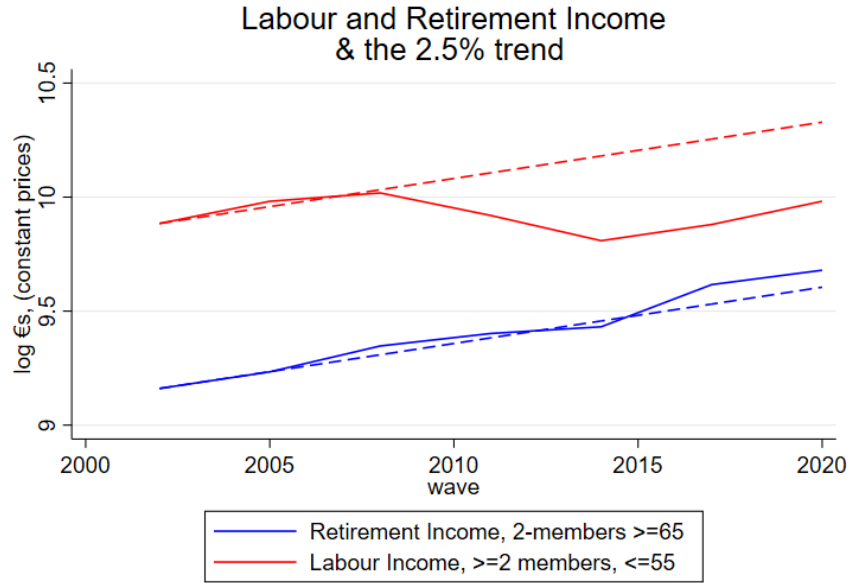
Figure 2: Labour and Retirement Income
labor income is defined as the sum of wage income, 2/3 of self-employment income and
unemployment benefits.

young households are accumulating housing, while the old might be dissaving in housing; therefore, the first ones lose from paying for overpriced homes while the latter benefit from selling at high prices. Second, young households usually finance their house purchases by taking mortgages, which they repay later in the life-cycle, resulting in a leverage profile that decreases with age. In 2002, the share of households holding debt was 60% among the 30-39s, whereas it was less than 10% among the 70-79s (Figure 4a). Young households were more indebted in the intensive margin too, with the median leverage, as measured by the debt over assets ratio, being above 20% among the 30-39s having debt, the measure decreasing with age (Figure 4b). Overall, young households are more leveraged than the old, and therefore, even for the same value of wealth, their wealth is affected more by house price swings.

Finally, the fueling of the housing bubble is often associated with the sharp drop of interest rates,both borrowing and lending, from close to 10% in the early 90s to close to 0% in the early 2000s (Figure 5). After the burst of the housing cycle, interest rates have remained at low levels.
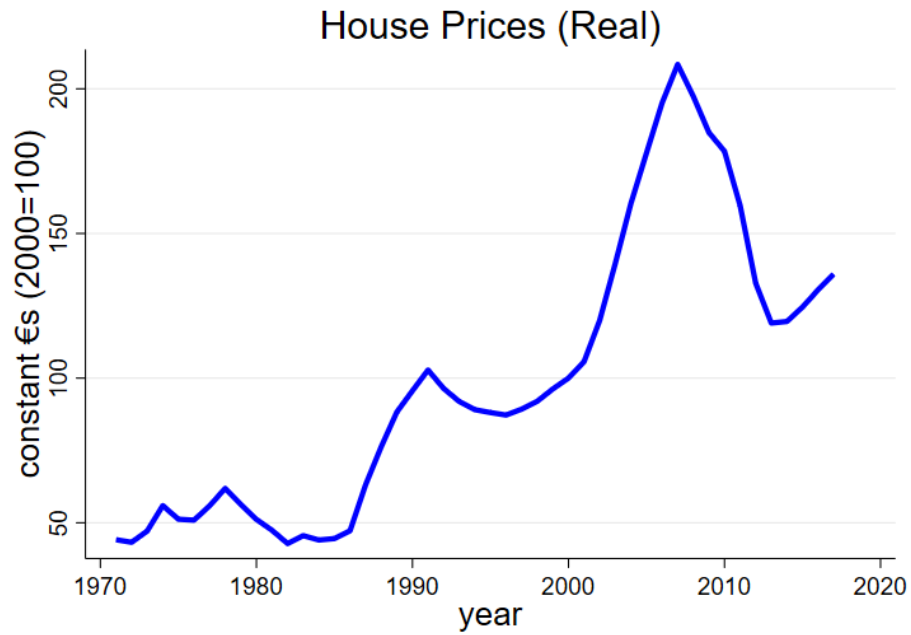
Figure 3: Real House Prices

The house price index is taken from Taylor et al. (2018)
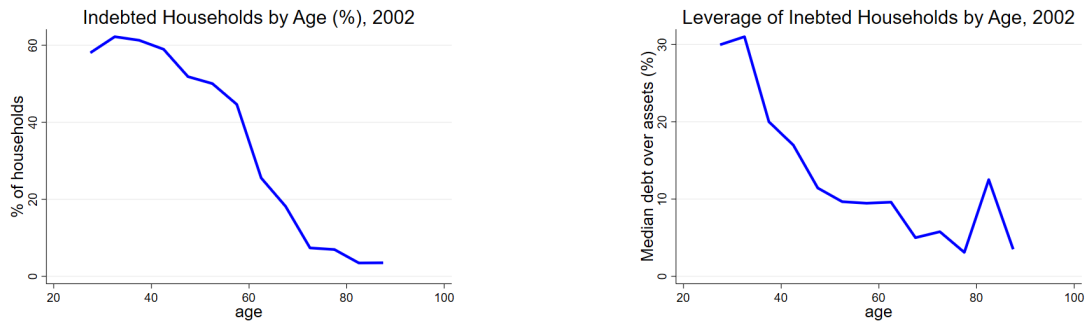
(a) Share of households having debtb by age,2002

(b) Median Leverage by age, 2002

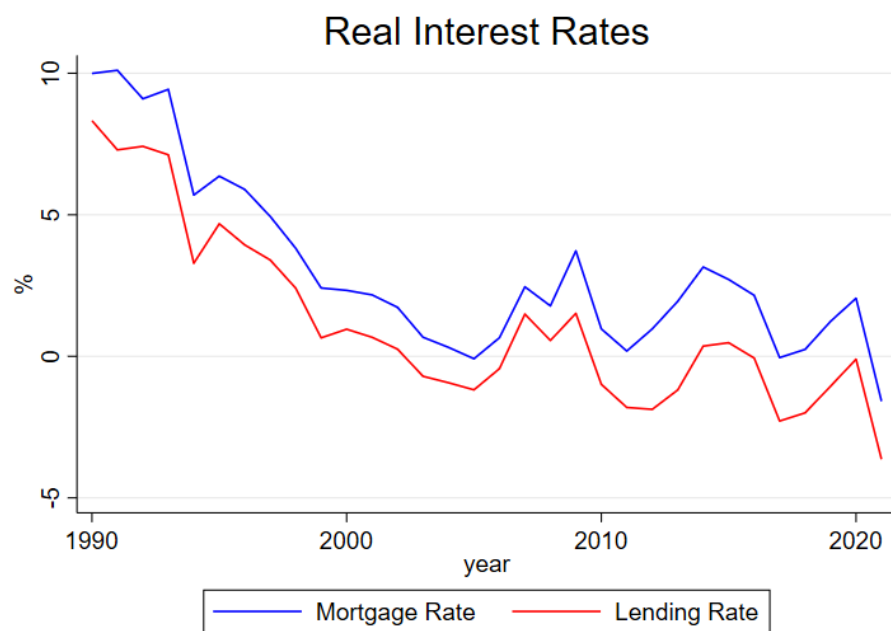**Figure 4:** Debt and Leverage across age

Figure 5: (Real) Lending & Borrowing Interest Rates
Lending Rate: Short Term Interest Rate (OECD), Borrowing Rate: Mibor of 1 year (BdE)
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3.2   Intergenerational Redistribution in favor of the Old

During this period, the EFF data present a striking picture of wealth redistribution in favor of the old household.

In order to track the evolution of inter-generational wealth inequality, I assign households to 5-year age bins and calculate the median net worth for each age bin. I normalize all the medians of the age bins by the median net worth of the 45-49 bin, obtaining ratios that are informative about "how much richer is the median household at age bin j than the median household at age bin 45-49". This approach reveals a stark increase in inter-generational wealth inequality in the years of the survey: while in 2005 the median 70-74 household used to hold 20% less than the wealth of the median 45-49 household, in 2014 it was holding 110% more than the wealth of the median 45-49 household, i.e. more than double the wealth of the median young. Similarly, the median 60-64 household was as wealthy as the median 45-49, but in 2014 it was more than twice as rich as the second. As Figure 6a shows, the large shift of the wealth-age profile towards the older is evident no matter which age bins one looks at. Interestingly, this shift took place in a short period, from 2008 to 2014, with the wealth-age profile being relatively stable before and after that period. This observation about the timing of the changes implies that the transformation of the wealth-age profile may be associated with the burst of the housing bubble and the recession.

Focusing in the period 2008-2014, Figure 7 depicts the changes in median networth and assets across different 5-year age-groups between 2008 and 2014. For age-groups below the age of 60, asset losses have been relatively homogeneous across age-groups and around 30%, but in terms of networth the drop in median wealth was much higher for younger ages; the median networth of households aged 30-35 was 60% lower than the median networth in 2008 for this age-group. The wedge between the changes in median assets and median networth for the younger age-groups provides further evidence for the hypothesis that the leverage of the young is associated with the rise in intergenerational inequality.

More intriguing are the limited changes in median wealth for older age-groups, above

(a) Selected waves: 2005,2011,& 2014
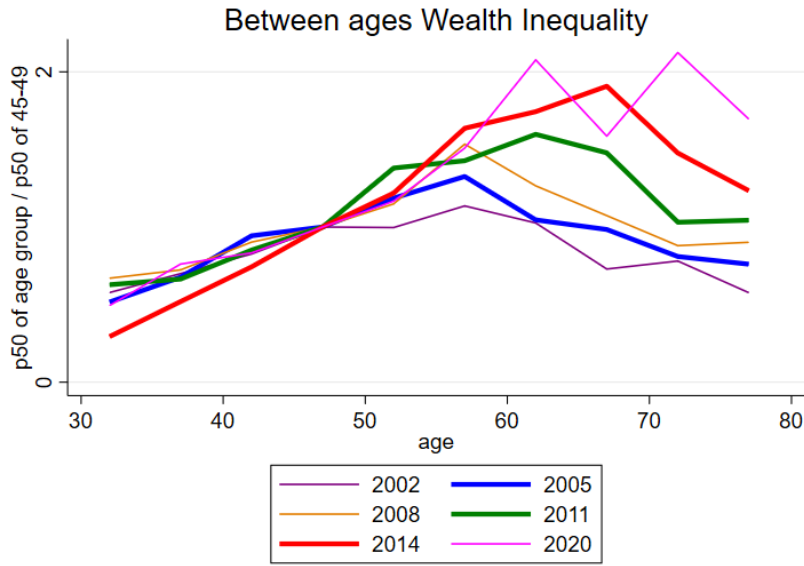
(b) More Waves: 2002,2005,2008,2011,2014,2020

Figure 6: Wealth Redistribution across ages

60. Debt holdings in those ages is limited, and therefore changes in assets and networth are similar. The median household aged 65-69 in 2014 appears to hold the same wealth and assets as the median household aged 65-69 in 2008. This change does not come from some older cohorts over-estimating their house prices in the later surveys (see Appendix A.3). The limited change in median wealth for the older age groups may also be related to the housing
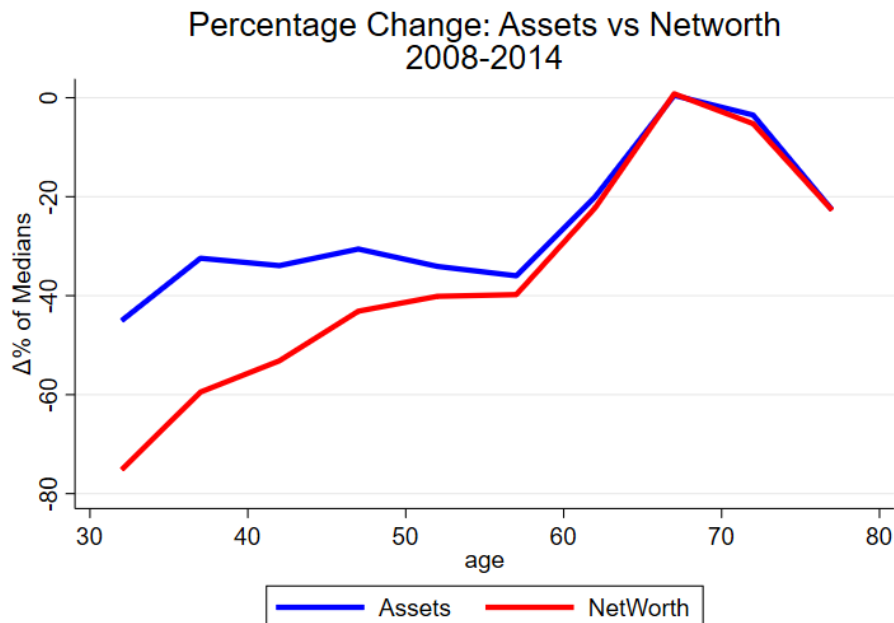
Figure 7: Percentage Change of Median Networth and Assets by age

cycle because of life-cycle savings behavior: some cohorts may have dissaved in housing when house prices were large [4]

In this section, I have documented that two large aggregate shocks, the housing bubble and the Recession, have affected cohorts heterogeneously. Moreover, in the same period, the wealth-age profile has shifted in favor of the old households. These facts that have been documented here will motivate an OLG heterogeneous agents model with housing, to evaluate the effects of the recession and the housing cycle on the wealth-age profile and perform a welfare analysis

4 Model

To pursue my analysis I build an OLG model with portfolio choice among 2 assets (housing and a financial asset). Prices are exogenous and households are heterogeneous in labor productivity, age, and their housing holdings and financial assets. Households can take a

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[4]Other candidates behind the limited changes in median asset for older age-groups do exist (e.g. potential differences in lifetime income), but this paper focuses on the effects of the housing cycle and the recession

mortgage to finance their home purchase when they are young and have to repay their mortgage before retirement. They also face uncertainty regarding their labor productivity (when young) and housing prices (aggregate uncertainty). The economy grows at rate g.

