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Homeownership and portfolio choice over the generations

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Abstract

Earnings are riskier and more unequal for households born in the 1960s and 1980s than for those born in the 1940s. Despite improvements in financial conditions, younger generations are less likely to be living in their own homes than older generations at the same age. By using a life-cycle model with housing and portfolio choice that includes flexible earnings risk and aggregate asset price risk, I show that changes in earnings dynamics account for a large part of the reduction in homeownership across generations. Lower-income households find it harder to buy housing, and as a result accumulate less wealth.

Keywords: Housing demand, earnings risk, wealth accumulation, intergenerational inequality.

JEL classification: D31, E21, E24, G11, J31

Non-technical summary

Homeownership rates of younger people have progressively decreased over time. In the case of the US, the percentage of households that were living in their own homes at age 35 decreased from 75% within the cohort born in the 1940s to 55% within the cohort born in the 1980s. Similar trends have been documented for European countries like the U.K.; in Spain and Italy, the average age of emancipation from the parental home is around 30.

This paper studies the determinants and consequences of low homeownership rates for younger generations, focusing on the role of their labor market experiences and the implications for their accumulation of wealth. I study the case of the United States, with data spanning six decades (1968-2017), using a life-cycle heterogeneous-agent model with portfolio choice between risk-free assets, risky assets, and houses, realistic mortgages, and a rich structure of risks that includes flexible household earnings risk and asset return risk, which are allowed to be correlated at the aggregate level.

I find that changes in labor market income dynamics can explain around half of the drop in homeownership rates across generations. Younger households face more inequality and volatility in the labor market. Thus, relatively lower earners find it harder to access a house than people in the same position in the income distribution did 40 years ago. Besides, higher earnings instability discourages households from getting a mortgage and making a large expenditure like a house, because doing so exposes them to risk. The remainder of the difference is explained by higher house prices with respect to median incomes, partially mitigated by the easier availability of credit during the 1990 and 2000 decades.

These changes in homeownership rates impact the wealth distribution. Households not only buy houses as a means to save, but also because they enjoy owning them, because they provide insurance against rental risk, and because leveraging with a mortgage allows them to benefit from gains in the housing market. In younger generations, fewer generations are buying housing and, because of these additional reasons to hold housing, they do not fully compensate the missing wealth by accumulating more financial assets.

These results suggest that policies that encourage homeownership or affect mortgage eligiblity can affect wealth accumulation by low-income households and thus the overall wealth distribution. Furthermore, they highlight that household portfolios are changing across generations, which can have implications for the transmission of monetary policy.

1 Introduction

The economic conditions faced by young US households are radically different from those that their parents and grandparents experienced when they were their age. There is less mobility in the labor market, career-long positions are less and less prevalent, and earnings inequality has increased. While the labor incomes of high earners have increased substantially over time in real terms, income-poorer individuals have seen their earnings stagnate or decrease.[1]

Meanwhile, homeownership for younger generations has shrunk. Within the cohort born in the 1940s, at age 35 over 70% of households were living in houses they owned. The figure was ten percentage points lower for those born in the 1960s, and more than 20 percentage points lower for the early 'Millennials' born in the 1980s. This happened in a context in which financial markets have become more developed[2] and stock market participation has been increasing for younger generations. These distributional changes cannot be perceived in aggregate homeownership rates, which have remained stable during most of this period.

This paper studies the role of these changes in household labor income dynamics and financial conditions in explaining homeownership and portfolio composition across generations. To do so, it proposes two novel contributions. First, it designs a flexible, cohort and business-cycle dependent earnings process, based on Arellano et al. (2017), that allows shocks to household labor income to be age-varying, non-normal, non-linear, and correlated with stock market returns and house prices, as in the data. Second, it builds and calibrates a rich life-cycle model with correlated aggregate and idiosyncratic risk, in which households decide their consumption, savings, housing stocks, portfolio share of safe and risky assets, and mortgage debt. Importantly, households only need to satisfy downpayment constraints and income tests at the time of mortgage origination, which implies that the outstanding mortgage can go above the value of the house if there is a negative shock to house prices. Households can also hold liquidity whilst they have a mortgage. In the model, homeownership, in addition to being a way of accumulating wealth, provides utility and insurance against rental price risk.

I use the model to compare the life experiences of three generations, namely, those born in

[1] These facts have been established in a large literature surveyed in Acemoglu and Autor (2011) and Goldin and Katz (2009). Guvenen et al. (2017), using US administrative data, and Borella et al. (2019), using survey data, find decreases in median male wages in real terms between the cohorts born in the 1940s and the cohorts born in the 1960s.

[2] Dynan et al. (2006) describe how financial deregulation, changes in risk-assessment methods, and the expansion of secondary markets increased the fraction of households with access to credit and how much those who already had access could borrow.

the 1940s, 1960s, and 1980s. I assume that an American born in the 1940s differs from younger generations in three main ways. First, they face different experiences in the labor market. I use household earnings data from the Panel Study of Income Dynamics (PSID) to estimate the earnings process separately for all three generations, thus incorporating the changes in earnings inequality and earnings risk in a flexible, data-driven manner. I separate the persistent and transitory components of earnings, which allows me to control for potential measurement error in the survey. Second, they face different conditions in financial and housing markets. Housing has become more expensive over time with respect to average incomes, and different generations entered the labor market in different stages of the business cycle or the house price cycle. Third, the 1980s generation faced particularly looser financial constraints when they started to buy houses in the early 2000s, which I capture with a reduction in downpayment constraints.

Time, age, and cohort are explicit in the model. Average earnings, homeownership, and stock market participation at each age differ across generations as they do in the data. I do not homogeneize age profiles across cohorts and thus do not need to disentangle year and cohort effects to obtain them.[3] I adopt the actual realizations of house prices and stock market returns each year from historical data, and use the Survey of Consumer Finances (SCF), including its earlier versions dating back to 1963, to obtain information about household portfolio compositions by age and generation.

The main results are as follows. First, intergenerational changes in earnings dynamics, asset returns, and housing prices obtained from the data fully explain the differences in homeownership between the 1940s and 1960s cohorts. For the 1980s cohort, who started to buy houses in the early 2000s, looser borrowing constraints partially counteracted the effect of high house prices. I do not need to assume that preferences have changed to explain the lower homeownership rates for younger generations.

To isolate the effect of changes in labor market income dynamics, I perform a counterfactual experiment in which I attribute the earnings process of the 1940s cohort to the younger generations, whilst keeping all other elements of the model constant, including house prices. More than half of the difference in homeownership at age 30 for both generations can be accounted for by changes in earnings inequality and risk. Not all of it is due to delayed home-buying: changes

[3] Age, year, and cohort are collinear. To obtain age profiles in a sample with several cohorts and years, the usual practice is to either remove year fixed effects or cohort fixed effects, which can lead to very different implications. See Heathcote et al. (2005) for a discussion on how the choice of removing year or cohort effects impacts measures of earnings and consumption inequality, and Ameriks and Zeldes (2004) for the effect on household portfolio shares.

in earnings dynamics still have an important effect at age 40 and afterwards. These results are robust to letting house prices adjust, assuming an empirically plausible level of housing supply elasticities.

The main driver of these changes is the increase in earnings inequality at labor market entry, with a more limited role for the increase in earnings risk. Households with lower initial and expected lifetime earnings find it harder or suboptimal to engage in a large expenditure like a house, which would leave them with a sizeable mortgage with respect to their current income, and thus exposed to income and house price risk.

Second, the increase in stock market participation of younger cohorts can be rationalized with a substantial reduction in stock market participation costs, which reflects easier information acquisition. Today, many workers who are starting new jobs either receive information about retirement accounts or are automatically enrolled into retirement plans like IRAs or 401(k)s.

These intergenerational changes also have implications for household wealth accumulation. In the 1940s generation, relatively poorer households bought housing. They did so to accumulate wealth, but also because they wanted to be homeowners, because it provided insurance against rental risk, and because leveraging with a mortgage allowed them to benefit from gains in the housing market. Similarly ranked households in younger generations are no longer buying houses and, because of these additional reasons to hold housing, they do not fully compensate the lack of housing wealth by saving in financial assets. Financial wealth now represents an increasing share of household portfolios, but it is more unequally distributed than housing wealth. The model predicts that lowering the cost of access to financial markets for lower and middle income households can increase their wealth holdings and reduce wealth inequality.

Overall, these findings suggest that changes in labor market income dynamics and in the housing market are having substantial effects in the life experiences of most Americans, and they can influence, in the longer term, the distribution of income and wealth, intergenerational mobility, and the effects of policies.

Related literature

This paper builds on the tradition of Bewley-Aiyagari life-cycle models that study optimal consumption and saving in the presence of realistic labor market income risk, and in particular those that have studied the role of housing on wealth accumulation (Fagereng et al., 2019) and the limited investment of households in stocks (Gomes and Michaelides (2005), Cocco et al. (2005), Alan (2006), to name a few). Fewer contributions have explored, like I do, the interaction between housing, portfolio choice, and the life-cycle.[4] Cocco (2005) shows that younger and poorer investors have less financial wealth to invest in stocks because they start out by buying houses. My life-cycle model draws from this insight, but includes more realistic mortgages, for which downpayment constraints do not bind every period, and a much richer risk structure, both in terms of aggregate asset prices and idiosyncratic earnings risk.

I model idiosyncratic earnings risk based on a recent literature that has described its rich features (Guvenen et al. (2016)), such as age variation, non-normalities such as negative skewness, and nonlinear persistence, and their implications (De Nardi et al., 2020). However, most of these processes abstract from cyclical fluctuations. I propose an extension of the econometric framework devised by Arellano et al. (2017) that allows for business cycle variation in rich earnings dynamics in the form of a Markov-switching regime, and incorporates that the left-skewness of earnings shocks fluctuates over the cycle: during recessions, large drops in earnings become more likely (Guvenen et al., 2014). This contrasts with more standard earnings process, that usually displays countercyclical variance (Storesletten et al., 2004). Another recent contribution that designs and implements an earnings process with variation in higher order moments over the business cycle is Busch and Ludwig (2017). I use a flexible nonparametric model that I estimate in panel data, while they define a rich parametric process and estimate it, à la Storesletten et al. (2004), by using cross-sectional moments to identify the sequence of past shocks. Unlike theirs, my approach allows for variations in earnings dynamics over different cohorts.

Several previous studies have analyzed the implications of the changes in U.S. earnings dynamics on aggregate outcomes. Nakajima (2005) studies the impact of higher earnings inequality on portfolio allocations and asset prices with a general equilibrium model. In particular, he finds that increasing earnings inequality can spur demand for financial assets and thus decrease their return in general equilibrium, which in turn increases the demand for housing assets. This paper incorporates the increase in earnings inequality as a key force, and replicates exogenously the observed changes in asset prices. However, in my model there is a minimum house size, which not only generates a notion of homeownership, but also implies that households who want to hold more housing (because of precautionary reasons or because the return on financial assets is lower) might be constrained because of LTV or LTI requirements.

[4] These include Flavin and Yamashita (2011), Yao and Zhang (2005), and Vestman (2012), who focuses on the role of preference heterogeneity to explain why homeowners participate more in the stock market. Becker and Shabani (2010) and Chetty et al. (2017) study the role of mortgage debt on portfolio allocations.

The increase in earnings uncertainty has also been related to the decrease in marriage rates (Santos and Weiss, 2016) and in fertility (Sommer, 2016). However, its link to homeownership rates across cohorts has received less attention. A notable exception is Fisher and Gervais (2011), who in a stationary equilibrium framework find that the increase in earnings uncertainty is a major candidate to explain the reduction in homeownership of the young between 1980 and 2000.[5] This paper builds on their contribution along several dimensions. First, I model each cohort separately, which allows me to better capture the earnings process, house prices, and cyclical histories they faced. Furthermore, I do not need to make assumptions about the convergence of future homeownership rates of younger cohorts with those we observe for the currently old. Second, in my model house prices are risky and agents can hold liquidity while they have a mortgage. Both affect the risk associated with buying a house: the former increases household exposure to risk, but the latter decreases it, because it allows them to better smooth income fluctuations. Third, I study the role of housing in the context of a richer household portfolio decision, and thus can accommodate possible substitution effects across asset classes as prices and returns change over time, which also allows me to draw conclusions about overall household wealth accumulation.

Despite the intergenerational changes, aggregate homeownership rates have been remarkably flat between the 1960s and the 1990s. They increased in the period leading up to the 2008 financial crisis: Chambers et al. (2009) relate most of the increase to mortgage innovations. My model incorporates more flexible mortgages for the youngest generation and also finds that they had a positive effect in homeownership. Mankiw and Weil (1989) study the effect of generation sizes in housing demand and housing prices. They suggested that the baby bust episode that ocurred in the late 1960s would generate reduced housing demand in the 1990s. The forces described in this paper, that reduce within-cohort homeownership rates, generate effects in the same direction. Puzzlingly, house prices have continued to rise. This can be related with supply restrictions (Falcettoni and Schmitz, 2018), but also with the increased saving of older generations, both because it might drive down interest rates (Martin, 2005) and because they live longer and hold on to their houses for longer.

[5] Fischer and Khorunzhina (2019) suggest that changes in divorce rates can also explain the reduction in homeownership rates, as increased divorce risk triggers precautionary savings for the young but reduces homeownership for older working-age households.

2 An overview of intergenerational changes

The generations born in the 1960s and 1980s, when compared to that of the 1940s, have faced more earnings inequality, more earnings volatility, and more expensive house prices on average. They are less likely to be homeowners, but more likely to participate in the stock market. I now turn to empirical evidence from the U.S. to describe these differences in detail. Appendix A provides information about the data and sample selection.

The top panels of Figure 1 show median and mean earnings for US households by age and decade of birth. Although the earnings of the median male earner have actually decreased over these different generations, the large increase in female labor force participation acted as a counteracting force and kept median earnings constant in real terms, and higher after age 30 for the younger cohorts.[6] Comparing average and median earnings suggests that earnings have become progressively more right-skewed and the earners above the median have seen larger increases than the earners below. The middle left panel confirms this intuition and show that earnings dispersion has grown for younger cohorts. Most of the difference is already present at age 25. This large increase, together with relatively little action in the medians, implies that the earnings-poorest of more recent cohorts are relatively worse off than people in the same percentile of earnings of earlier cohorts, and conversely the earnings-richest are better off today.[7]

Apart from more inequality, for younger cohorts there is also more earnings volatility, as measured by the standard deviation of household earnings *changes* (middle right panel of Figure 1), particularly at younger ages.[8] This evolution is closely linked to the so-called reduction in "fluidity" in the US labor market (Davis and Haltiwanger, 2014), which has affected different workers differently. On the one hand, longer-duration jobs are an increasing proportion of the job tenure distribution and workers' median tenure has increased (Hyatt and Spletzer, 2016). On the other hand, jobs with very long tenure are becoming less likely and large disruptions to careers are more frequent than before (Molloy et al., 2021). The rate of job loss has been decreasing over time, but so have the job finding rates of the unemployed and the probability that they stay in the same sector after becoming unemployed (Fujita, 2018). In my PSID sample,

[6] Appendix C.1.1 compares male and household earnings, and C.2.2 reports the same results using a different deflator.

[7] Part of these can reflect intergenerational changes in family composition and delayed household formation. Appendix C.2.3 shows that patterns are similar in a sample of married couples.

[8] This agrees with a plurality of studies that use different data sources, income definitions, and income processes (Gottschalk et al. (1994), Carr and Wiemers (2018), Braxton et al. (2021), etc.), although there is some evidence with individual male earnings pointing in the opposite direction (Bloom et al., 2017)

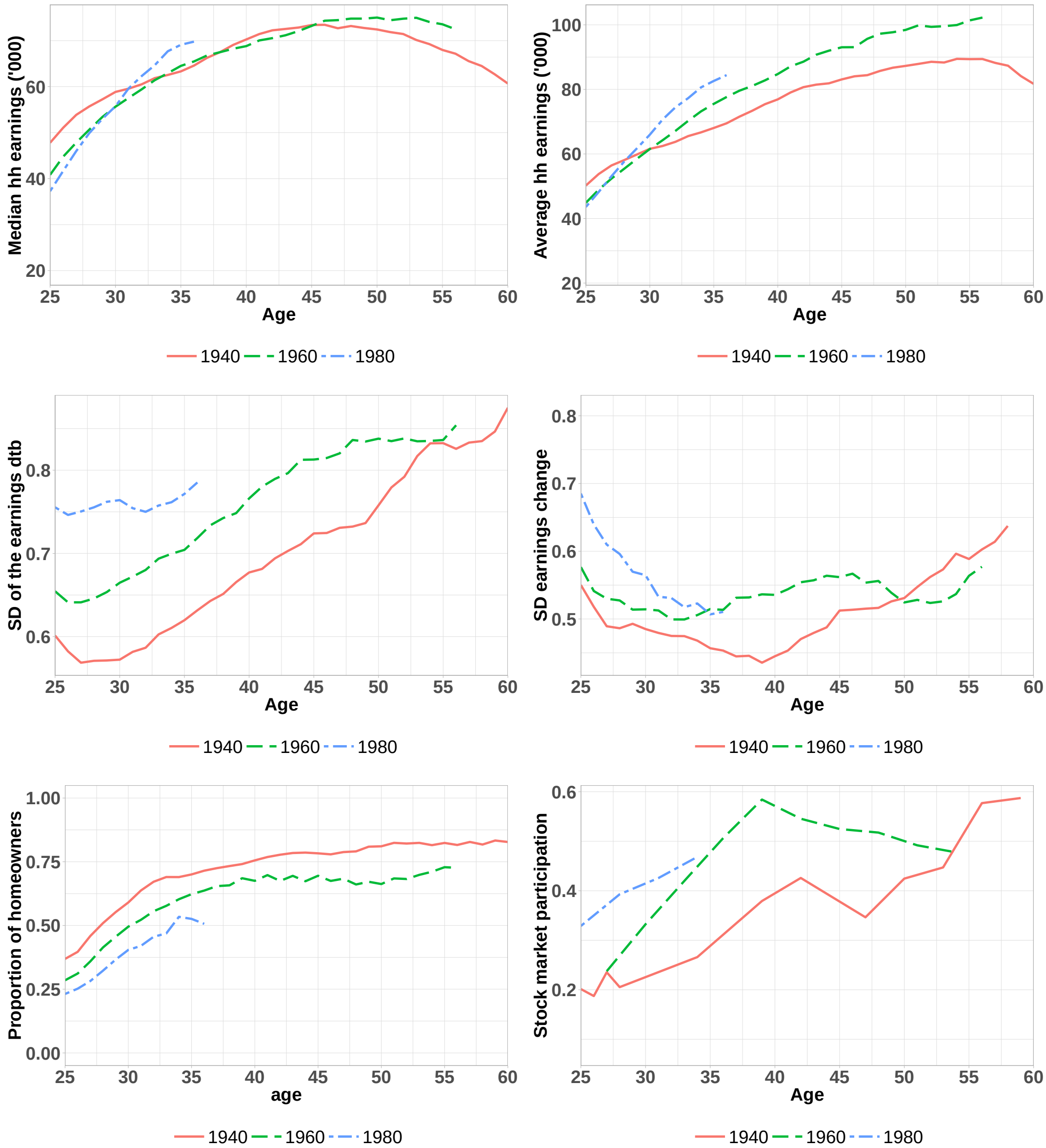

Figure 1: Intergenerational changes. Top: median (left) and average (right) household earnings. Middle: standard deviation of the log earnings distribution (left), and standard deviation of log earnings changes (right). Bottom: homeownership (left) and stock market participation (right). PSID data (Panel Study of Income Dynamics, 2017), deflated using the CPI, stock market participation from SCF (Survey of Consumer Finances (2019) and Survey of Consumer Finances (1960 to 1986)).

the growth in earnings volatility is closely linked to the longer average duration of unemployment for younger generations, which is only partially mitigated by the reduced likelihood of job loss (see Appendix C.1.2 for details).

Parallel with the changes described earlier, homeownership rates have been falling for recent cohorts. I use the word homeownership to refer to the percentage of households that live in owner-occupied housing. In the bottom left panel of Figure 1, we observe that, at age 35, homeownership has dropped by over 10 percentage points between the cohorts born in 1940 and 1960, and by another 10 percentage points between the cohorts born in 1960 and 1980. These intergenerational changes have occurred during a time in which, remarkably, the homeownership rate has been very stable and high for historical standards, around 65%, only fluctuating noticeably during the housing boom and bust.[9]

At the same time, stock market participation has increased significantly for younger cohorts (Figure 1, bottom right), but most of it has happened through indirect stock market participation via mutual funds or retirement accounts (direct stock market participation did not change much, see Appendix C.5.2). Stock market participation also displays year effects. For instance, direct stock market participation increased significantly in the years before the 2000 stock market crash, and dropped dramatically afterwards, as it can be seen in the profile for the 1960s cohort when they were 40 years old.