4.1 Demographics & Preferences

A cohort of unit 1 is born at each period, and each household of age j survives to the next period with probability π_j, being able to live at most J years. They work for the first J_{ret} years, and they receive a pension afterward. Each household is born owning the mimimum amount of house h_{min} and with an initial endowment of financial asset $a_0 Z$ which is drawn from a log-normal distribution, with $log(a_0) \sim \mathcal{N}(\mu_{a_0}, \sigma_{a_0})$.

At each period, agents receive utility from housing h' and a consumption good c. The utility function has the form

$$u_j(c, h') = e_j \frac{(\frac{c^\alpha h'^{1-\alpha}}{e_j})^{1-\gamma}}{1-\gamma}$$

where e_j is an equivalence scale

Once they die, agents receive utility from bequests b equal to

$$\phi(b) = \phi_1 Z^{\alpha(1-\gamma)} \frac{(1 + \frac{b}{\phi_2 Z})^{(1-\gamma)}}{1-\gamma}$$

, where $b = p_h h' + a'$, Z if the tfp, ϕ_1 & ϕ_2 are bequests parameters that regulate how strong is bequest motive and to what extent bequests are a luxury good. This formulation is taken from De Nardi (2004), adjusted for having a balanced growth path.

4.2 Labour Earnings & Pensions

At each period, agents receive earnings $Zy(z, j)$, which depend on their labor productivity z, and their age j. During their working age, their labor productivity z follows a Markov Process, whereas during retirement it is fixed.

Taxable income is the sum of labor/pension earnings and any interest income the agents may have. Mortgage interests are not deductible, and taxable income y^τ is taxed at rate $\tau(y^\tau)$.

4.3 Housing & financial asset

Households can save into 2 assets, a financial asset and housing.

Housing is a discrete choice and provides utility. Each period, households decide whether to move or not. If they move, they have to pay transaction costs that are equal to the sum of a fraction of the old value of the house and a fraction of the new value of the house, i.e. $c_{h,h',p_h} = \psi_{buy}p_h h' + \psi_{sell}p_h h$.

Also, working-age households can take a mortgage to fund their purchase, up to $\kappa p_h h'$, and have to repay their debt before retirement. Pensioners do not have this option. A young household with negative financial assets can only repay its debt and cannot expand its credit (unless it moves to another house). Households cannot default on their debts [5].

House prices p_h are equal to $Z\tilde{p_h}$, where $\tilde{p_h}$ is the deviation from trend, which follows a Markov Process. A positive amount of savings yields a (gross) interest rate of R_l, while the mortgage rate is R_b.

4.4 Timing

The household's problem is split into two stages. In the first stage, all uncertainty is resolved and the agents decide whether to move or not. If they don't move, they carry their financial assets to the second stage (s=a). If they decide to move, they can take a mortgage (if working-age) and enter the second stage with an amount of intermediate financial assets $s \geq \min\{a, -\xi p_h h'\}$. With this model feature, house price fluctuations do not cause the default of stayers, and also heavily indebted households are allowed to smoothly

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[5]Tenure choice is not modeled either, as renting was quite limited and stable in Spain in 2002-2014, with about 11% of households choosing to rent their main residence.

repay their debt by dissaving in housing. In the 2nd stage, agents receive their earnings (labor income/pensions), pay/receive interest on the intermediate financial assets and decide how much to consume & save into the financial asset a.

The Bellman equation for the first stage is

$$V_j(a, h, z, \mathcal{A}) = \max_{s, h'}\{\tilde{V}_j(s, h', z, \mathcal{A})\}$$

$$s.t. \ s + p_h h' + p_h c_{adj}(h, h') = a + p_h h$$

$$s \geq \min\{a, -\xi p_h h'\} \ if \ h' \neq h$$

$$s = a \ if \ h' = h$$

$$s \geq 0 \ if \ j \geq J_{ret}$$

$$h' \in \mathcal{H}$$

and for the 2nd stage:

$$\tilde{V}_j(s, h', z, \mathcal{A}) = \max_{c, a'}\{u(c, h') + \beta E[(\pi_j V_{j+1}(a', h', z', \mathcal{A}')]$$

$$+ (1 - \pi_j)\phi(p'_h h' + a', Z'))|z, \mathcal{A}\}$$

$$s.t. \ a' + c = s(1 + r(s)) + Zy(j, z) - Z\tau\left(y(j, z) + \mathcal{I}_{(s \geq 0)} r(s)\frac{s}{Z}\right)$$

$$r(s) = r_b \mathcal{I}(s \geq 0) + r_l \mathcal{I}(s < 0)$$

$$a' \geq min\{0, s\}$$

$$\phi(b, Z) = \phi_1 Z^{\alpha(1-\gamma)} \frac{(1 + \frac{b}{\phi_2 Z})^{(1-\gamma)}}{1 - \gamma}$$

$$Z' = Z(1 + g)$$

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The above problem features a Balanced Growth Path, along which c*,s*,a* are homogeneous of degree 1 with respect to Z and h* is homogeneous of degree 0 with respect to Z (for details see Appendix B.1) My numerical solution to the above problem is building on Bakota and Kredler (2022), employing Markov-Chain approximation (widely used in continuous time) in a discrete time environment. The computational method can deal with non-convexities in the value functions, which arise from the housing discrete choice. Notice also that the model feautures a balanced growth path [6], in which house prices, expenditures, and consumption grow at rate g.

5 Calibration

The objective of the model is to quantify to what extent the heterogeneous exposure to the housing cycle and the Recession of different cohorts can explain the trend of increasing intergenerational wealth inequality, as measured by the ratio of median wealth of 10-years age groups over the median wealth of aged 40-49s households. Therefore the model should be calibrated to match some key features of the wealth-age distribution in 2002 (the earliest year for which the wealth survey data are available) and then the path of the economy should be simulated up to 2014.

What complicates the exercise is that 2002 was a year in the middle of the housing cycle, few years after a massive drop in the interest rates; therefore it cannot be assumed that the economy was in a steady state in that year. To overcome this difficulty, I assume that the economy was at steady state in 1996 with high interest rates, and then unexpectedly interest rates fall. Then I run the model up to 2002 and I target moments from the 2002 distribution to calibrate the free parameters. House prices and interest rates are updated yearly.[7]

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[6]It can be easily seen that the returns function of the problem is homogeneous of degree $\alpha(1 - \gamma)$ in Z and the constraints are linear in Z

[7]Since I employ the computational method presented in Bakota and Kredler (2022), I need to use a shorter period in the model, equal to $dt = \frac{1}{8}$ in order to secure that agents move no more than 1 gridpoints up or down in the second stage problem. However, prices are updated yearly, and all parameters (including interest rates & parameters of stochastic processes) are reported at the yearly frequency to ease exposition

The calibration proceeds in 2 stages. First, some parameters can be taken directly from the data or can be set equal to standard values used in the literature. Second, the free parameters are calibrated using the method of simulated moments. The model features 5 free parameters, which are the discount factor β, the beuests parameters ϕ_1, ϕ_2 & the parameters that regulate the distribution of initial endowments μ_{a_0}, σ_{a_0}.

Notice that since I don't model household formation, all my households are formed at the same age and therefore the data counterpart of initial endowments includes both family transfers at or after household formation as well as transfers that happen before household formation (for those members who form a household later). Since the latter are not observed, these parameters of the initial endowment distribution have to be calibrated endogenously.

5.1 Demographics

Each agent in the model corresponds to a household in the data and for this reason, I estimate age-specific household survival probabilities from the data. I am doing this by taking the mortality rates published by the National Statistical Institute of Spain (INE) for 2002, sex and age-specific, and assigning them to each Reference Person and each partner (if any) in the data. I then calculate a mortality rate for each household, and I fit a 4th-order polynomial function of the household's age (age of highest earner) to the sample of all households above 50 years old. The resulting function is convex and increasing and matches the data well. For simplicity, the probability of survival below 50 years old is set to 1. Age $j = 1$ in the model is "25 years old" in the data, and $J = 76$ is "100 years old".

5.2 Preferences

In the utility, the share of non-housing expenditure α is set to 0.77, as is estimated by Eurostat for the year 1994 (the closest to 1996), while the intertemporal elasticity of substitution γ is set to 2 as it is common in the literature. The bequests parameters ϕ_1, ϕ_2 will be estimated endogenously, targeting the median and 75th percentile of wealth for

households in the [75,79] age bin.

To calibrate the equivalence scale $\{e_j\}_{j=1,...,J}$ I first compute OECD equivalence scales for each household in the 2002 EFF survey. I then regress households' equivalence scales on a 3rd-degree polynomial of age, imposing that households are born as a couple at age 25 and also are singles at age 100 (Details about the values of the parameters are given at Appendix C.2)

5.3 Earnings

Earnings are the product of tfp and labor productivity. The tfp component of earnings Z grows at rate $g = 0.025$, which is a realistic approximation of long-run growth in Spain in the 40 years before the recession (see Appendix A.2) . Labor productivity is the product of a deterministic and stochastic component, i.e.

$$y(z,j) = exp(P(j))exp(z)$$

P(j) for the working age is a second-order polynomial of age for $j \leq J_{ret}$, while it is a constant after retirement. To estimate the polynomial P(j) for the working-age, I use households between 30 and 65 years old with no retirement income and positive labour income in the [1st,99th] percentile bracket from the 2002 wave. I define labour income as the sum of wage, 2/3 of self-employment income, and unemployment benefits. For $j >= J_{ret}$, P(j) is a constant and equal to the mean retirement income (including widow benefits) of households aged above 75 years old.

The stochastic component z follows (during working age) an AR(1) process with persistence ρ_z and standard deviation σ_z. After retirement, z is constant and equal to the household's last working-life realization. To calibrate ρ_z, I calculate the persistence of employment-earnings deviations from age-predicted income for households aged 30-55 in the panel dimensions 2002-2005,2005-2008,2011-2014, and I set ρ_z equal to the mean of

those. For the standard deviation, I use the households aged 35-55 in the 2002 cross-section, with no retirement income and positive labor income in the [1st,99th] percentile bracket. For pensioners, z is still normally distributed, but the standard deviation σ_p is equal to the standard deviation of retirement income (including widow benefits) of households aged above 75 years old (from the 2002 wave). Households transitioning from working life to retirement keep their rank of labor productivity.

I approximate the AR(1) process numerically using Rouwenhurst's method (Rouwenhurst (1995)) with 7 points.

5.4 Taxation

Income taxation is calibrated using the parametric estimation of the Spanish personal income tax from García-Miralles et al. (2019). Taxable incomes y^τ that are above a threshold $\tilde{y}$, are taxed according to tax schedule $1 - \lambda_1 (y^\tau)^{-\lambda_2}$. The three parameters of the tax function (income threshold $\tilde{y}$, tax level λ_1 & tax progressivity λ_2 are calibrated using the estimates of those parameters from García-Miralles et al. (2019) for 2013, (see Table A8 in García-Miralles et al. (2019)). Given that the exemption level $\tilde{y}$ in García-Miralles et al. (2019) is estimated as a multiple of average household income, I impose that it grows at rate g throughout the period covered.

5.5 Housing Prices

Housing prices consist of a trend component and a stochastic one. The trend component equals the tfp growth g. The stochastic one ($\tilde{p}$) is the percent deviation from trend and follows an AR(1) process with persistence ρ_h and standard deviation of the innovation $\sigma_{p_h}^2$.

$$\ln \left(\tilde{p}_{h,t+1} \right) = \rho_h \ln \left(\tilde{p}_{h,t} \right) + \epsilon_{p_h,t+1}, \quad \epsilon_{h,t+1} \sim \mathcal{N} \left(0, \sigma_{p_h}^2 \right), \quad \tilde{p}_{h,t} = \frac{p_{h,t}}{Z_t}$$

I employ the Taylor et al. (2018) house price index to calibrate the stochastic process of

house prices. The house prices series (after adjusting with cpi) seems to follow close enough the 2.5% trend in the period 1996-2014 (Figure 8). In the model, I assume that house prices grow at the same rate as labor income, which also seems to be a reasonable hypothesis based on the data (in Figure 8 I use Wage Compensation per Working Age Population as a proxy for labour income per working-age household) .

I set the persistence and the standard deviation of the house price deviations from trend equal to the ones in the data.

Ideally, the house price index would agree with the house prices in the survey. To check this, I calculate a house price index for each wave of the survey as the median percentile of value per square meter of the primary residence for homeowners. It turns out that the survey-constructed index has a lower cycle peak, which translates into a smoother house price drop at the end of the cycle [8] (Figure 9). Since I do not want the comparisons of the model predictions with the data to be influenced by this inconsistency, I choose to use a merged series in my simulations. This merged series uses the Taylor et al. (2018) index for 1996-2002 and merges with it the survey-created series for 2002-2014. I impose that they are equal at 2002. Notice that the survey is triennial, therefore I need to interpolate between the waves.