These changes are closely related with the evolution of asset prices and financial conditions. The ratio of median house prices to median income has increased, on average, in the United States over the last 60 years (left panel of Figure 2, based on PSID data).[10] Younger generations, at the same age, now have to devote more years of their income to buy a home compared with their parents. The right panel of Figure 2 compares stock returns and house price growth. There are large cyclical variations in house prices, although they are not always correlated with the business cycle. These induce an additional source of variation across cohorts, as some of them may have entered the labor market in a time where house prices were cyclically low, and benefitted from the situation to make housing purchases earlier on in their lives. On the other hand, the evolution of stock returns shows larger annual fluctuations, which are more strongly

[9] Homeownership rates have also fallen for younger generations under alternative sample selection procedures (C.2.1), for married households or households with children (C.2.3) or by education groups (C.3.2). Using census data instead of the PSID reveals very similar patterns (Appendix C.5.1) and allows to show that they have also fallen across geographical areas, but that they have aggregated into a stable national average homeownership rate

[10] Lovenheim (2011) shows that both median and mean home price indices constructed from PSID data track Federal Housing Finance Agency repeat home sales indices very well.

correlated with the business cycle, and less autocorrelation. However, much of house price risk is idiosyncratic or local (Landvoigt et al., 2015), and is not captured in this comparison.

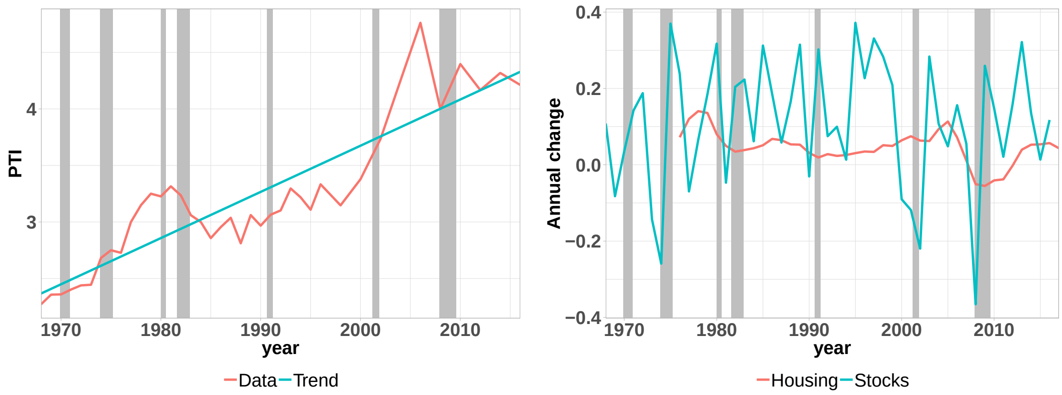

Figure 2: Evolution of house prices and asset returns. Left: median Price to Income (PTI) ratios for housing (PSID data). Right: Stock returns, S&P 500, vs. growth in Federal Housing Finance Agency (FHFA) house price index. Shaded areas correspond to NBER recessions.

The process of financial deregulation and innovation that started in the 1980s and expanded during the 1990s improved the access of households to credit, both from an extensive (more people can get credit) and intensive (the same household can borrow larger amounts) perspective. See, for instance, Gerardi et al. (2007) for a detailed description of the regulatory changes, the changes in the structure of the financial sector, and the new mortgage products that became available over this period. These changes were partially encouraged by policymakers, who were worried about low homeownership rates (for instance, Bill Clinton's National Homeownership Strategy).

Another important change was the introduction of tax-advantaged retirement accounts, such as individual retirement accounts (IRAs), which started in 1974 and became popular in the 1980s, and 401(k)s, which were introduced in 1978 and also became popular later on. Later reforms made these accounts more beneficial and less restricted, and automatic enrollment in pension plans further increased the number of stock market participants by reducing both the financial and psychological costs of enrollment.

3 A business-cycle dependent earnings process

In this section I develop a flexible earnings process that can capture the differences across generations I have just described, whilst encompassing a set of elements that have been shown to be important to describe the features of household earnings risk and its implications on household consumption and self-insurance (De Nardi et al., 2020). These include age-varying persistence, variance, and higher order moments, non-normalities such as high negative skewness and large kurtosis, and non-linearities such as previous-earnings-dependent persistence.

The process is based on Arellano et al. (2017), but, on top of that, it includes three important factors: business cycle variation in earnings dynamics, including its non-normal and nonlinear features, intergenerational changes in the distribution of earnings, and intergenerational changes in earnings risk. The former is necessary because idiosyncratic risk correlates with aggregate asset price risk, which can have implications for household portfolio decisions and insurance over the business cycle. The latter two are necessary to address the questions posed in this paper.

Let $\tilde{y}_{it}$ denote the logarithm of pre-tax labor earnings, net of age effects, for household i of cohort c_i ($c_i \in \{1940, 1960, 1980\}$) living in calendar year t with age age_{it}. I assume earnings are the sum of a persistent and a transitory component:

$$\tilde{y}_{it} = \eta_{it} + \epsilon_{it} \tag{1}$$

where both have absolutely continuous distributions. The persistent component η_{ith} is assumed to follow a first-order Markov process, while the transitory component ϵ_{ith} has zero mean and is independent over time and of the persistent component.

We can introduce these assumptions by writing the processes for η and ϵ, and the initial condition for the persistent component η_1 as:

$$\eta_{it} = Q_\eta(\nu_{it}^{\eta}|\eta_{i,t-1}, age_{it}, c_i, \Omega_t^y), \nu_{it}^{\eta} \overset{iid}{\sim} U(0,1), t > 1 \tag{2}$$

$$\epsilon_{it} = Q_\epsilon(\nu_{it}^{\epsilon}|age_{it}, c_i), \nu_{it}^{\epsilon} \overset{iid}{\sim} U(0,1) \tag{3}$$

$$\eta_{i1} = Q_{\eta_1}(\nu_{it}^{\eta_1}|age_{it}, c_i, \Omega_t^y), \nu_{it}^{\eta_1} \overset{iid}{\sim} U(0,1) \tag{4}$$

Equation 2 specifies the dependence of η_{it} on its previous realization with a flexible quantile function Q_η. This function depends on the age of the household, age_{it}, its cohort, c_i, and the aggregate state of the labor market, Ω^y, which is a Markov process. Thus, the features of earnings shocks are allowed to be different in expansions and recessions. In this way, this formulation explicitly includes age, cohort, and year effects.

Q maps draws ν_{it} from the uniform distribution $U(0,1)$ into quantile draws for η. ν_{it} can be thought of as a rank: if it is 0.9, it implies that the realization of η_{it} is on the 90th percentile conditional on age and $\eta_{i,t-1}$. A similar reasoning follows for the initial realization of the persistent component, with the further simplification that it only depends on age, cohort, and the current state of the labor market; and for the transitory component, which only depends on age and cohort. I treat the transitory component as measurement error or alternatively as a fully-insurable source of earnings fluctuations.

Following Arellano et al. (2017), to estimate the process I specify a parametric form for the quantile functions as low order Hermite polynomials. Appendix D contains details about the implementation and its comparison with a more standard canonical earnings process. While the earnings process is estimated on pre-tax rather than post-tax household earnings, most of its features regarding non-linearity and non-normality are qualitatively similar to De Nardi et al. (2020) and therefore I refer the interested reader to the discussion therein.

I estimate the earnings process on PSID data for all three cohorts. Given that the PSID became biennial from 1997 onwards, the period is two years for both the earnings process and the structural model. I use the full length of the PSID (1968-2017).[11] More details about the data treatment, cohort definitions, and sample selection are available in Appendix A.

3.1 Implications of the earnings process

The earnings process captures the intergenerational changes in earnings dynamics in terms of earnings inequality and uncertainty documented in Section 2 well (see Appendix D.2). Unlike more standard earnings processes, it also captures *countercyclical* skewness: during recessions, skewness becomes more negative, thus implying that large decreases in earnings become more likely with respect to large increases in earnings. This business cycle effect is also present in first moments: during a recession, all individuals expect lower increases in their earnings than they usually would (Figure 3).

[11] The semiparametric implementation of the nonparametric model defined in Arellano et al. (2017) allows to interpolate and obtain an earnings process for every state and age even if not all combinations are present in the data.

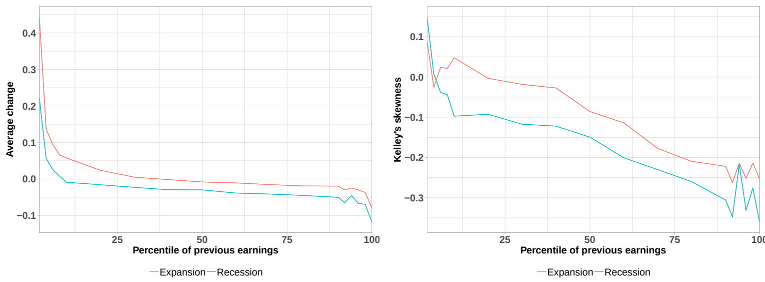

Figure 3: Average expected change in earnings (left) and Kelley's skewness of earnings changes (right). 1940s cohort.

An additional realistic feature that the Markov-switching earnings process captures is history dependence: at any point in time, the distribution of earnings for a given cohort depends on the set of expansions and recessions that the cohort has lived through. In particular, the recovery from recessions is usually sluggish. Unlike a standard process with countercyclical variance in logs, in which average earnings in levels counterfactually *increase* during recessions, my flexible earnings process generates drops in average earnings during a recession, from which agents (particularly the young) take long to recover (see Appendices D.3 and D.4 for details).

4 Model

I build a life-cycle structural model to evaluate to which extent the changes in earnings and financial conditions described in Section 2, modelling the former using the process described in Section 3, can account for the intergenerational differences in homeownership and portfolios I described earlier. In the model, the economy is populated by a continuum of households i that belong to cohort c. From the perspective of a cohort, age and time are equivalent and indexed by t. The model period is two years. All variables in the model are real.

4.1 Demographics

Households are born in the model at age 25, retire at age 60 and face positive and increasing death probabilities starting at that age. They die for sure at age 86. An average demographic profile at each age is introduced in the model with a taste shifter θ_t, which represents the average OECD equivalence scale at each age, and generates age-varying marginal utility from nondurable and housing consumption.

4.2 Preferences

Preferences are Epstein and Zin (1989) and allow to disentangle the elasticity of intertemporal substitution ψ and the risk aversion coefficient γ. Since I assume $\gamma > \frac{1}{\psi}$, they imply that agents prefer an early resolution of uncertainty, as standard in studies on the equity premium and risk-free rate puzzles, and in portfolio choice models (e.g. Cocco et al. (2005)). Thus, utility is:

$$U_{it} = [(\theta_t c_{it}^{\nu} s_{it}^{1-\nu})^{\frac{(\psi-1)}{\psi}} + \beta(\mathbb{E}_t U_{it+1}^{1-\gamma})^{\frac{1}{1-\gamma}\frac{\psi-1}{\psi}}]^{\frac{\psi}{\psi-1}} \tag{5}$$

where θ is the taste shifter described earlier, c is nondurable consumption, s is the housing service flow, β is the discount factor and ν measures the relative importance of nondurable consumption with respect to housing. This Cobb-Douglas specification assumes an elasticity of substitution of 1 between both goods, which is justified by stable shares of expenditure in housing in micro data (e.g. Davis and Ortalo-Magné, 2011). In practice, since housing in the model is discrete, this is equivalent to assuming that housing utility is a proportional scaling of the utility from nondurable consumption.

The utility value of housing s_t depends on the quality of the owned home and does not vary with its aggregate price. It is highest for owners of high-quality houses ($\bar{s}^2$), lower for owners of low-quality houses ($\bar{s}_1$), and lowest for renters ($\bar{s}^0$).

Households value bequests left b according to De Nardi (2004). For simplicity, I assume that bequests left are not received by other generations and thus leave the economy.

$$v(b) = \phi_1(\phi_2 + b)^{\frac{(\psi-1)}{\psi}} \tag{6}$$

4.3 Environment and technologies

4.3.1 Aggregate state

During each year t, the economy is in an aggregate state Ω_t that determines house prices, stock market returns, and the state of the labor market, which in turn affects the earnings process. Households know the (Markov) process governing the aggregate state, and use it to make predictions about the future, which in turn affect their decisions. Section 5.1 describes each of its elements and their correlations in more detail.

4.3.2 Earnings

Earnings are composed of a deterministic component, which depends on age, and a stochastic persistent component η_{it}, which depends on the aggregate state of the labor market:

$$\log y_{it} = f(t) + \eta_{it}(\Omega_t) \tag{7}$$

Section 3 contains more details about the earnings process and its estimation. Transitory shocks may be reflecting measurement error or almost fully insurable fluctuations, so to save on computational costs I do not include them in the model.

4.3.3 Liquid accounts

Liquid accounts a_t are risk-free and they yield an exogenous and constant interest rate r^a. They cannot be negative: if they wish to borrow, households must apply for a specific type of financial asset, mortgages m_t, which I describe in detail in Section 4.3.6.

$$a_{t+1} \geq 0 \tag{8}$$

4.3.4 Risky financial assets

Households can also hold risky financial assets or stocks f. Stock returns r_t^f depend on the aggregate state of the stock market Ω_t^f. Households cannot short financial assets:

$$f_{t+1} \geq 0. \tag{9}$$

When $f_{i,t} = 0$, households pay a fixed entry cost κ^f to start investing in stocks. This cost represents psychological, financial, and technical barriers to start investing in the stock market (opening financial accounts, acquiring information about them, etc.), and is frequently used in the portfolio choice literature (Gomes and Michaelides, 2005). Once a household participates, there are no additional costs of adjusting financial assets.

4.3.5 Housing

Households can either be renters, own a small house h_1 or own a big house h_2. i.e., $h_{i,t} = \{0, h_1, h_2\}$. Average house prices p_t^h depend on the aggregate state Ω_t. They are expected to grow, but fluctuate around a trend as described in Section 5.1. I abstract from housing depreciation and assume that households costlessly and fully repair their homes every period.[12] I assume that the price of the different housing sizes is a fixed fraction of average house prices.

A minimum house size h_1 is necessary so that homeownership is meaningful in the model; it is grounded both in previous literature (Cocco (2005), Attanasio et al. (2012), Sommer and Sullivan (2018)) and in empirical evidence, which shows very few households living in very small or cheap owner-occupied housing units, and few of those available for sale. The set of house sizes that households can buy is limited to 2 due to computational considerations. In Appendix F.3.1 I discuss these assumptions and show that results are robust to different sizes for the small house and several specifications in which there are three different house sizes.

Housing is illiquid. Households pay a proportional transaction cost to buy or sell housing $\kappa^h p_t^{h_j}(\Omega_t)$, which depends on the price of the house which is being bought. It reflects the costs associated with selling or buying a home, which can include taxation, real estate agent fees, and other costs.

Households that do not own a home must participate in the rental market. I assume that foreign or institutional investors, who are not explicitly modelled, supply housing in the rental market, and I abstract from the equilibrium determination of house prices for tractability and simplicity[13]. The rental price $r_t^s(\Omega_t^h)$ depends on current housing prices $p_t^h(\Omega_t^h)$.[14]

$$r_t^s(\Omega_t) = \gamma^r p_t^h(\Omega_t). \tag{10}$$

During the working period, households are subject to exogenous moving shocks with probability π_{hm}. They represent events such as finding a new job in a different place or suffering a job relocation, and add to the riskiness of owner-occupied housing as an investment. In the model, when the moving shock realizes, agents sell their houses at the beginning of period, before they make their consumption and saving decisions. They must then spend that period in rental

[12]In the data, housing depreciates between 1 to 2 percent a year (Fraumeni, 1997). However, imposing a fixed cost of 1 or 2 percent of their housing value likely overestimates the liquid resources that households spend in home repairs (which is a median of 0.7% of family income for homeowners according to 2005-2013 PSID data) and artificially reduces housing demand. In reality, households that suffer negative shocks can postpone investments in their houses or let them depreciate.

[13]Appendix E.4 contains an approximation to how my counterfactual results would change under endogenous determination of housing prices

[14]Davis et al. (2008) show that the ratio of rents to prices stayed relatively stable over the period 1960-1995, so I assume rents are just a fixed fraction of housing prices. Rent-price ratios decreased in the early 2000s, which could be an additional channel to discourage homeownership for the young, contributing to those I explore in this paper.

housing but can freely reoptimize afterwards. I keep π_{hm} fixed over generations based on the empirical evidence from the PSID and other studies, which I discuss in Appendix C.3.1, that the increase in earnings volatility has not been coupled with an increase in mobility for younger generations.

4.3.6 Mortgages

When a household wants to acquire a house of quality j, it can apply for a loan or mortgage m_t. I define mortgages so that $m_t \leq 0$. In order to get it, the household must fulfill two conditions: a downpayment or loan-to-value (LTV) restriction and an income test or loan-to-income (LTI) restriction. They only apply at mortgage origination.

$$m_{t+1} \geq -\lambda_h p_t^{h_j}(\Omega_t) \tag{11}$$

$$m_{t+1} \geq -\lambda_y y_{it}(\Omega_t) \tag{12}$$

where $\lambda_h < 1$. There is no uncollateralized debt.

Borrowers pay an exogenous interest rate on their debt r^b which is larger than the risk-free rate r^a. Households decide on their repayment schedule, but in every period they must at least pay the interest accrued by their debts and cannot reach their terminal age T with an unpaid mortgage balance. I do not explicitly model 30-year fixed-rate mortgages to reduce the dimensionality of the problem, but in Section 6.1 I show that the model generates repayment patterns that are according with the data. To reflect that households might have more difficulty acquiring a mortgage during retirement, I assume that retirees cannot upsize: if they are renters, they stay renters; if they own a home, every period they can decide to stay in the same house, downsize, or become renters.

$$m_{t+1} \geq \frac{m_t}{1+r^b} \tag{13}$$

$$m_T = 0 \tag{14}$$

Households can extract equity from their homes in two ways. First, they can sell them and either move to rental housing or buy a new smaller or cheaper house. Second, they can delay the repayment of the mortgage principal, thus extending their mortgage duration. This assumption indirectly incorporates arrangements such as mortgage forbearance. For simplicity, I assume that they cannot increase the principal of their debt by remortgaging or accessing home equity lines of credit.

To reduce the dimensionality of the problem, due to computational considerations, I assume that households cannot simultaneously hold a mortgage m_t, risk-free assets a_t, and risky assets f_t, but only two of the three. This assumption is weaker than modeling mortgages as negative safe assets, because it still allows households in debt to make a choice between positive safe and risky assets, as long as the choice is not interior. Therefore, mortgagors in the model are able to hold liquidity without incurring the participation cost to the stock market. Because households cannot increase the principal of their debt without selling the house and incurring transaction costs, holding some positive amount of financial assets can insure their consumption flow against relatively small negative shocks to their labor market income.

$$a_{t+1} f_{t+1} m_{t+1} = 0 \tag{15}$$

4.4 The government

Disposable income $\lambda(y_{i,t})$ is obtained from pre-tax income $y_{i,t}$ using the tax function $\lambda(\cdot)$ (Benabou (2002)):

$$\lambda(y_{i,t}) = \lambda y_{i,t}^{1-\tau} \tag{16}$$

This specification can be negative at lower income levels and thus includes, in a parsimonious way, both progressive labor income taxation and many income-tested welfare programs, such as unemployment insurance, EITC, food stamps, etc.

The government also taxes capital income from risky and safe assets at a flat-rate τ_a and finances social security for old people $p(\cdot)$. The latter is a function of a household's last income realization.

I replicate the preferential tax treatment of owner-occupied housing: owner-occupied rents are not taxed and mortgage interest is tax-deductible. Both in the US tax code and in the model, households can choose between getting the standard deduction, which is a fixed amount, and itemization, which implies that they individually deduct qualifying expenses such as mortgage interest. Thus, only households who have a sufficiently large mortgage get the mortgage interest deduction. Furthermore, stock market losses are deductible against asset income and labor income up to \$3,000. I also assume that the government provides housing aid to income-poor households for whom rental costs are large. In particular, the government pays all rent that is above 30% of household income.[15]

4.5 Negative net worth and default

Both in the model and in the data, a household can have negative net worth. In the model, that can arise when a household suffers a negative housing price, income, or financial shock while holding a significant mortgage. Households can continue to hold their house as long as they are able to make interest payments to their mortgage out of their financial savings or labor income.