5.6   Interest Rates & Borrowing Constraints

There are two interest rates in the model: the lending rate and the borrowing one. I treat the Short Term Interest Rate for Spain from OECD as the data counterpart of the first, and the Mibor of 1 year from BdE [9] as the counterpart of the second. The two series closely comove and experience a sharp drop just at the start of the housing cycle (Figure 5). Therefore I proceed in 2 steps: (i) set a wedge ζ between the two rates equal to 2% (which is roughly true in the data: the mean is 1.88 for years after 1990) and (ii) split the years that

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[8] I don't take a stance on why this inconsistency arises. Potential reasons may include that the Jorda index is based on transactions whereas the survey index is based on all primary residencies of homeowners in the survey, or that there is misreporting at the survey.

[9] Tipo de interés. De referencia. Oficiales. Mercado hipotecario. Interbancario. Mibor a 1 año
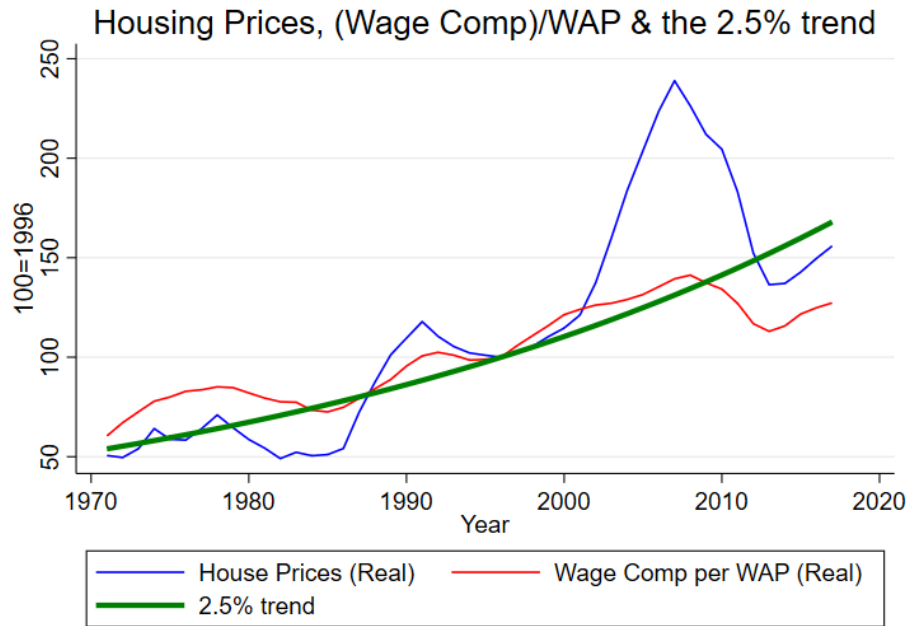
Figure 8: House Price Index, deviations from 2.5% trend
The house Price Index series is taken from Taylor et al. (2018), and is adjusted for cpi. The Wage Compensation over WAP population data come from BdE (BDMACRO), after adjusting for inflation using CPI.
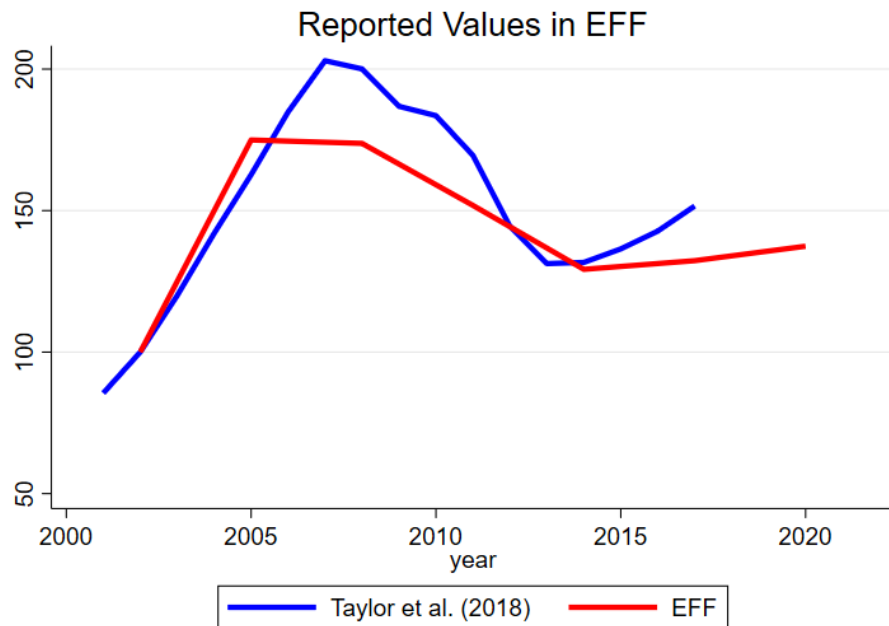

Figure 9: Taylor et al. (2018) vs EFF-based index
A noteThe EFF-based index is constructed using the median value per sq. meter of the main residence, as reported by households

Parameter	Description	value	source
$\{\pi_j\}_{1,\ldots,J}$	Survival Probabilities	see text	INE & EFF
α	Share of non-housing expenditure	0.77	Eurostat
γ	IES	2	standard
$\{e_j\}_{1,\ldots,J}$	Equivalence scale	see text	oecd eq.scale & EFF
$P(j)$	deterministic productivity	see text	EFF
ρ_z	Stochastic productivity, persistence	0.9	EFF
σ_z	Stochastic productivity, s.d.	0.58	EFF
μ_p	pensions, mean	8.87	EFF
σ_p	pensions, s.d.	0.49	EFF
g	tfp growth	0.025	Appendix A.2
$[\lambda_1, \lambda_2, \lambda_3]$	tax schedule parameters	[0.8970,0.1252,42%]	García-Miralles et al. (2019)
ζ	Borrowing-lending rates wedge	0.02	OECD BdE
$[R_b^H, R_b^L]$	Borrowing Rates	[7.3%,1.9%]	BdE
ρ_{p_h}	Housing Prices, persistence	0.92	calculations using Taylor et al. (2018)
σ_{p_h}	Housing Prices, s.d.	0.23	calculation using Taylor et al. (2018)

Table 1: Exogenous Parameters
Note:House Prices and earnings are reported in logs

the model covers into a "high-interest rates era" and a "low-interest rates era". I set the (gross) R_b for the "high-interest rate era" equal to the mean (real) 1-year Mibor in 1992-1996 & equal to the mean (real) Mibor in 1997-2014 for the "low-interest rate era".

Working-age households who move can borrow up to $\kappa = 0.9$ of the value of their new house.

Table 1 summarizes the calibration strategy for the exogenous parameters

5.7 Endogenously Calibrated Parameters

There remain 5 free parameters which are calibrated using the method of simulated moments. These are the discount factor β, the warm-glow parameters ϕ_1, ϕ_2 and the initial endowments' distribution parameters $\mu_{\alpha_0}, \sigma_{\alpha_0}$. The corresponding targeted moments from the wealth-age distribution are the median of 55-59, the median and p75 of 75-79 and the median and p75 of 35-39 (Table 2).

Using the above calibration, the model successfully replicates the median wealth-age profile in 2002, as seen in Figure 10. Notice that the model lacks features such as business assets, welfare programs, or a rental market, which the literature has shown as important

Parameter	Description	value	Targeted Moment	Model Moment	Data Moment
β	Discount factor	1.0383	median of 55-59	140	150
ϕ_1	Warm glow, scale	0.16	median of 75-79	90	77
ϕ_2	Warm glow, luxury good	499.97	p75 of 75-79	120	132
μ_{α_0}	mean, initial endowment distr.	1.9	median of 35-39	91	92
σ_{α_0}	s.d., initial endowment distr.	3.2	p75 of 35-39	158	154

Table 2: Endogenous parameters

Note: Data moments are taken from the 2002 distribution & reported in thousand euros.

for matching the tails of wealth inequality. For this reason, in my discussion of model results

I will focus on the median household.
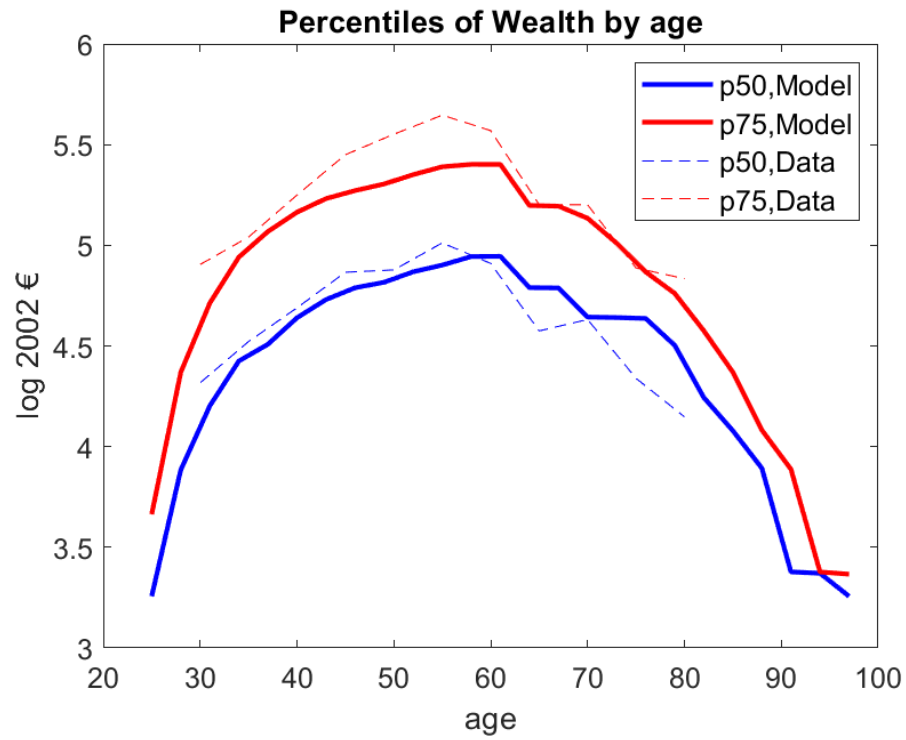
Figure 10: Wealth-Age Profile, 2002

The y-axis reports logs of net worth in constant 2002 prices, while the x-axis consists of 5 years age bins. The dashed lines are the data, while the solid lines are the model.

6   The Baseline Economy

In the baseline scenario, I simulate the evolution of house prices and labor incomes from 1996 to 2014. To replicate the recession, I assume that after 2008 workers' labor productivity is hit by unexpected shocks, common to all ages $j \leq J_{ret}$ and productivity states. This way, workers' earnings are reduced, but those of pensioners' are not, as is the case in the data (Figure 2). Once the shock hits the workers, they are still on a balanced growth path but with a lower level of working-age incomes. The magnitude of these shocks is calibrated to match the deviation of median labor earnings from the 2.5% trend in the data after 2008 (see Figure 2). House prices and productivity shocks are updated yearly, and since I use information from the EFF survey, I interpolate between the survey years.

To shed light on the mechanics of the model, it is instructive to look at the portfolio composition of old and young households (Figure 11). As representative cases, I take households aged 43 (red line) and households aged 61 (blue line) in 2008, i.e. just before the burst of the bubble, and I picture the cdf of their financial-asset-to-housing ratio [10]. Young households in the model tend to have a portfolio skewed to housing, with a 40% of households aged-43 holding negative financial assets (debt). This implies that the wealth of the young is more exposed to fluctuations in housing prices, relative to the old's, and when house prices drop in 2008-2014 they will lose the most. Notice that this channel, which will turn out to be quantitatively important requires a model with 2 assets, as presented here.

Overall, the model tracks relatively well the evolution of wealth across both different cohorts and age groups, especially at the median

Regarding the predictions of wealth for different cohort groups, the model gives surprisingly accurate predictions for the cohorts that were 30-39 and 40-49 in 2002 (Figure 12). For the cohorts that were 60-69 and 70-79 years old in 2002, the model is getting the evolution of wealth qualitatively right. It underestimates the wealth of those aged 60-69 in 2002 by 19% in 2011 & 21% in 2014, with these numbers being 23% and 33% for those 50% for

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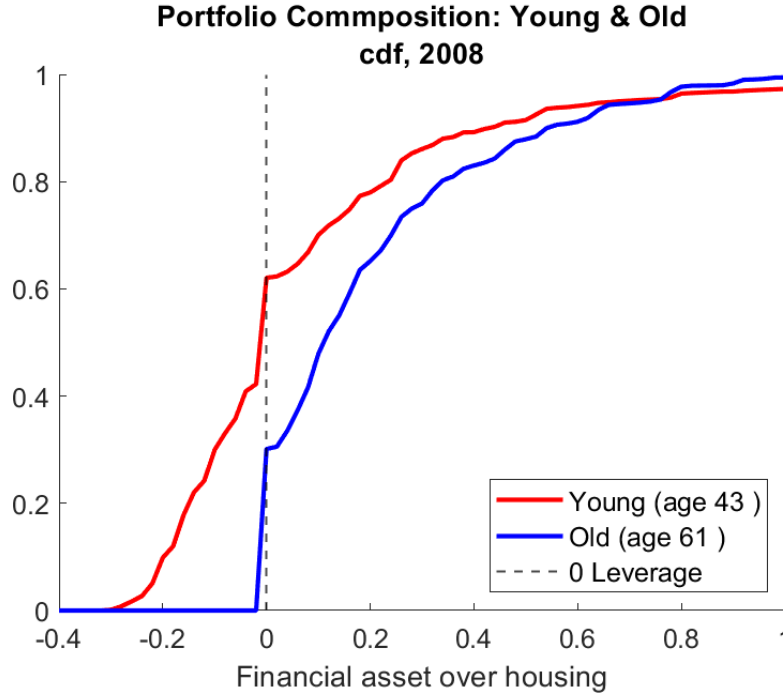[10]The takeaway does not depend on the specific age-group chosen

Figure 11: Portfolio Composition: Youngs vs Old

those aged 50-59 in 2002. The deviations for those cohort groups, although significant, are expected since the model doesn't aim to replicate the full magnitude of the changes in the wealth-age profile, but to isolate the part of the changes that are due to the housing cycle and the recession.