Households can choose to default on their mortgages. I assume they file for bankruptcy if they do so: their debt is cancelled, the creditors seize all of their housing and financial assets, they suffer a utility penalty of χ^{bk}, and they become renters with zero wealth.

4.6 Timing

At the beginning of the period, households learn the common realization of the aggregate state Ω_t, which implies that they find out about housing prices $p_t^h(\Omega_t)$ and stock returns $r_t^f(\Omega_t)$, and their individual realization of labor income $y_t(\Omega_t)$. Jointly, those determine their net worth or cash-on-hand in period t:

$$coh_t = p_t^h(\Omega_t)h_t + (1 + r_t^f(\Omega_t)(1 - \tau_a))f_t + (1 + r^a(1 - \tau_a))a_t + (1 + r^b)m_t + T(y_t(\Omega_t), m_t) \quad (17)$$

where $\lambda(\cdot)$ represents progressive taxation of labor earnings net of mortgage interest payments.

As shocks realize, mortgagors decide whether to default or continue paying their mortgages. Then, households get utility from their housing stock h_t at the beginning of the period. Then they decide on their consumption c_t and their savings for the next period, which are composed of their liquid accounts a_{t+1}, stocks f_{t+1}, and housing h_{t+1}, minus any outstanding mortgage balance m_{t+1}.

[15]This is a stylized representation of housing aid programs in the United States, in particular the Section 8 program (Housing Act of 1937), which provides families with low income with Housing Choice Vouchers or project based assistance. In the PSID data roughly 2.75% of working age households receive this subsidy.

The budget constraint and household's problem that summarize all of these elements are reported in Appendix E.1.

5 Calibration

5.1 Aggregate state

The aggregate state of the economy in a calendar year Ω_t is the combination of the state of the labor market Ω_t^y, stock market returns r_t^f, the state of the housing market Ω_t^h and the house price p_t^h. So far, t indexed both year and age, which were equivalent from the perspective of a cohort. Naturally, calendar years and their associated states happen at different ages for different cohorts. To keep the notation in this section clear, I describe it from the perspective of a single cohort.

The aggregate state of the labor market Ω^y in $t+1$ takes two possible realizations, expansion and recession, and determines the conditional distribution of earnings shocks that agents face given their earnings in t, as described in Section 3. I define a period to be recessionary if any part of it falls under an NBER-defined recession. Ω^y is persistent.

Stock market returns r^f take four possible realizations. Three of those correspond to historical averages of each tercile of the distribution of stock market returns in the S&P500 during my sample period (1963-2015). Additionally, I include a disaster state, that corresponds to the average of the lowest 5% of annual stock market realizations during this period.[16] Stock market returns do not depend on their previous realizations[17] or on housing prices, but their conditional distribution is a function of the aggregate state of the labor market $r_t^f = F(\Omega_t^y)$. Thus, stock market returns are more likely to be low when labor market income receives a bad shock, which makes these financial assets more risky from the perspective of households. The persistence in stock returns induced by the persistence in Ω^y is very small (see Appendix F.4.1).

The housing market state Ω^h denotes whether house prices are increasing or decreasing. It is persistent, which helps the model generate procyclicality in homebuying: households buy more housing when its price is growing because they expect it to grow further. There is no

[16] The possibility of stock market crashes is important to understand the low stock market participation and high equity premium puzzles (Bansal and Yaron (2004)), as well as the age patterns of stockholding (Fagereng et al., 2017).

[17] Price-dividend and earnings-price ratios are predictors of future stock returns (Campbell and Yogo, 2006), although some of the relationships between economic and financial variables and future stock performance are unstable and change over time (Pesaran and Timmermann, 1995).

idiosyncratic house price risk. Aggregate house prices evolve following:

$$p^h_{t+1} = (1 + r^h_{t+1})p^h_t + \epsilon^h_{t+1} \tag{18}$$

where $\epsilon^h_{t+1} \sim N(0, \sigma^h)$ and

$$r^h_{t+1} = \begin{cases} r^h_{low} \text{ if } \Omega^h_{t+1} = \text{decreasing} \\ r^h_{high} \text{ if } \Omega^h_{t+1} = \text{growing} \end{cases} \tag{19}$$

I estimate the persistence of Ω_y and Ω_h, the conditional distribution of stock returns $F(\Omega^y_t)$, and the two possible realizations of r^h_{t+1} directly from their empirical counterparts over the 1975-2015 period. Because the model period is two years, it may overestimate the average length of recessions; however, it also implies that the probability of exiting a recession after one model period is relatively high. I set σ^h so that, taking Equation 18 into account, the standard deviation of percentage growth rates of housing prices is 0.10, within the range reported in Landvoigt et al. (2015). Because the correlation between Ω_h and both Ω_y and r^f is low and not statistically significant in the data, I set it to zero.

Households know the processes for the aggregate variables and form expectations about their evolution accordingly.[18]. In the simulation, the realizations of $\Omega^y_t, \Omega^h_t, r^f_t$ and p^h_t correspond to their data counterparts for each specific year (Appendix E.2 shows that the model fits the evolution of house prices and stock returns very well). For instance, when agents of the oldest cohort, born in 1942, reach 53 years of age, they face a good realization of the stock market state because 1995 was a year of high stock returns.

5.2 Externally calibrated parameters

I set the risk aversion coefficient γ to 4, which is on the higher side of usual estimates in the macro literature, but on the lower side for the literature that rationalizes the equity premium puzzle with Epstein-Zin preferences (e.g. 10 in Bansal and Yaron (2004)). The elasticity of intertemporal substitution ψ is also disputed. I follow Kaplan and Violante (2014) for its exact quantification (see their footnote 28 for a discussion regarding this estimate) and set it to 1.5. I set the housing utility share ν to 0.2, based on NIPA data on budget shares.

[18]Appendix F.4 shows that my results are robust to alternative specifications of household expectations about aggregate variables.

I establish the risk-free rate at 1%, plus an additional 1% to account for the liquidity services of risk-free money. The mortgage interest rate is set to 4%. Both rates correspond to historical averages for the 1940s generation. I assume that the mortgage interest rate is 1% higher for retired people to reflect the more stringent credit conditions they are subject to, which is looser than assuming they cannot get a mortgage. The downpayment is 20% of the value of the house, and the income test consists in having yearly household income that is at least 1/9th of the value of the mortgage (Johnson and Li, 2010).

I set the social security replacement rate to 55% (Mitchell and Phillips, 2006). I explicitly model itemization and the standard deduction, so I already incorporate part of tax progressivity by construction. Taking this into account, I estimate the progressivity coefficient τ to be 0.085, following the procedure described in Appendix A.1.2. The parameter that controls average taxation $\lambda = 0.64$ implies an average tax rate of 35% for the average household, close to the historical level for the 1940s generation comprising federal and state taxes and FICA contributions. I set the standard deduction at a level (6% of average income) that implies that the percentage of people choosing to itemize is close to the data, which is around 30% (IRS, 2014) .[19]

The minimum housing size h_1 is chosen such that the small house is worth 50% the price of the median house in the data. This means the cheapest house in the model sells for around twice median household income in 2015 ($120,000). Housing adjustment costs are around 10% of the value of the property (Smith et al., 1988), which I distribute equally amongst seller and buyer. Rental rates are 5% of house prices (Davis et al., 2008). I set the bankruptcy penalty $\chi^{bk} = -5$, which is equivalent to a loss of around 15,000 dollars for a poor, low-income renter, to the value that keeps bankruptcies around the housing boom and bust episode aligned with the data.[20]

5.3 Internally calibrated parameters, targets, and model fit

The model has 7 free parameters which are jointly calibrated to match 7 targets in the data. I perform the calibration for the 1940s cohort, and then keep them constant across cohorts in the experiments unless otherwise specified. Table 1 summarizes the data and the parameter which

[19]This is lower than its historical levels (e.g, around 10% of average income in the early 70s) because the model abstracts from itemizable expenses other than mortgage interest and local property taxes, such as out-of-pocket medical expenditure, state taxes, charitable contributions, etc.

[20]Appendix F.3.5 shows that results are robust with respect to changes of this parameter.

Moment	Data	Model	Key parameter	Value
W/Y ratio	3.1	3.1	Discount factor β	0.929
Average bequest (/average income)	2.7	2.6	Bequest taste ϕ_1	12.3
Fraction of population leaving no bequests	20%	19%	Bequest taste ϕ_2	6.9
Housing ownership at age 40	76%	76%		
... of detached houses	68%	63%	Housing taste s_2	9.4
... of other housing at age 40	8.1%	12%	Housing taste s_1	1.3
Percentage buying houses at age 40	5.9%	5.5%	Moving shock π_{hm}	0.051
Stock market participation, age 40	38 %	36%	Participation cost k^f	0.39

Table 1: Targeted moments, model fit, and calibration

is more closely related with each of the targets. The wealth to income ratio of 3.1 corresponds to the wealth to income ratio of the bottom 95% of the wealth distribution, which I am focusing on. I obtain house ownership data from the PSID, stock market participation from the SCF, and I adjust the bequest targets for this specific cohort (see Appendix A for more details).

Matching homeownership at a particular age allows me to get an estimate of how much households enjoy owner-occupied housing, over and above its value as a financial investment and collateral. On the other hand, getting the level of stock market participation right allows me to discipline the stock market participation cost κ^f. Finally, the percentage of people buying houses after prime homebuying age is informative of the number of people who are moving for reasons that I do not model explicitly, which I summarize in the moving shock.

As Table 1 shows, the model fits its targets very well with the associated calibrated coefficients. The discount rate is relatively low with respect to what is standard in a one-asset model. Households value housing, and the utility value of owner-occupied houses provides a further motive to hold assets beyond life-cycle and precautionary savings, which reduces the value of household patience. Besides, low levels of β are also frequent when stocks are available as an investment option with high returns.

There is a 5.1% yearly probability of receiving a shock that forces the household to move. A particularly relevant parameter is the one-off cost to start participating in the stock market k^f, which is calibrated to be 39% of average yearly earnings.