Looking at the wealth of different age groups, the model is relatively successful, too (Figure 13). Especially for households aged 40-49s and 50-59s, the model predicts the median wealth quite well in all available waves. For the older age groups, the model underestimates the median wealth of 60-69s by 24% in 2011 & 31% in 2014, as well as the median wealth of 70-79s by 27% in 2014. The model also overpredicts the wealth of the very young (30-39s) in 2014 (by 31%), but this is an expected shortcoming too, given that initial endowments and household formation are oversimplified in the model.

Having demonstrated that the model, for all its simplicity, fares reasonably well in predicting the actual evolution of net worth for different cohorts and age groups, I conclude that I can consult it in uncovering the role of the housing cycle and the recession in the changing
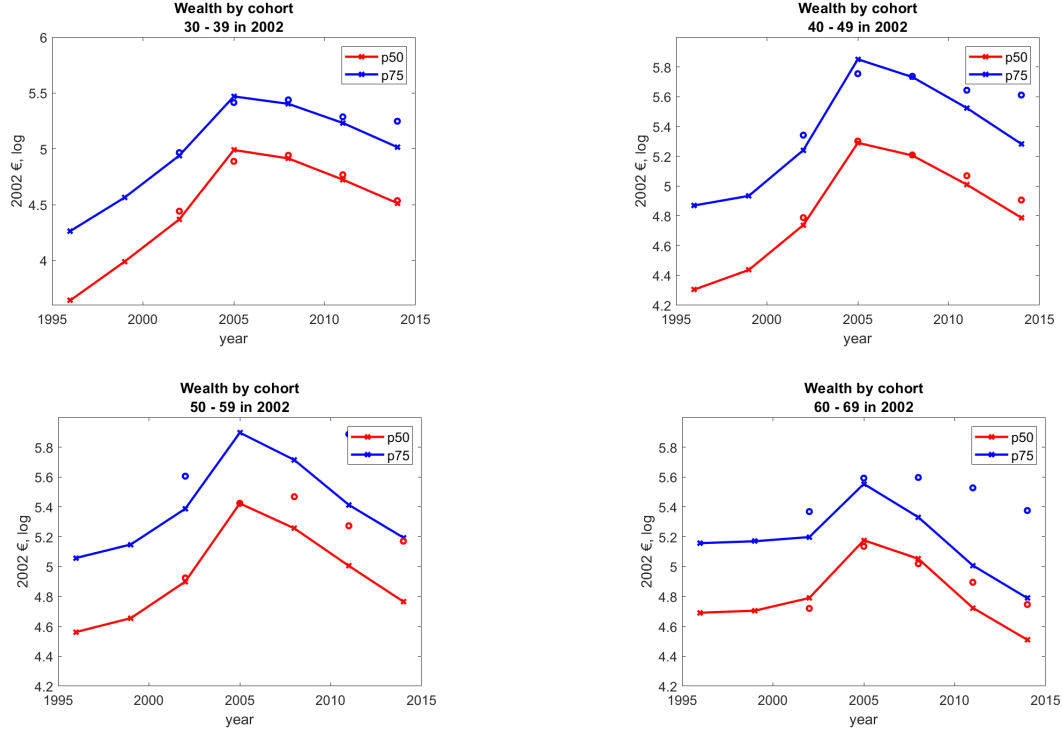
Figure 12: wealth by cohort-groups: Model predictions and Data
Note: The solid lines are the model predictions, while the circles are the data. Both are
median wealth, measured as net-wroth in constant 2002 prices

wealth-age profile in Spain. Notice that this is most true for the median household, so my analysis focuses on the median. In the Appendix A.1, I argue that if one understands the changes on the median, then one can also understand the changes at the right tail.

To judge to what extent the model accounts for the rise of inter-generational inequality after 2008, I form 10-year age groups and I normalize the median wealth of each group by the median wealth of households of the 40-49 bin. The model succeeds in replicating an increase in intergenerational inequality between the young and the old (Figure 14): from 2002 to 2014 the ratio of median wealths relative to the 40-49s, rises from 1.15 to 1.34 for the 50-59, from 1.05 to 1.34 for the 60-69s and from 0.9 to 1.02 for the 70-79s. In the data, these ratios changed from 1.15 to 1.64, from 0.93 to 2.12 and from 0.74 to 1.52 respectively. In other words, the model can account for 33% of the observed change for 50-59s, 24% for 60-69s, 15% for the 70-79s. Notice also, that the model gets the timing of the changes in intergenerational inequality roughly correct with most of the movement after 2008, as in the
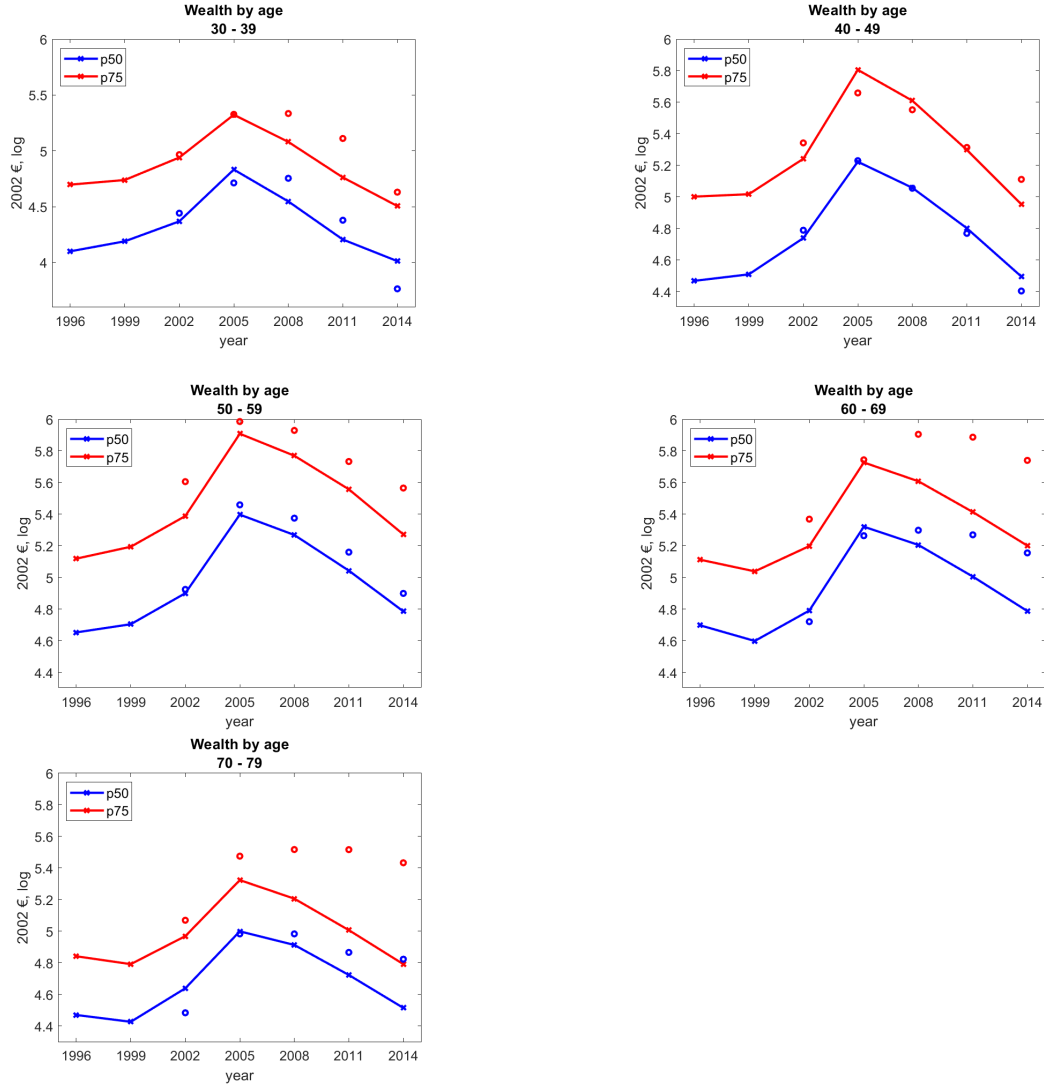
Figure 13: wealth by age-groups: Model predictions and Data
Note: The solid lines are the model predictions, while the circles are the data. Both are median wealth, measured as net-wroth in constant 2002 prices
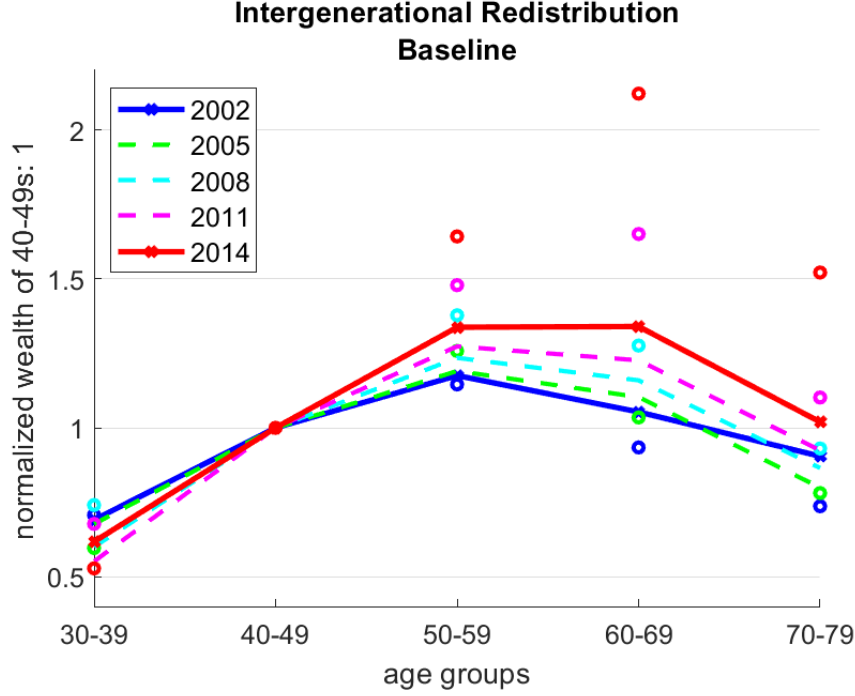
data.

Figure 14: Wealth Redistribution across ages

The x-axis corresponds to 10-year age bins (e.g. 30-39s). The y-axis is the the ratio of the median wealth of a household at age bin j over the median wealth of a household at age 40-49s.

7 Quantitative Experiments

7.1 Decomposing the Wealth-Age dynamics

Having a model that can account for a large share of the observed changes, I can construct counterfactual scenarios to examine the role of each force behind the changes in the wealth-age profile. The main counterfactual would be an economy that hadn't experienced the housing cycle nor the recession. In this economy, interest rates drop in 1997, house prices grow at rate g each year and the earnings of working-age households do not drop in 2008-2014. Notice that the wealth-age profile in 2014 may still be different from 1996 since the interest rates have fallen in this period. The other two counterfactuals are what would have happened in an economy that experienced only the housing cycle, or only the recession.

In the main counterfactual (Figure 15b), if neither the housing cycle nor the recession had occurred, intergeneratinal wealth inquality in 2014 would be very similar to that of 2002,

29

with only the ratio of median wealth of aged 50-59s households to that of the aged 40-49s increasing significantly from 1.2 to 1.27.

If only the Recession had occurred, (Figure 15d) the median 40-49 household would have have become relatively poorer with respect to older households. The median household aged 50-59 in 2014 would be 1.29 times as rich as their 40-49s counterpart, compared to 1.2 in 2002, the median household aged 60-69 in 2014 would be 1.16 times as rich, compared to 1.07 in 2002 and the median 70-79 would have been as rich as the median 40-49 in 2014, comparing to 0.92 as rich in 2002. Notice that a large part of the rise in inequality between the 50-59s and 40-49s can be accounted for in the main counterfactual by the drop in interest rates (from 1.2 to 1.27), whereas the rise of inequality between the 40-49s and older ages is due to the recession.

If only the housing cycle had occurred, (Figure 15c), the increase in intergenerational inequality would have been higher vis-a-vis the 50-59s and the 60-69s and of similar magnitude for the 70-79s. Specifically, the median 50-59s in 2014 would have been 1.3 as rich as the median 40-49 in 2014, compared to 1.15 in 2002, the median 60-69s would have been 1.29 as rich in 2014, compared to 1.06 in 2002, and the median 70-79s would have been 0.98 as rich as the median 40-49s in 2014, compared to 0.9 in 2002.

Table Table 3 gathers the above results for all counterfactuals. The housing cycle seems to have been a more important force for driving the rise in intergenerational inequality between the 40-49s and the middle aged (50-59s & 60-69s), but the recession and the housing cycle contribute equally to the rise in inequality between the 40-49s and the middle-aged.