There is scarce data about the initial wealth of the 1940s cohort at labor market entry. I set the initial condition of the model to the most conservative possibility that is consistent with the observed homeownership (20% equity on the house for the initial homeowners) and stock market participation (1$ in stocks for the initial stockholders).

Appendix B briefly describes the solution method of the model.

6 Results

6.1 Untargeted moments, 1940s cohort

The model replicates life-cycle homeownership profiles, the patterns of house buying by age, and stock market participation for the 1940s cohort very well (Figure 4), particularly during the working age period. Most households become homeowners between ages 25-35, and then the share of households that live in their own home stabilizes around 80%. In the model, young households do not participate in the stock market because they are concentrating their resources in saving for a downpayment and starting to pay their mortgages, rather than spending time and resources in acquiring information and access to the stock market.

Many households hold mortgages at the same time as they start investing in stocks. Figure 4, bottom right panel, shows that in the model households pay back their mortgages slowly, a feature which is not targeted in the calibration. Thus, the model suggests that the horizon of available mortgage products closely resembles what households would choose if they were to freely decide on their repayment schedule.

The model implies relatively low homeownership rates for this generation during retirement. The reason is that, in the model, many households release equity from their homes and become renters as they approach retirement, taking advantage of the high house prices they face around this period. Although retirees' housing decisions are responsive to this type of financial incentives (McGee, 2021), the effect is stronger in the model than in the data. Additionally, there are a set of reasons to hold housing during retirement which are not explicitly modelled and would bring homeownership for retirees up, including a desire to age in one's home and self-insurance against uncertain medical expenditures (Nakajima and Telyukova, 2020).

In the model many households make housing adjustments right before the retirement period, during which they are no longer allowed to upsize their homes.[21] It then closely tracks the low

[21] In a version of the model where this restriction is not imposed, this spike does not occur and all of the main conclusions still hold, but the model overestimates how many housing sales there are in retirement and how many retired households still hold mortgages (see Appendix F.3.2).

proportion of retired home buyers. Given the fixed entry cost structure, households that enter the stock market find it optimal not to exit: as a result, stock market participation stays high during retirement.

The model is successful in replicating portfolio patterns by wealth (Figure 5). A standard portfolio choice model would yield stock holding patterns which are mildly *decreasing* rather than increasing in wealth (Gomes and Michaelides, 2005). In this model, the role of housing and the correlation of labor income and stock returns reduce the incentive of the income-poorer to participate in the stock market. Richer individuals, on the other hand, have sufficient resources available even after buying their homes, and they invest them in the stock market, in which they reap higher returns that in turn make them wealthier.

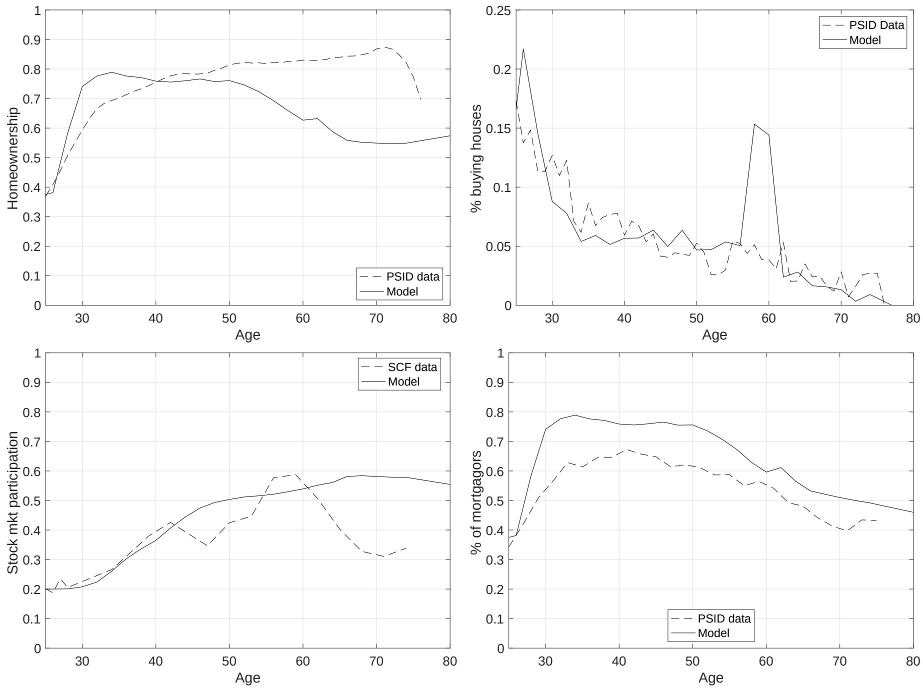

Figure 4: Life-cycle profiles for the 1940s cohort. Top left: homeownership by age; top right: proportion of households buying a house by age; bottom left: stock market participation; bottom right: percentage of all households with a mortgage by age.

6.2 Explaining intergenerational differences in homeownership

Keeping constant all preference parameters, I now turn to studying which are the key intergenerational changes that explain the reduction in homeownership for younger cohorts. In this experiment, cohorts differ in four ways. First, younger cohorts face more unequal and riskier

Figure 5: Bottom: portfolio shares of assets by wealth decile at retirement age (left: PSID data, right: model).

earnings processes. Second, the exogenous house prices and stock returns correspond to those that each generation actually faced, so that, for younger generations, the median earner needs to spend more years of income to buy a house. Third, there have been changes in financial conditions. On the one hand, different mortgage products were available to the 1980s generation during their homebuying years, which I replicate as a reduction in downpayment requirements. Namely, I assume that the maximum LTV ratios of mortgages increased from their baseline level of 80% to 97.5% between 2000 and 2010, after which they unexpectedly went back to normal.[22] On the other hand, I reduce stock market participation costs to match the stock market participation profile (see Section 6.3). Fourth, I input to each generation their specific average demographic profile by age, which I report in C.4, which captures the effect on consumption needs of differential timings in marriage and childbearing. For a cleaner comparison, I keep initial wealth at age 25 constant across generations.[23]

Figure 6 shows the homeownership rates for each of the three cohorts in the data, compared with the profile implied by the model. Notably, keeping preference parameters constant, the model very closely replicates the decrease in homeownership that occurred between the 1940s and the two latter cohorts.[24]

[22] Glaeser et al. (2012) use housing industry data and show that for most of the 1998-2008 period the 75th percentile of LTV ratios at origination was above 95%, with the 90th percentile consistently around 100%. Duca et al. (2011), using American Housing Survey data, show that average LTV ratios for first time buyers, which were stable around 0.80-0.85 in the 1980s and early 1990s, jumped up to 0.90-0.95 during the 2000s.

[23] This assumption is conservative, as it is likely that younger generations are entering the labor market later and with less wealth. In Appendix F.1 I provide results for the case in which all agents start at zero wealth. All conclusions are unchanged, but the model with initial zero wealth underestimates homeownership at earlier ages.

[24] Figure 6 only represents the 1960s and 1980s cohorts up to the ages in which I can fully observe them in the data. In Appendix F.5 I show the model-implied homeownership rates for the future under different simulated realizations of the aggregate state.

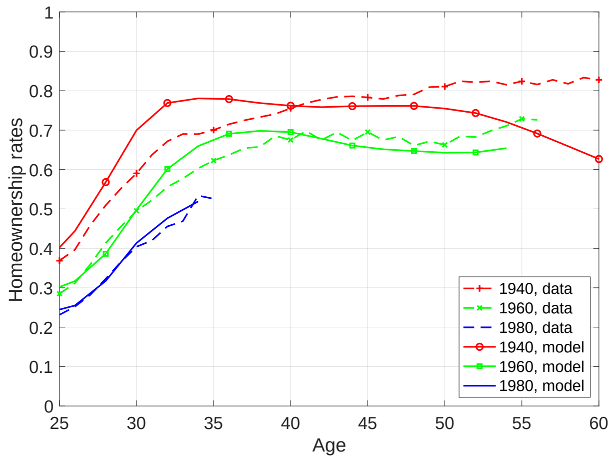

Figure 6: Homeownership by cohorts, data vs. model

6.2.1 Decomposing the decrease in homeownership

I now turn to evaluating, using the model, which are the key factors that drove the decrease in homeownership. Table 2 shows the results of a Shapley-Owen decomposition in which I evaluate the relative contributions of six key elements in explaining the reduction in homeownership at different ages: initial earnings inequality, earnings risk thereafter, changes in average housing price-to-income ratios, histories of aggregate shocks, average demographic structure at each age, costs of participation in the stock market and, for the 1980s generation, changes in financial conditions. These are the only differences across cohorts in the model. Thus, by counterfactually changing them one by one I can quantify their relative contribution to the difference between the observed profile for a given generation and that of the 1940s.[25]

At age 30, changes in labor market outcomes explain 80 percent of the homeownership gap of the 1960s generation with respect to the 1940s, mostly due to initial earnings inequality. With a more unequal earnings distribution, and little average increases in earnings, households in low ranks of the income distribution have lower initial and expected lifetime earnings than their counterparts in older generations. These households face two issues when they consider buying a house. First, they are financially constrained, as they need to save for a downpayment and pass an income test. Second, they are aware that having a large mortgage with respect to their incomes is risky, as negative shocks could take them to a situation in which they must

[25] All elements in the decomposition have potential interaction effects, which means that shutting them on and off alternatively would not sum to 100% of the change. The Shapley-Owen decomposition allows to obtain the total contribution of each element to the change by considering its contribution to every possible permutation of the other factors being on and off, and averaging over all of these.

	1960s generation			1980s generation	
Age	30	40	50	30	35
Total	-10	-8	-14	-19	-18
Earnings	84	90	7	87	56
initial inequality	76	18	-37	70	27
risk	8	72	44	17	30
Aggregates	16	-2	92	119	126
house price trend	35	112	43	76	84
histories	-19	-114	49	43	42
Financial conditions	0	0	-2	-108	-83
stock participation costs	0	0	-2	-2	-1
borrowing conditions	0	0	0	-107	-81
Demographics	0	13	3	2	1

Table 2: Contribution of each factor in the change in homeownership with respect to the 1940s generation (% of the change), by age

reduce a lot their nondurable consumption to make mortgage payments. Thus, they choose to be renters. For some this is a delay in the decision to buy houses, but for some this state is relatively persistent. At age 40, earnings dynamics still explain 90% of the homeownership gap.