	No Housing Cycle, No Recession	Only Housing Cycle	Only Recession	Baseline
50-59s	1.27 (+0.08)	1.3 (+0.13)	1.29 (+0.1)	1.34 (+0.16)
60-69s	1.08 (+0.01)	1.29 (+0.24)	1.16 (+0.1)	1.34 (+0.28)
70-79s	0.93 (+0.01)	0.98 (+0.08)	1 (+0.08)	1.02 (+0.12)

Table 3: Median Wealth of age groups over median wealth of 40-49s
The table reports the ratio of the median wealth of age group j (e.g. 50-59) over the median wealth of the 40-49s in 2014 for the 3 counterfactuals and the baseline scenario. The numbers in parenthesis report the change of the ratio from 2002 to 2014 for each experiement

(a) No Housing Cycle, No recession

(b) baseline

(c) Only Housing Cycle

(d) Only Recession
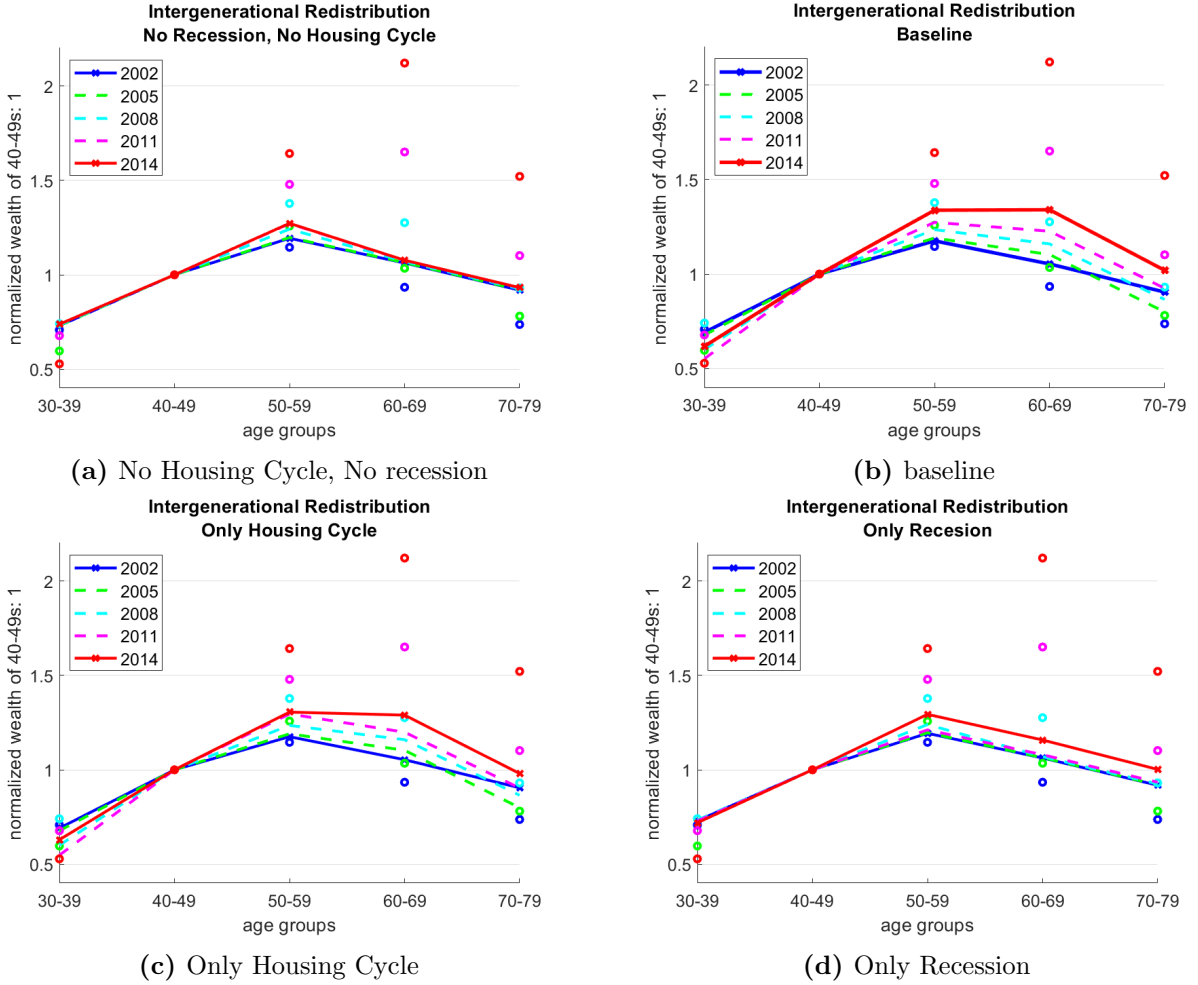
Figure 15: Wealth Redistribution across ages: Counterfactuals
The x-axis corresponds to 10 age bins (e.g. 50-59s). The y-axis is the the ratio of the median wealth of a household at age bin j over the median wealth of a household at age 40-49s. Panel (a) reports what would have happened if the recession had never occurred (i.e. isolates the effect of the housing cycle), panel (c) depicts what would have happened if the housing cycle had never occurred (i.e. isolates the effect of the recession) and panel (d) depicts what would have happened if neither the housing cycle nor the recession had occurred

7.2 Welfare Analysis

There are two questions of interest regarding the welfare implications of the house cycle & the recession. The first one; what are the implications of the double crisis on the lifetime welfare of different cohorts. To answer this question I assume that house prices evolve after 2014 are equal to Z_t each period (i.e. exactly equal to their expected value in each period) and wages grow at the 2.5% trend from their 2014 levels. The latter assumption implies that the earnings of working age-households will never revert to the pre-crisis trend after 2014, which seems a reasonable assumption at least when looking at the period 2014-2020 (see Figure 2). Since the answer to the second question hinges on contestable assumptions about the evolution of the economy after 2014, a second question of interest is what have been the welfare gains and losses of the double crisis for households of different cohorts in the period 1997-2014, for which none assumption about the future evolution of house prices and labor earnings is needed. In both cases, I calculate consumption equivalents for each household state at the end of 1996, defined as the percentage change of consumption and bequests that would make the household indifferent between living on the realized scenario and a counterfactual world without a housing cycle and a recession. I also survey the welfare implications of the counterfactual scenarios in which either the recession or the housing cycle hadn't occurred, isolating the welfare effects of the two.

In both welfare measures the young are losing from both the recession & the housing cycle, while the old are having small gains from the housing cycle. Examining the lifetime impact (Figure 16a), young households are affected much more by the recession, facing up to 20% losses in CE depending on the cohort chosen, compared to up to 3.8% losses from the housing cycle. This is expected, since the housing cycle is a transitory shock and after 2014 prices are expected to revert to the trend, whereas after the recession workers' incomes never catch up with the pre-crisis trend. On the other hand, retirees are not affected by the recession and they face small welfare gains from the above-trend housing prices during the cycle, up to 3.9%.

The picture changes considerably for the young when looking at the realized welfare for the young in 1997-2014 (Figure 16b). What is striking is that for this period, the cohorts who were buying housing during the boom faced welfare losses of up to 6.7% in CE, an amount equivalent to the losses they incurred from the recession. For the rest of the cohorts, the welfare effects are qualitatively similar, with changes in the magnitude that depend on the length of the period covered. For example, the gains from the housing cycle are slightly higher for the early retirees of 1999 when looking only at the period 1996-2014, compared to lifetime, since the capital gains that these cohorts realize are likely spent within the 18 years covered in the analysis.

(a) Lifetime   **(b)** 1996-2014
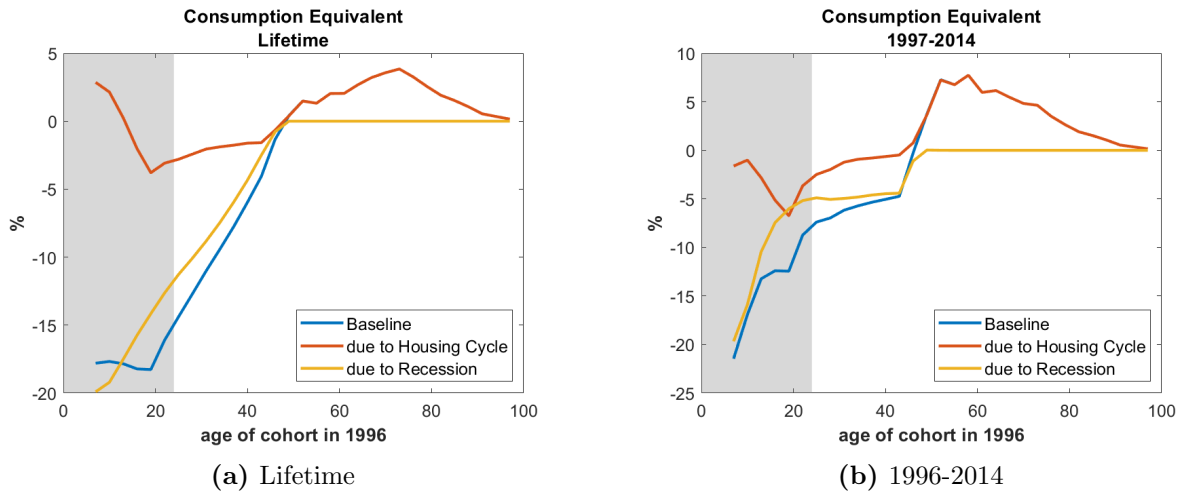
Figure 16: Average Consumption Equivalent by cohort
The x-axis corresponds to 10 year cohort bins (e.g. age 50-59s at 1999). The y-axis is the average consumption equivalent for each cohort. Panel (a) reports the lifetime consumption equivalent, while panel (b) depicts the consumption equivalent for the period 1996-2014.

8   Conclusion

This paper has provided empirical evidence that the housing cycle and the recession have had a heterogeneous impact across cohorts. It also documented that in the years after the burst of the housing cycle and during the recession, the wealth-age profile shifted dramatically in favor of the old. By modeling life-cycle savings using a quantitative choice

model with two assets, the paper provides a mechanism through which the housing cycle and the recession may have affected the wealth-age profile and evaluates the extent to which they can account for the observed changes. It, then, uses the model to quantify the welfare effects of these aggregate shocks on different cohorts.

The recession causes a drop in working-age households' income while doesn't affect the elders' income. Young households are also negatively affected by the housing cycle as they tend to be buyers of houses, while the elders are benefiting from selling at high prices. The net worth of young households is also more exposed to house price swings since they are leveraged, a result of taking mortgages to finance their house purchases.

The model can account for up to 33 % of the changes in wealth inequality between the 50-59s & 40-49s, up to 24% of the increase in the wealth gap between the 60-69s & the 40-49s, and up to 15% between the 70-79% and the 40-49%. The housing cycle is found to affect mostly the rise in young vs middle-aged wealth inequality, while both the housing cycle and the recession are found to drive the rise in the wealth gap between the young and the elderly.

Regarding expected lifetime welfare the young have faced major losses from the recession up to 20% in consumption equivalent and fewer losses from the housing cycle, up to 3.8%. These results are driven by the housing cycle being a temporary phenomenon, while the recession causes a permanent drop in the level of wage income. When looking at realized welfare gains and losses in 1997-2014, for the younger cohorts the welfare losses from the housing cycle were up to 6.7%, i.e. they have been comparable to the ones from the recession. On the other hand, the elders were not affected by the recession and they experienced significant lifetime welfare gains up to 3.8%.

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Appendix

A Data

A.1 Accounting for the changes at the top

Figure 6b documents that the median elder household has become richer relative to the median aged 40-44 household. In this section I show that the change in the wealth-age profile has not affected only the median household but also the top 10% of wealth. Moroever, increased wealth inequality between ages is the dominant factor behind the increased prevalence of elder households (≥70 yeas old) among of the richest top 10% of households in Spain after 2008.

A.1.1 Intergenerational Wealth Inequality at the 90th percentile of wealth

Figure 17b plots the ratio the 90th percentile of networth of a certain 5-year age bind, over the 90th percentile of networth among households aged 40-45, for different years. In 2002, the 90th percentile of wealth among aged 70-74 households was 25% less than the the 90th percentile of wealth among households aged 40-44. But in 2011 and 2014, the 90th percentile among the 70-74s was respectively 70% and 90% higher than the 90th percentile of wealth among the households aged 40-44. In other words the shift of the wealth-age profile in favour of the old ahs occurred not only at the median but also at the top of the wealth distribution.

(a) Median   (b) p90
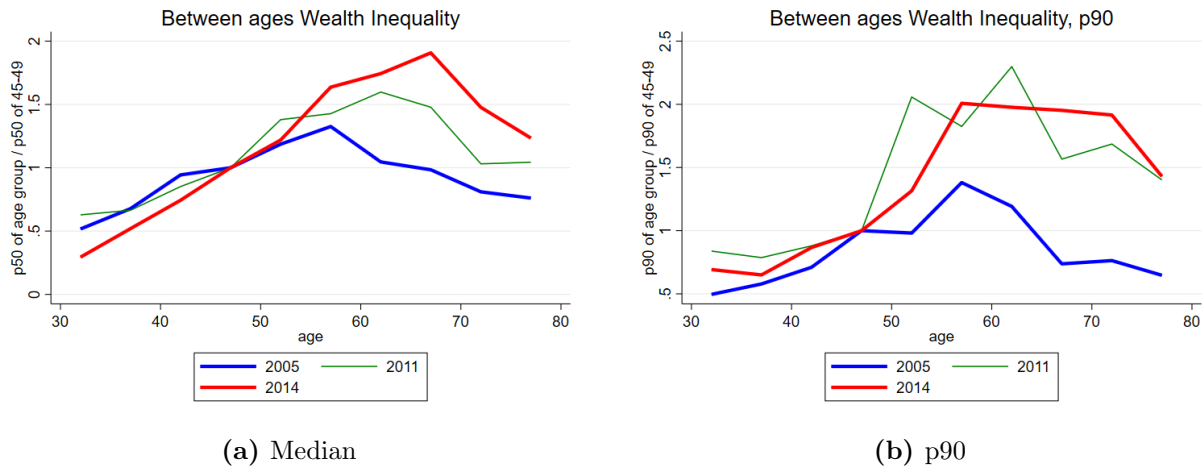
Figure 17: Wealth Redistribution across ages: at the Median and at the 90th percentile

A.1.2 The age composition at the top 10% of wealth

A striking feature of the data is that since 2011, a large share of the richest households in Spain are elders (≥ 70 years old). In 2002 only 1 in ten households in the top 10% of wealth were above 70 years old and 30% of the households were above 60 years old (Appendix A.1.2).

However, in 2011 the share of households above 60s years old in the top 10% of wealth had risen to more than half, and a quarter of the households were above 70 years old. The same trend has occurred at the top 5% of wealth, with the shares of above 60 years old and above 70 years old rising from 10% & 30% in 2002 to 22% and 50% in 2011 respectively (Appendix A.1.2).
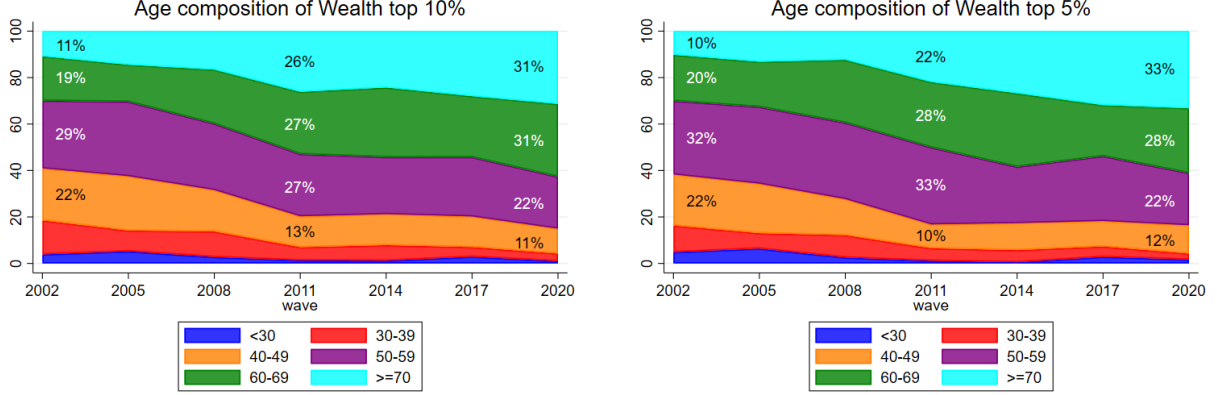

Figure 18: Age Composition at the top of Wealth

These changes in the age composition of the top wealth groups reflect the rise in intergenerational wealth inequality that is observed across the wealth distribution. To demonstrate this point, I pursue an accounting exercise that decomposes the evolution of wealth inequality in (i) demographic change, (ii) changes in intra-age inequality, and (iii) changes in inter-age inequality. In other words, the larger share of elders at the top of wealth in 2011 maybe the outcome of 3 factors; (i) the share of elders in the population has grown, (ii) the distribution of wealth within age groups has changed (e.g. the right tail of wealth distribution has become fatter among elders) or (iii) the elders have become richer relative to the young.

Notice that the survey provides information with respect the age of the households, their networth and a weight. For each wave w, I split households into 7 age-groups ($< 30, 30 - 39, ...70 - 79, \geq 80$), and for each age-group I split the intra-age group into 20 wealth bins. This way, there are 7*20 age-quantile groups (j,q) for each wave. Let med_{wh}: the median wealth of age group h, at wave w and χ_{wqj}: the ratio of median wealth of age-quantile group (j,q) h, at wave w over med_{wj}. Then for each observation i, in age-group j, quintile group q at wave w, I construct a counterfactual networth

$$nw_{ijwq}^{cf} = \frac{med_{2002j}}{med_{wj}} * \frac{\chi_{2002qj}}{\chi_{wqj}} nw_{ijwq}$$

and a counterfactual weight $weight_{ijw}^{cf} = \frac{Share\ of\ group\ j\ in\ 2002}{Share\ of\ group\ j\ in\ w} weight_{ijw}$.

The term $\frac{med_{2002j}}{med_{wj}}$ reverses any changes in between-age inequality that have occurred between 2002 and w, the term $\frac{\chi_{2002qj}}{\chi_{wqj}}$ reverses the intra-age changes in wealth inequality and the counterfactual weights correct for demographic change. The resulting distribution by accounting is similar to the 2002 wealth-age distribution, since all changes are reversed (Figure 19a).

In order to isolate the impact of each of the 3 drivers, I adjust only for one of the changes at once. The result of this exercise is that reversing the changes in between-ages wealth inequality (by adjusting the median of each age group) is almost all that matters. Reversing only the changes in between-ages wealth inequality implies a counterfactual share of above 60s at the wealth top 10% of 34% in 2011 and 30% in 2020, comparing to 53% and 62% in the Data (Figure 19e). By contrast, reversing the changes only in intra-age wealth inequality results in a rise of the share of above 60% in the wealth top 10% of 42% in 2011 and 66% in 2020, while by adjusting only for demographic change, these numbers are 49% & 57%.
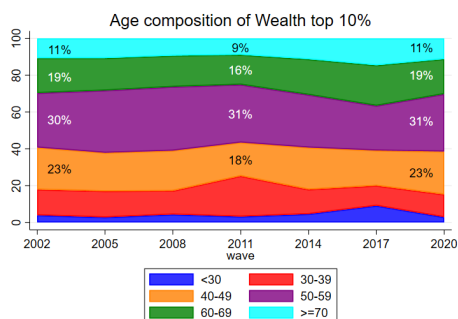
(a) All Changes Reversed
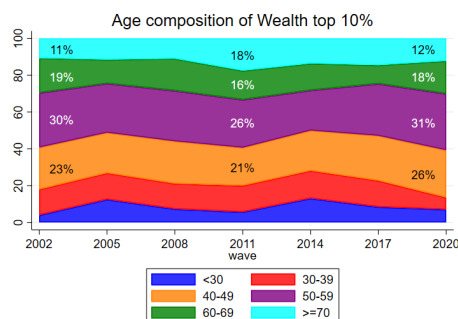
(b) Reverse changes in Inter-Age inequality
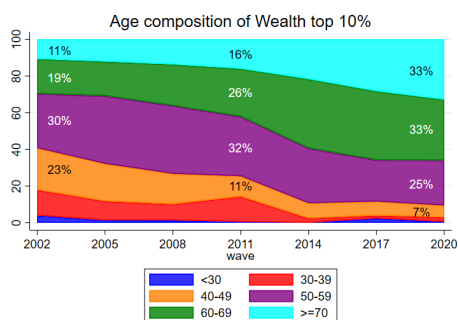
(c) Reverse changes in Intra-Age inequality
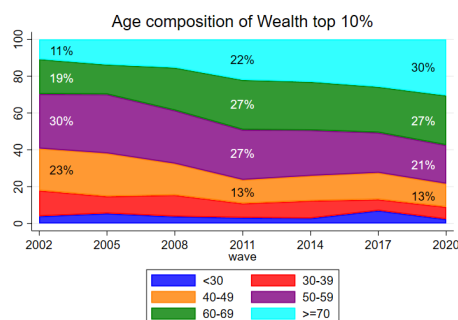
(d) Reverse changes in demographics
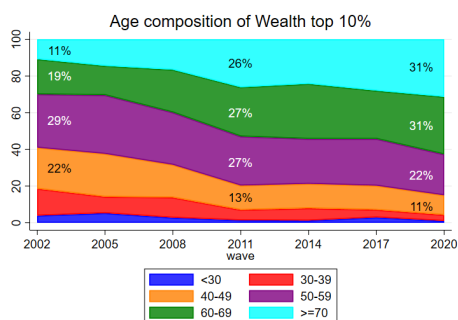
(e) Data

Figure 19: Age Composition at the top: An accounting Exercise

A.2 Trend Growth

In both Data and Model I assume that the economy grows at the 2.5% trend. In this subsection I show that this is a realistic assumption.

I consider 3 measures of growth: GDP per capita, GDP per Working Age Population (WAP) and wage compensation per WAP. Figure 20a plots these measures against the 2% and 3% trend. THe 3 measures mostly commove, especially from the 80s onwards, and it's not discernible by eye if the 2% or 3% trends describes better the time series. On the other hand, the 1% trend seems a bad assumption (Figure 20b).

(a) Trend Growth: 2% & 3 %   **(b)** Trend Growth: 1% & 2 %
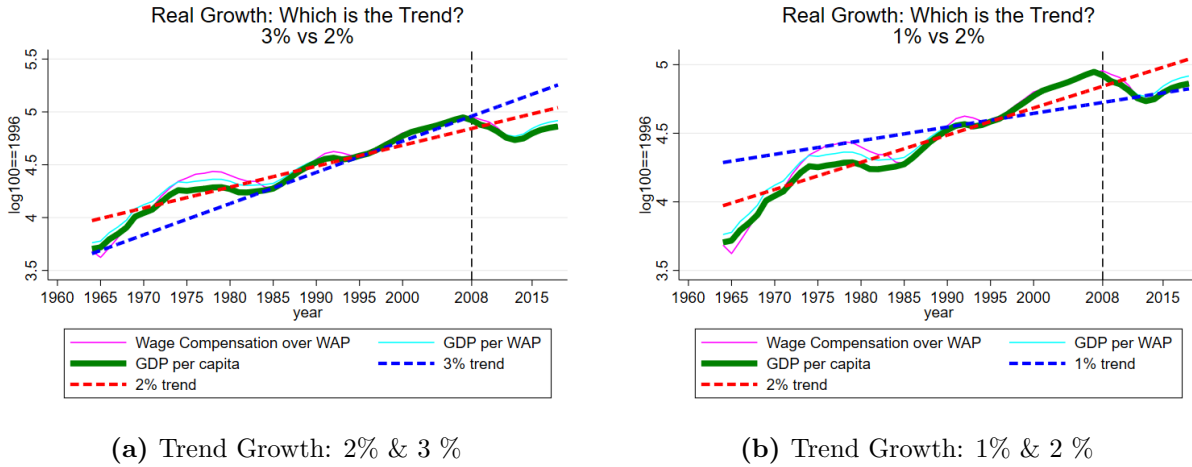
Figure 20: Growth Measures and Trend

The 3 measures of grwoth considered are GDP per capita, GDP per WAP & (total) Wage Compensation per WAP. Data come from BdE and all measures are deflated using the CPI (OECD). Panel (a) plots these measures against the 3% & 2% trend, while panel (b) does the same against the 2% & 1% trend.

As seen in Figure 20a, the evolution of all 3 measures features considerable short-run deviations from the long-run trend, which makes the estimation of the long-run trend sensitive to base effects. To delve into this issue, I regress the log of GDP per capita (the longest available series) on year, selecting all subperiods of the form y-2007 with $y \in [1967, 2006]$. Figure 21 plots the estimates against the starting year (y). Almost all of the estimates are between 2% and 3%, with the mean estimate being 2.56%. Taking all information into account, I conclude that the 2.5% growth trend is a realistic assumption.

A.3 Reported House Prices

A valid concern when interpreting the changes in median assets and networth is that elder households do not update their house prices after the burst of the housing cycle. To dispel this concern I calculate the median reported price per square meter of the main residence for different cohorts in 2008 and 2014. The percentage drop is similar for households across cohorts between 2008 and 2014 (around 35%), and the same is true for the percentage change of the median assets (Figure 22).
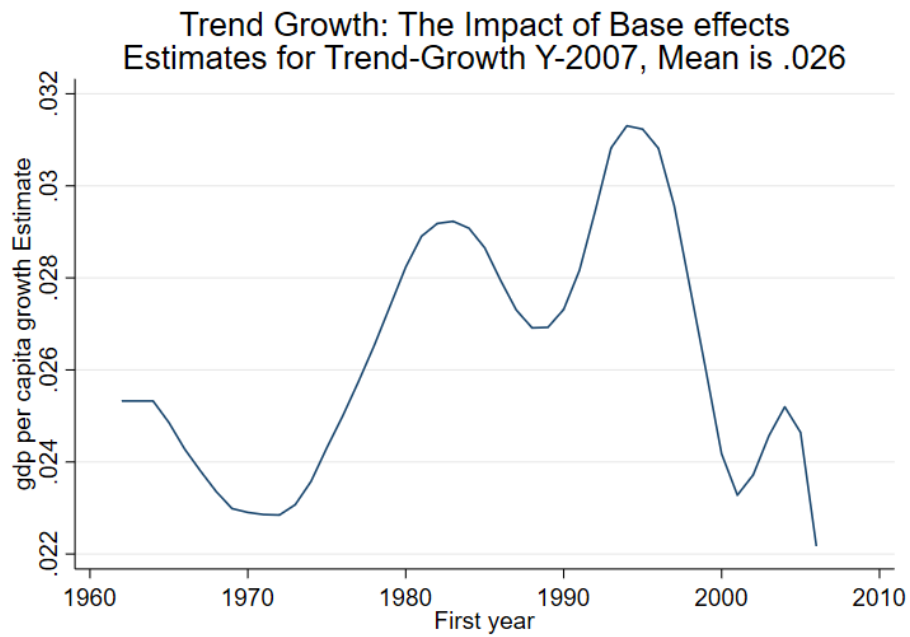
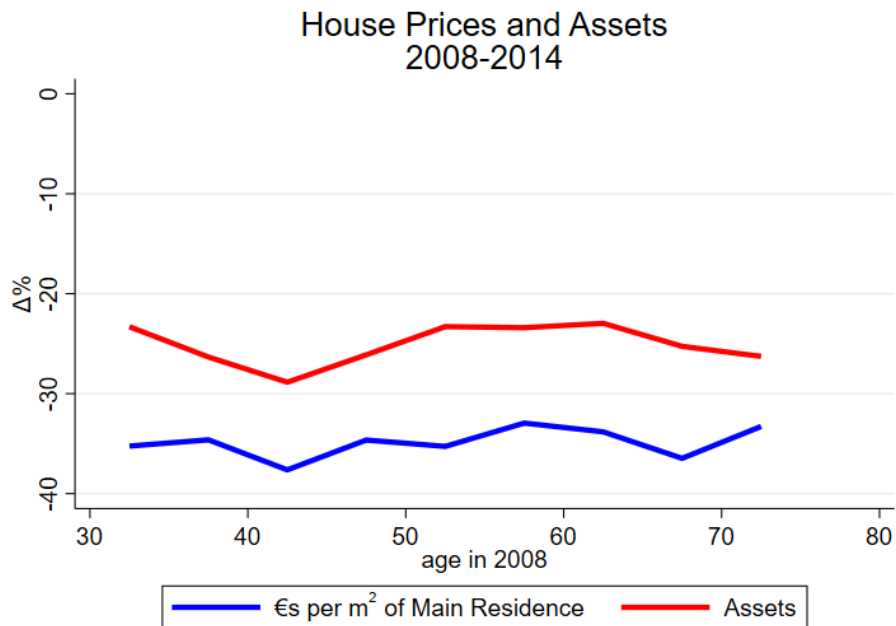**Figure 21:** Trend Growth: The Impact of Base Effects