Earnings inequality and risk are closely linked. Even if everyone faced the same distribution of earnings shocks, their impact would depend on their earnings at labor market entry. However, to separate both, I compute the contribution of changes in earnings dynamics over and above initial realizations. At age 40, riskier earnings explain 70% of the drop in homeownership rates. The higher volatility of earnings discourages households from engaging in a large, risky expenditure like a house. At later ages, the dependence on initial earnings realizations progressively dies out and it is harder to disentangle the effects of initial inequality and risk.

The intuition about earnings inequality and earnings risk is supported by the empirical evidence shown in Figure 7. The gap in homeownership rates between the 1940s and 1960s generations is larger for the lowest earners, which is consistent with the contribution of earnings inequality, but there are also differences all across the earnings distribution, which is consistent with the role of earnings risk.

The 1960s generation entered the labor market in a period of cylically low house prices, which explains the low or negative contribution of aggregate conditions to the change in homeownership until the 2000s boom in house prices (when this generation was around 45-50 years of age).

Despite later household formation and a lower number of children for younger generations, the change in the average number of people in a given household at each age (θ_t in the model), which affects consumption needs, has a small effect on homeownership rates.

The 1980s generation entered the labor market in a radically different period. House prices were high both from a secular and cyclical perspective, but financial constraints were laxer. For the 1980s generation, prices alone would have explained the drop in homeownership, but the lower downpayment requirements counteracted most of the potential decrease. This result suggests that changes in financial conditions were key to prevent homeownership rates of younger cohorts to plummet in a context of unstable, unequal earnings and high house prices. The remainder of the difference, over 80 percent at age 30, is also accounted for by earnings dynamics.

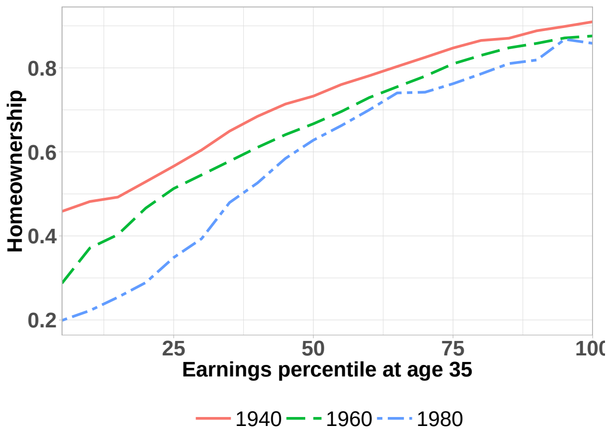

Figure 7: Homeownership by cohorts, by percentile of the earnings distribution at age 35

In all of these experiments, earnings dynamics are computed on household income, so they embed other factors that changed over the generations such as the timing of family formation. However, as shown in Appendix F.2.2, these results are robust to focusing on married couples alone. Additionally, these counterfactual experiments assume that housing supply is perfectly elastic and so house prices would not react to the increase in housing demand induced by the change in the earnings process. In Appendix E.4 I relax this assumption and show that a reduction in earnings inequality and risk would imply a significant increase in homeownership for younger cohorts even if we assume that the increase in demand would drive prices up.

6.3 Explaining the changes in stock market participation

Understanding the increase in stock market participation documented in Section 2 requires taking into account not only the changes in earnings dynamics and asset returns, but also the progressive reduction in the cost of access to financial markets over time, which is partially related with the introduction of tax-advantaged, employer-sponsored retirement plans.

Figure 8 shows the implications of the model in terms of stock market participation when these changes are taken into account. More specifically, it assumes that stock market participation costs are 50% lower for the 1960s and 85% lower for the 1980s generation than they were for the 1940s generation, and additionally that the initial share of people with positive participation in the stock market has increased over the generations from 20% (1940s and 1960s) to 30% (1980s). Both of these changes capture the reduction in information costs and the effect of auto-enrolment.[26] If the reduction of participation costs is not taken into account, the profiles generated by the model are counterfactual (right panel of Figure 8). The fiscal incentives of IRAs and 401(k)s do not explain the increase in stock market participation either (see Appendix F.3.4).

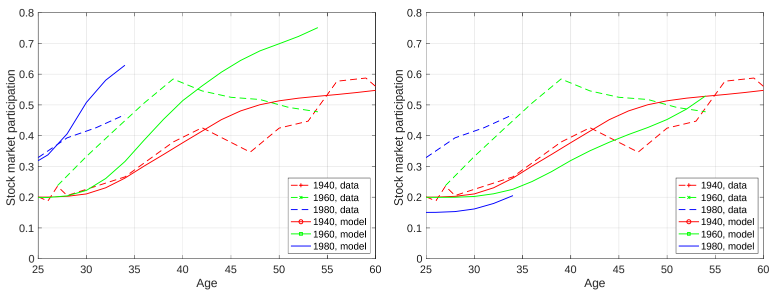

Figure 8: Stock market participation by age and cohort, data vs model. Left: main model; right: constant participation costs

6.4 Implications for wealth accumulation

As a result of these changes in earnings dynamics and asset returns, many younger households are accumulating less wealth than similarly-ranked households in earlier generations (left panel

[26] Appendix F.3.3 shows that changing the fixed cost of participation for per-period participation costs can generate similar patterns.

of Figure 9). The right hand side panel of Figure 9 shows that housing played a key role in this change. In the model where households do not enjoy owner-occupied housing (solid lines), most households in the 1980s generation save more, which is consistent with the precautionary savings motive induced by their higher earnings volatility. The complete model (dotted lines) can instead replicate a decrease in wealth accumulation for the bottom 70% of the distribution. Households in the 1940s and 1960s generations used to save more because they bought houses, partially because they enjoyed owning them, which made them act as an indirect way of forced savings. Additionally, homeowners could use their mortgages as leverage. When, because of changes in earnings dynamics, house prices, and financial conditions, households cannot access houses or buy them later, these forces are not in play and households save less. Consistently with this channel, the wealth holdings of the median household at each age have dropped over the generations (Figure 10), although average wealth holdings have remained relatively stable because of higher wealth accumulation by the richest.

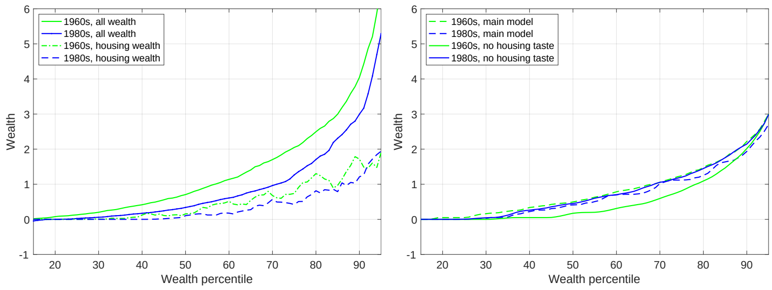

Figure 9: Net worth by wealth percentile, ages 30-40, by generation. Left, SCF data (not available for 1940s with sufficient granularity); right: model implied. Units are multiples of average income. For clarity, the top 5% and bottom 15% of the wealth distribution are not reported.

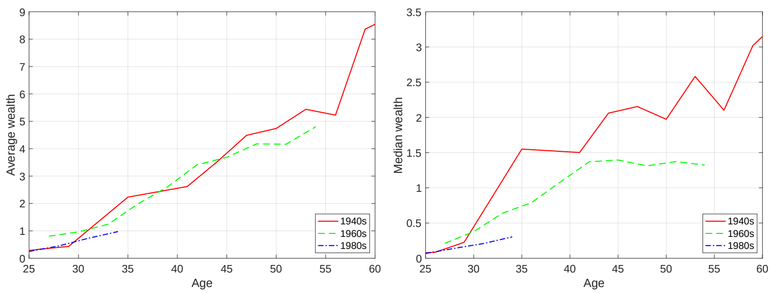

Figure 10: Median (left) and average (right) net worth by age and generation, SCF data. Units are multiples of average income.

Given that 35-year-olds frequently do not have fully equity on their homes, the gap in wealth accumulation between generations is likely to grow as households age and miss out on house price appreciation. In Appendix F.5 I conduct a simulation exercise in which I predict, under a set of assumptions, the evolution of homeownership rates for the 1980s generation beyond 2015-2020.[27] The median prediction shows that the 1980s generation homeownership rates will stay below those of the 1960s as they age.

However, financial wealth is not a perfect substitute for housing wealth. Because fewer households participate in the stock market than become homeowners, and because relatively poorer households do not benefit from leverage when they invest in stocks, it is likely that these changes in household portfolios will lead to increased wealth inequality. In particular, the model predicts that wealth inequality will continue to grow, unless stock market participation costs are reduced such that almost all of the population accesses the stock market by age 60. The larger the share of households that participate in the stock market, the stronger the negative effect on wealth inequality.

6.5 Alternative specifications

Appendix F shows a set of robustness checks. They show that the main messages in the paper are robust to starting households at zero wealth (F.1), different assumptions about the earnings process (F.2), including considering changes in marital dynamics and family formation (F.2.2), different specifications of the asset structure, including alternative versions of the discretization of houses (F.3.1) or per-period stock market participation costs (F.3.3), and different assumptions about the dynamics of aggregate variables (F.4), including local correlation of income shocks and house prices (F.4.3). Appendix F.2.1 shows that a canonical earnings process would overestimate the intergenerational decrease in homeownership by overweighting the role of large initial inequality.

7 Conclusion

In this paper, I study how changes in earnings dynamics over different cohorts have affected their homeownership and portfolio choice decisions. First, I provide empirical evidence, extracted

[27] This analysis does not incorporate, due to the delay in availability of survey data, the Covid-19 recession and the subsequent changes in labor market conditions.

from PSID and SCF data dating back to the 1960s, that there has been a secular increase in household earnings inequality and risk, together with substantial reductions in homeownership and an increase in stock market participation.

Second, I design a flexible earnings process that accomodates rich features of earnings risk, which can be correlated with the aggregate performance of the economy and asset returns. This process replicates features of earnings data by age, over the earnings distribution, and over the business cycle, including the sluggish recovery after a recession.