Figure 22: Change in median House Prices (€s per m^2 and Assets across cohorts

B Model

B.1 Existence of Balanced Growth Path

To prove the existence of a Balanced Growth Path, I first need to merge the two stages of the problem into 1:

$$
\text{for } j=1,2,....T: \quad V_j(a,h,z;\mathcal{A}) = \max_{c,a',s,h'} \left\{ e_j \frac{\left(\frac{c^\alpha h'^{1-\alpha}}{e_j}\right)^{1-\gamma}}{1-\gamma} + \right.
$$

$$
\left. \beta E\left[\left(\pi_j V_{j+1}(a',h',z',\mathcal{A}') + (1-\pi_j)\phi_1 Z'^{\alpha(1-\gamma)}\frac{\left(1+\frac{a'+p'_h h'}{\phi_2 Z'}\right)^{(1-\gamma)}}{1-\gamma}\right)|z,\mathcal{A}\right]\right\}
$$

$$
s.t. \quad s + p_h h' + p_h c_{adj}(h,h') = a + p_h h
$$

$$
s \geq \min\{a, -\xi p_h h'\} \text{ if } h' \neq h, \quad s \geq 0 \text{ if } j \geq J_{ret}
$$

$$
a' + c = s(1+r(s)) + Zy(j,z) - Z\tau\left(y(j,z) + \mathcal{I}_{(s\geq 0)}r(s)\frac{s}{Z}\right)
$$

$$
r(s) = r_b\mathcal{I}(s \geq 0) + r_l\mathcal{I}(s < 0)
$$

$$
a' \geq min\{0,s\}
$$

$$
V_{T+1}(a,h,z;\mathbf{A}) = 0 \; \forall a,h,z,\mathcal{A}
$$

Rewriting the problem with $\tilde{x} = \frac{x}{Z}$ for x=c, a', s, p_h, it follows that (i) the returns function is homogeneous of degree $\alpha(1-\gamma)$ wrt Z and (ii) the constraints are independent of Z. From this it follows that the model features a balanced growth path and the Bellman Equation can be written with only normalized variables:

$$
\text{for } j=1,2,....T: \quad V_j(\tilde{a},h,z;\mathcal{A}) = \max_{\tilde{c},\tilde{a}', \tilde{s}, h'} \left\{ e_j \frac{\left(\frac{\tilde{c}^\alpha h^{1-\alpha}}{e_j}\right)^{1-\gamma}}{1-\gamma} + \right.
$$

$$
\left. \beta(1+g)^{\alpha(1-\gamma)} E\left[\pi_j V_{j+1}(\tilde{a}',h',z';\mathcal{A}') + (1-\pi_j)\phi_1\frac{\left(1+\frac{\frac{\tilde{a}'}{(1+g)}+\tilde{p}'_h h'}{\phi_2}\right)^{(1-\gamma)}}{1-\gamma}|z,\mathcal{A}\right]\right\}
$$

$$
s.t. \quad \tilde{s} + \tilde{p}_h h' + \tilde{p}_h c_{adj}(h,h') = \frac{\tilde{a}}{(1+g)} + \tilde{p}_h h
$$

$$
\tilde{s} \geq \min\{\frac{a}{(1+g)}, -\xi\tilde{p}_h h'\} \text{ if } h' \neq h, \quad \tilde{s} \geq 0 \text{ if } j \geq J_{ret}
$$

$$
\tilde{a}' + \tilde{c} = \tilde{s}(1+r(\tilde{s})) + y(j,z) - \tau\left(y(j,z) + \mathcal{I}_{(\tilde{s}\geq 0)}r(\tilde{s})\tilde{s}\right)
$$

$$
r(\tilde{s}) = r_b\mathcal{I}(\tilde{s} \geq 0) + r_l\mathcal{I}(\tilde{s} < 0), \quad \tilde{a}' \geq min\{0,\tilde{s}\}
$$

$$
V_{T+1}(\tilde{a},h,z;\mathbf{A}) = 0 \; \forall \tilde{a},h,z,\mathcal{A}
$$

Therefore, along the Balanced Growth Path, c*,s*,a* are homogeneous of degree 1 with respect to Z and h* is homogeneous of degree 0 with respect to Z (for details see Appendix B.1)

C Calibration

C.1 Survival Probabilities & Demographics

The estimated survival probabilities of households give rise to a unique stationary population distribution. Figure 23 shows how the model's stationary distribution compares with the census of 2001 data and the survey data of EFF in 2002. Notice that the model abstracts from household formation and when I estimate the survival probabilities, I impose a probability 1 of surviving for households below 50.
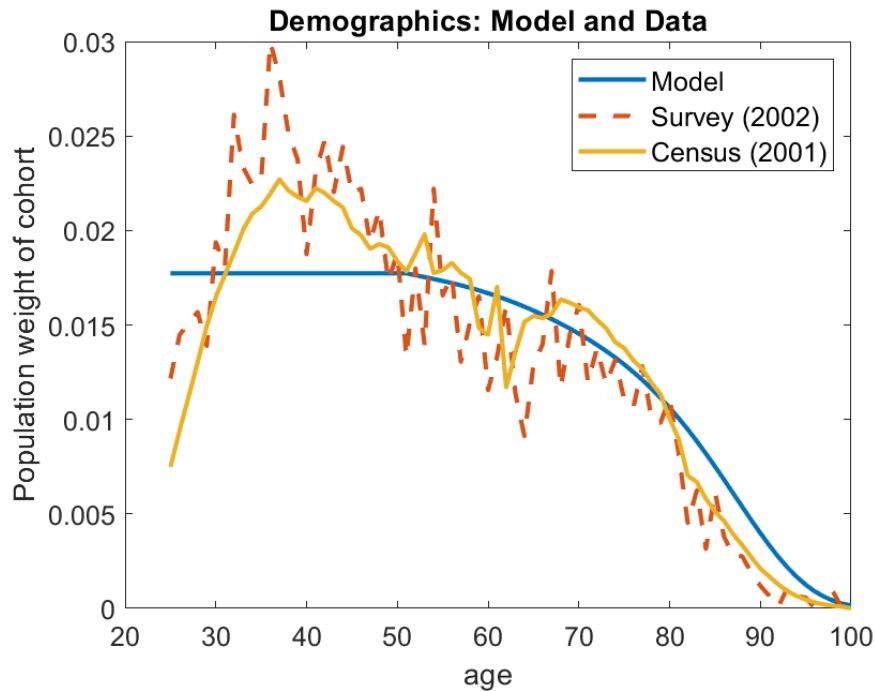

Figure 23: Demographics: Model & Data

C.2 Equivalence scale

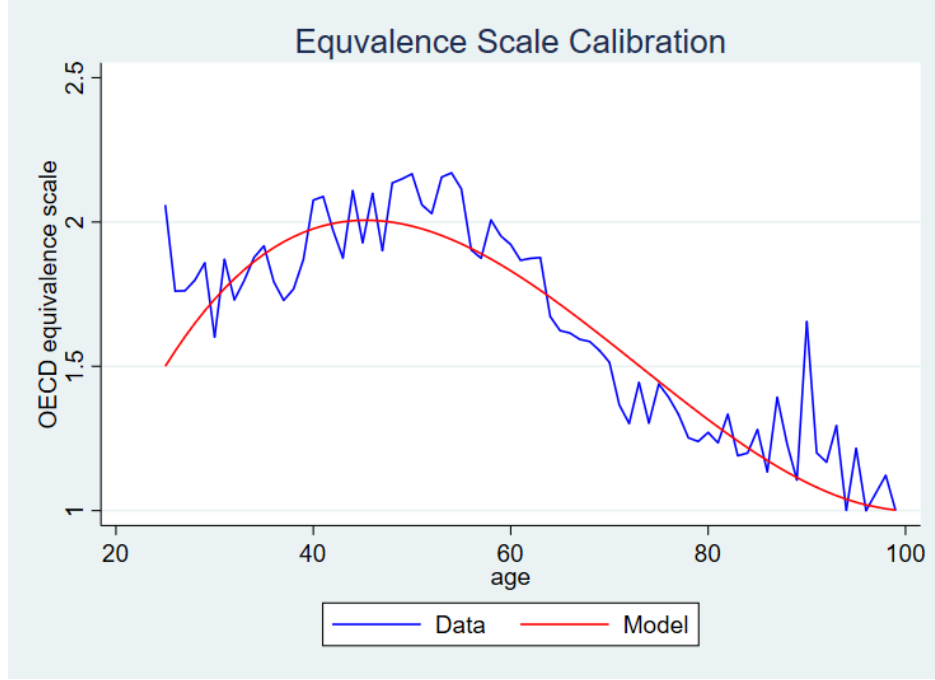The estimated coefficients of the polynomial are [-1.1235,0.16255,-0.0026, 0.00001]. Figure 24

Figure 24: Equivalence Scale: Model & Data
I use the oecd equivalence scale. The Data line are means of equivalence scale for each age.
I impose in the model that households are born with 2 members at 25 years old and at age
100 they are single-membered.

C.3   Housing Grid

I use 11 points for the housing grid. To calibrate these points, I first allocate households
with positive housing wealth from the 2002 wave into 10 deciles of housing wealth and set
the last 10 grid points equal to the 10 median of the deciles. (In other words, equal to
the 5th,15th,25th,..., and 95th percentiles of housing wealth). Finally, I add a new point at
the start of the grid, which will be the endowment of newborns in terms of housing. This
adjustment is essential to prevent newborns from benefiting too much from an increased
initial endowment during the housing boom.

The housing grid I use is: [5;25.2;42.6;58.4;78.2;90;104.2;130.3;156.4;208.5;355.2] (num-
bers are rounded to the first decimal)

D   Additional Results

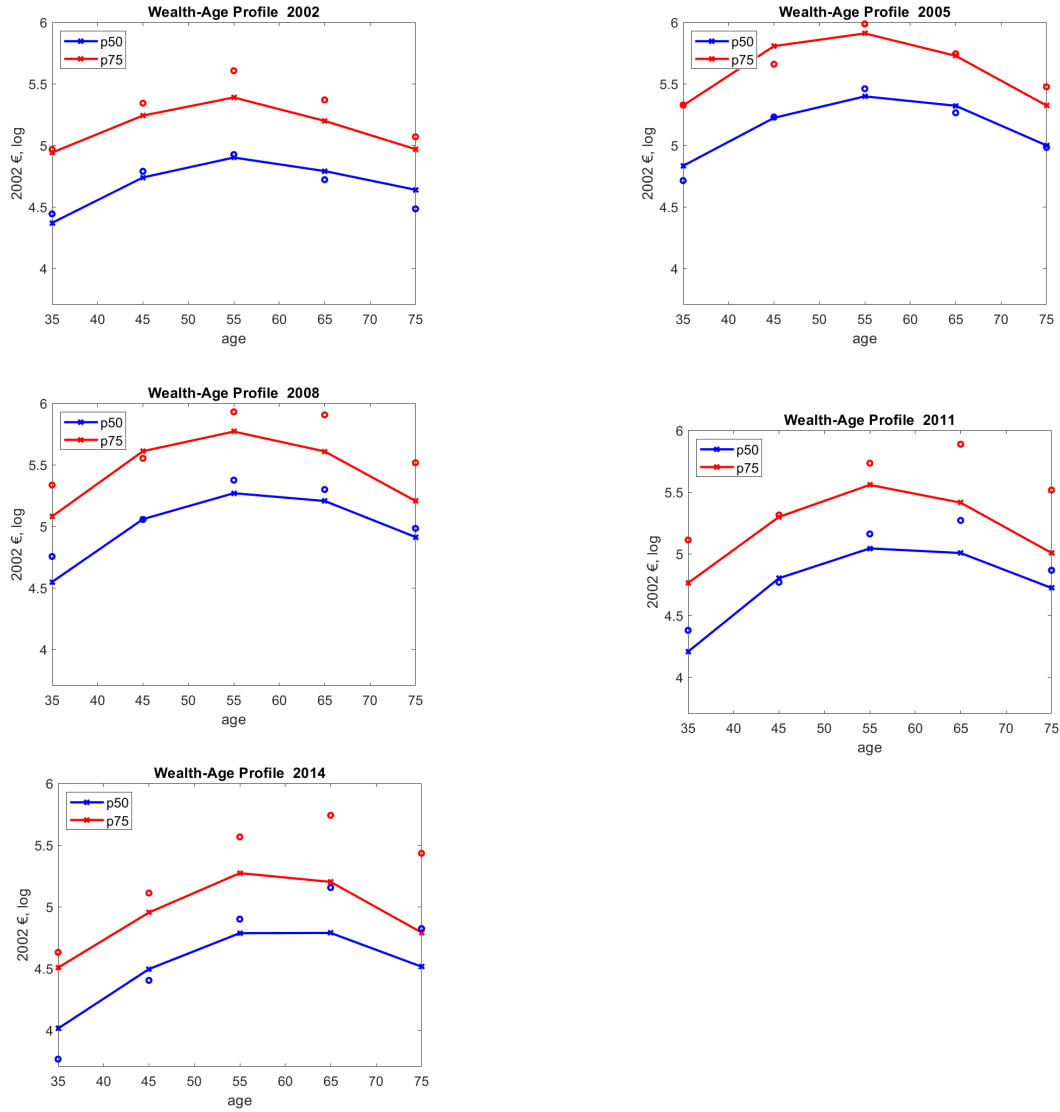## D.1   Wealth-age profiles for different counterfactuals

Figure 25: Wealth-age profiles: Baseline Model predictions and Data
Note: The solid lines are the model predictions, while the circles are the data. Both are median wealth, measured as net-wroth in constant 2002 prices
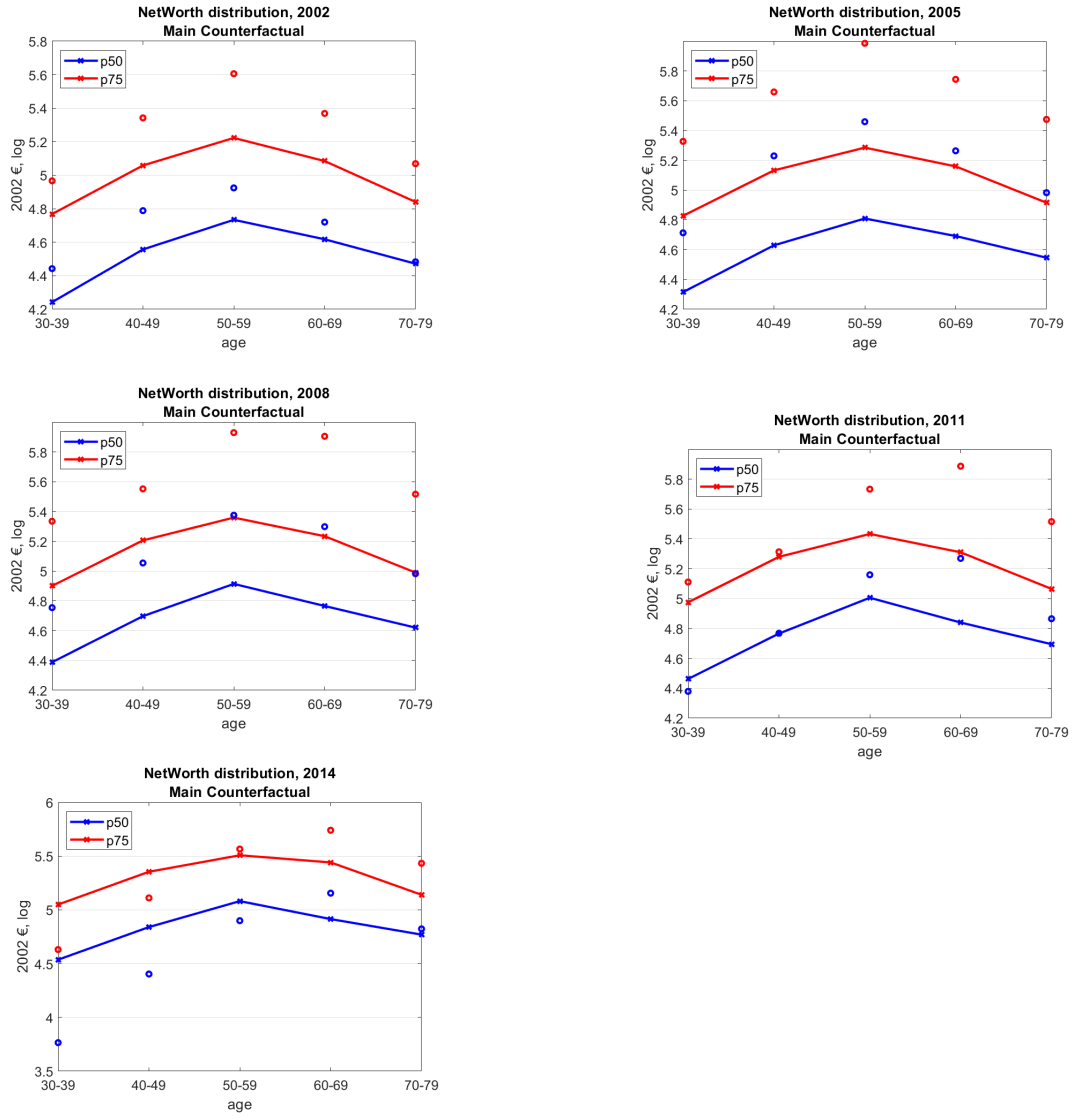
Figure 26: Wealth-age profiles: Main Counterfactual
Note: The solid lines are the model predictions, while the circles are the data. Both are median wealth, measured as net-wroth in constant 2002 prices
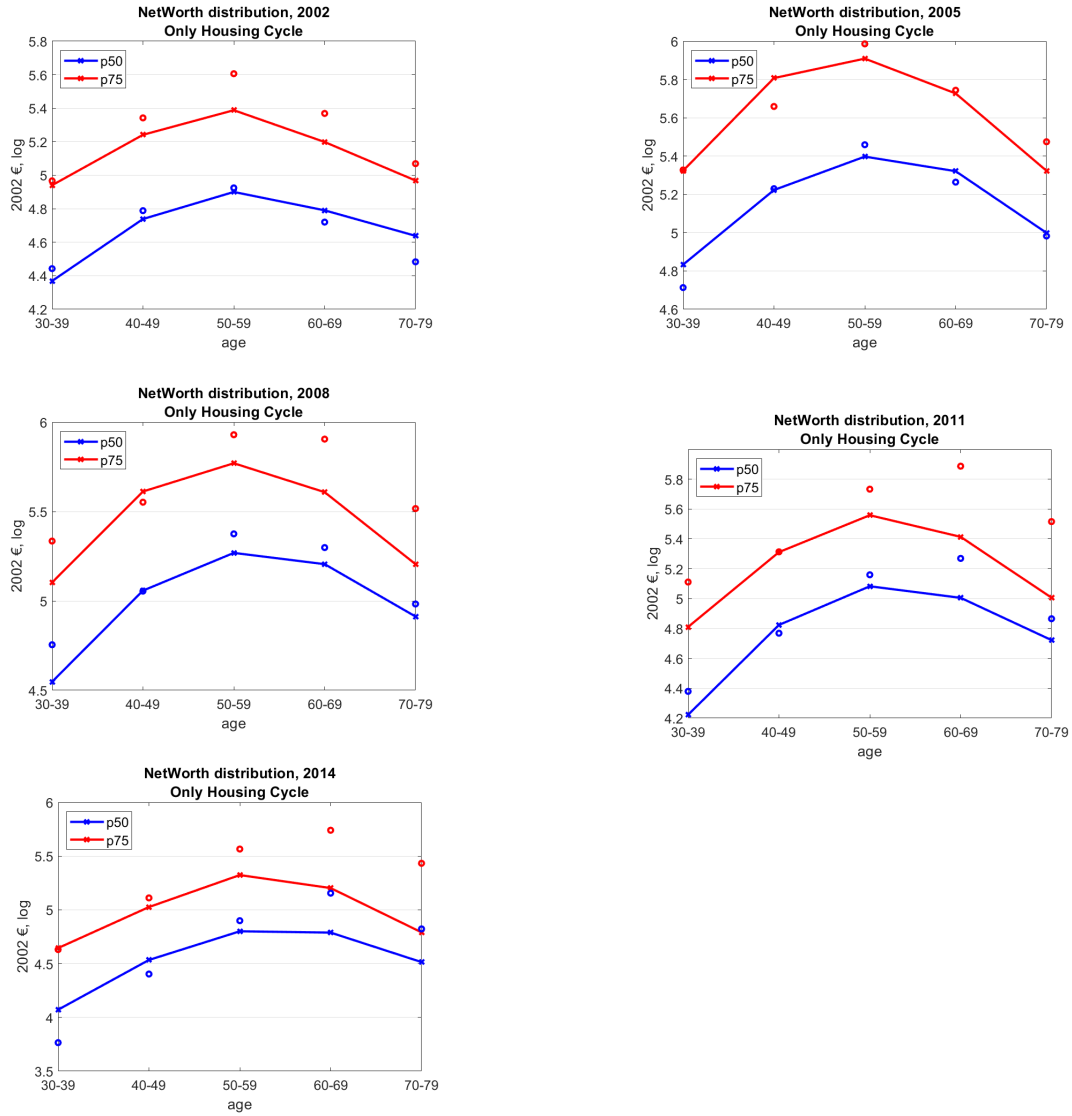
Figure 27: Wealth-age profiles: Only Housing Cyclel

Note: The solid lines are the model predictions, while the circles are the data. Both are median wealth, measured as net-wroth in constant 2002 prices
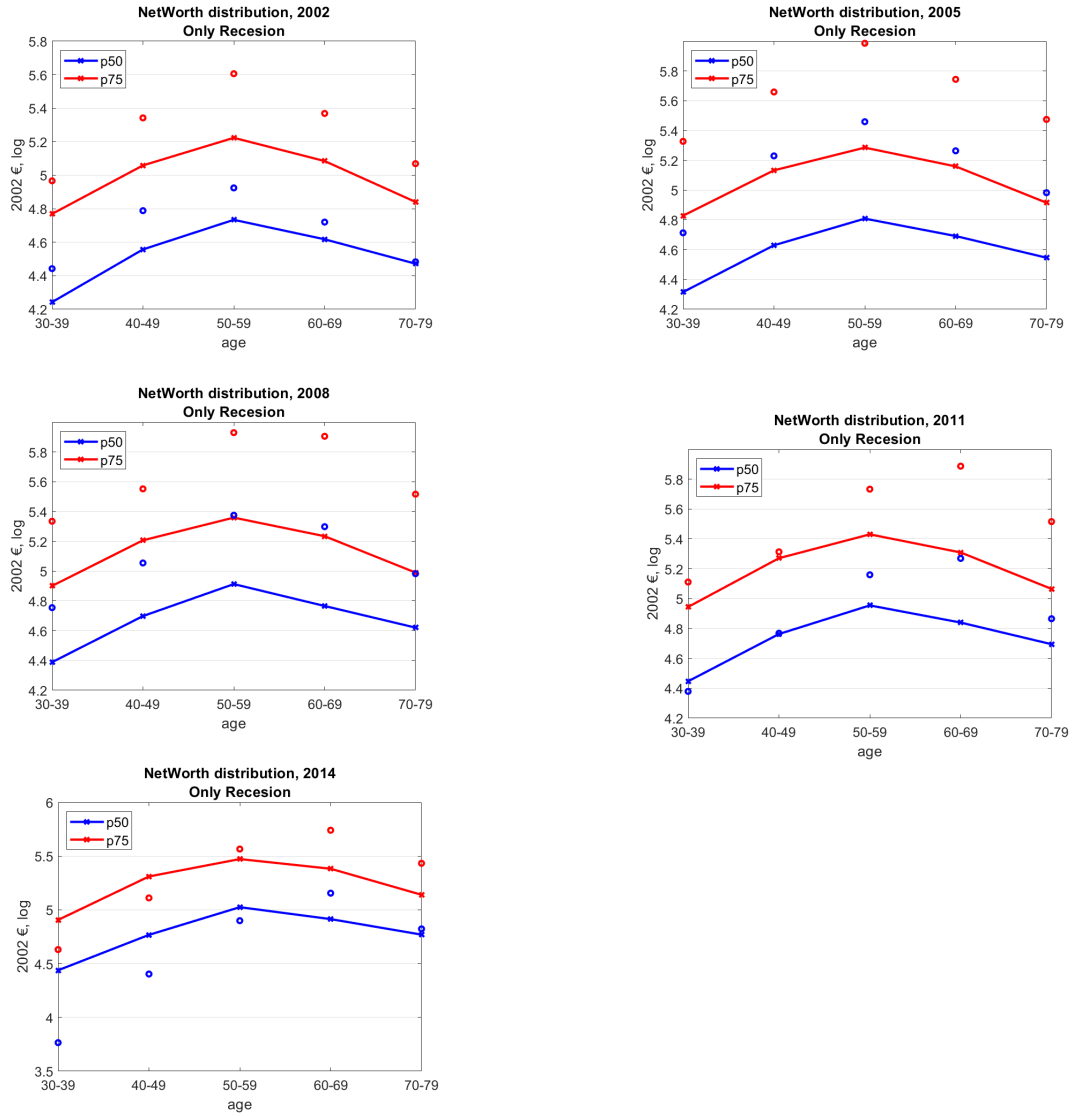
Figure 28: Wealth-age profiles: Only Recession

Note: The solid lines are the model predictions, while the circles are the data. Both are median wealth, measured as net-wroth in constant 2002 prices