Third, I develop a rich life-cycle model of housing and portfolio choice with a relatively parsimonious parametrization. Key elements are a taste for owner-occupied housing, a minimum size for houses, transaction costs, and stock market entry participation costs. I use the model to explain the intergenerational changes I observe in the data without assuming preference changes across generations. Differences in earnings dynamics account for more than half of the reduction in homeownership at ages 30-35.

My findings suggest that intergenerational changes are important for studies of household earnings, consumption, and wealth accumulation. At any point in time, the cross-sectional distribution of the economy is formed by many different households who have lived through different histories of shocks at different points in their lives. Acknowledging this fact matters to understand the economic decisions that have led them to be where they are today, and thus to infer parameters to study the effects of policies or the evolution of the economy. These results are of interest to policymakers who care about homeownership, intergenerational redistribution, and the evolution of inequality.

Finally, this paper also adds to a burgeoning literature that points out that considering household portfolio compositions is important for many macroeconomic questions, such as consumption responses to shocks or wealth accumulation over the life cycle.

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A Data

The data used in this paper is taken mostly from the Panel Study of Income Dynamics (PSID) and the Survey of Consumer Finances (SCF). The former is particularly valuable because it allows to follow several cohorts of households over a very long period of time (1968-2013), and it is the base for the estimation of the earnings process and most of the housing-related measures. However, it contains, particularly in its earlier periods, very limited information about stock market participation, wealth, and financial asset allocation of households. For these measures I rely on the Survey of Consumer Finances, which contains very detailed information about households' balance sheets. However, with limited exceptions, it lacks a panel dimension.

I now briefly describe the characteristics of each of the surveys, the sample selection criteria, and the estimation of the several targets and profiles used in the paper.

A.1 PSID

The Panel Study of Income Dynamics (PSID) follows a large number of U.S. households and their qualifying spinoffs since 1968 and provides information about demographic characteristics, sources of income, housing status, and, since more recently, their wealth and consumption. When it started, the PSID was composed of two main subsamples: the SRC (Survey Research Center), which was designed to be representative of the U.S. population at the time and which is a random sample itself, and the SEO (Survey of Economic Opportunity), which oversampled the poor. Later, the PSID was augmented with the Immigrant and Latino subsamples.

The survey was yearly from 1968 to 1997, and started being biennial since then. Wealth information was available in the 1984, 1989, 1994 waves, and from 1999 onwards, and has become progressively richer and improved in quality. Since 1999 it broadly replicates the wealth inequality patterns present in the SCF without oversampling the richest.

For my main results, I drop the SEO, Latino and Immigrant samples and am therefore left with a random sample, which makes computations simpler given that weights are not needed Haider (2001). However, the weighting of the final dataset can be affected by attrition and the sample selection requirements. In Appendix C.1 I report how different sample selection and deflation procedures affect some key features of the earnings process.

A.1.1 Measures and sample selection

In the PSID data, I define cohorts as follows:

- The **1940s cohort** are the households whose head was born between 1940 and 1950. For the estimation of the income process, I increase the sample size and consider households between 1930 and 1950. For simulation purposes, I consider they were born in 1942.
- The **1960s cohort** are households whose head was born between 1960 and 1970 (1950-1970 for the income process). For simulation purposes, I consider they were born in 1962.
- The **1980s cohort** are households whose head was born between 1980 and 1990 (1970-1990 for the income process). For simulation purposes, I consider they were born in 1982.

Naturally, the changes in earnings dynamics, homeownership, etc. have happened progressively over time and do not necessarily correspond with the admittedly arbitraty boundaries set. To some extent, the features of the 1940s earnings process are a weighted average of the earnings process of people born between 1930 and 1950. However, including those allows me to increase the sample sizes, and to obtain more observations of people going through a recession at different ages.

For the earnings process, I assume that all business cycle effects are absorbed by the business-cycle dependent process, so I do not extract year effects. For the representation of changes in earnings risk and the computation of age-efficiency profiles, I extract a linear yearly trend from earnings data.

The estimation of the household income process requires eliminating households that display very low attachment to the labor market (whose labor income in a given year is below a minimum level of $1500 in 2013 prices). This assumption is standard in the earnings processes literature (see De Nardi et al. (2020) for details) and avoids issues related with taking logs of very small numbers. Furthermore, I also drop those households for whom there are no two consecutive observations available.

For the older ages of the younger cohorts, there are some cases in which there are very few observations for a particular combination of the labor market aggregate state, which are not sufficient for the estimation of the flexible parameters. In those cases I replace the missing cohort-age-states with their correspondent levels of the previous cohort. This affects the 1960s cohort after age 50 for the states of recovery and staying in a recession, and the 1980s cohort for all states related to a recession after age 30. I follow a similar procedure for years which are not yet observable (1980s cohort from ages 35-40), and provide some robustness checks with respect to this assumption in Section 6.4.

For all of the other measures reported in the paper (homeownerhip, etc.) none of these restrictions are imposed. In particular, I do not require the sample to be composed of the same households in every year. This allows me to keep a bigger sample, but implies the assumption that any attrition or nonresponse happens randomly and does not affect the evolution of the measures reported.

With respect to the two types of housing, "detached houses" are those defined in the PSID as "detached single family houses" and "non-detached houses" are all other types of structures (including 2-family houses, apartments, etc.).

From 1968 to the end of the sample, housing PTI ratios are computed as the ratio of the median house price reported by PSID homeowners to median household income in the PSID.

A.1.2 Tax progressivity

As explained in Section 4.4, the model explicitly includes the choice between taking the standard deduction or itemized deductions. However, this implies that the tax progressivity coefficient τ in Equaton 16 needs to be reestimated, because in previous studies, such as Heathcote et al. (2014), it was computed taking into account the existence of itemization and the standard deduction. Removing the standard deduction from disposable income implies a reduction of the progressivity coefficient, as it is an important driver of progressivity in the US and other tax codes Blackburn (1967).

To perform this estimation, I need to compute the counterfactual disposable income or, alternatively, the counterfactual level of taxes paid T^*_{it} by a household with pre-tax income y_{it} in the absence of standard deduction or HMID. To do so, I first estimate the following equation in my PSID sample:

$$\log \hat{y}_{it} = \lambda_1 + (1 - \tau_1) \log y_{it} \tag{20}$$

where $\hat{y}_{it}$ is post-tax pre-benefit household income. I use the estimated parameters from this equation to predict T^*_{it}, assuming that $T^*_{it} = \log \tilde{y}^*_{it} - \lambda_1 + (1 - \tau_1) \log y^*_{it}$, where $y^*_{it} = y_{it} + max(sd, HM)$, sd stands for the standard deduction, and HM for the HMID that corresponds to a given household. The basic assumption here is that the taxes paid by a household with a certain level of income in the counterfactual world with no standard deduction are the same as those paid by a household with that level of income plus the deduction in the observed world. As for the mortgage deductions, I define them to be the product of the average mortgage interest rate in a certain year and the outstanding mortgage the household claims to have in the PSID, as long as they are smaller than the total mortgage payments the household has made in the previous year.

Once I have counterfactual taxes T^*_{it}, I construct counterfactual disposable income (post-tax, post-benefit) $\tilde{y}^*_{it} = \tilde{y}_{it} + T_{it} - T^*_{it}$, run the following regression:

$$\log \tilde{y}^*_{it} = \lambda + (1 - \tau) \log y_{it} \tag{21}$$

and obtain $\tau = 0.085$. In models where itemization and the standard deduction are not explicit, this value is frequently around 0.15-0.18 (0.151 in Heathcote et al. (2014)).

A.2 SCF

The Survey of Consumer Finances (SCF), conducted every three years since 1983, provides information about the financial situation of US households. It contains detailed data on household balance sheets, income, and other demographic characteristics. Given the focus on wealth, the survey oversamples the rich, who hold most of the assets in the economy. To do so, it combines an area-probability sample (geographical stratification) with a list sample that guarantees that a sufficient amount of wealthy individuals are included.

Apart from the 1983-2007 waves, I also consider the older historical waves of the Survey of Consumer Finances made available by the University of Michigan. Namely, I consider the 1963, 1968, 1969, 1970, 1971, and 1977 waves to construct, where relevant, statistics like wealth to income ratios or shares of stock market participants. While this data is less exhaustive than the recent waves of the SCF, it is the only source to provide reliable information about household wealth and its composition for the cohorts I am interested in before 1980. For a longer discussion, analysis and harmonization procedures of these waves of the SCF, see Kuhn et al. (2017).

I use the SCF to obtain stock market participation data. I consider a household to be participating in the stock market if any of its members hold stocks directly or indirectly via an IRA account, Keogh plan, mutual fund or pension plan like a 401(k). For most of the waves the composition of these funds is provided as a categorical variable, so for indirect holders I consider them to be stockholders if they hold any such plan which is formed of "mostly or all stock".

A.2.1 Bequest targets

The main bequest targets are based on Hurd and Smith (2001), who use the Asset and Health Dynamics among the Oldest Old (AHEAD) study from the Health and Retirement Study (HRS). This study focuses on households whose heads were born in 1923 or before, which is significantly earlier than the first cohort considered in this paper. Therefore, the bequest targets reflect bequests left by a generation which had potentially different characteristics to the ones I consider.

Bequest data for the 1940s cohort is not yet available, as the majority of it was alive at the end of my sample period. However, SCF data reveals that the generation born in the 1940s had accumulated around 30% more wealth at age 75 than the generation born around 1910-1920. Thus, for the main version of this model I adjust the average bequest target by increasing it by exactly as much as average wealth increased at age 75 between these cohorts. This imperfectly captures several possible reasons for holding more wealth during retirement (longer life expectancies, different patterns of medical expenditure, different histories) - future data on wealth decumulation by this cohort can impose more discipline on this assumption. I do not adjust the targeted percentage of people with zero bequests, but the calibration tends to underpredict it.

A.3 Higher order moments of earnings

I define skewness and kurtosis as the third and fourth standardized moments of log earnings changes, respectively. Kelley's skewness (KS) and Crow-Siddiqui kurtosis (CS) are defined following Guvenen et al. (2016):

$$KS = \frac{(P_{90} - P_{50}) - (P_{50} - P_{10})}{P_{90} - P_{10}} \tag{22}$$

$$CS = \frac{P_{97.5} - P_{2.5}}{P_{75} - P_{25}} \tag{23}$$

where P represents a percentile in the distribution of earnings changes. Thus, Kelley's skewness is more positive the further away the 90th percentile is from the median; and more negative the further away the 10th percentile is from the median, while Crow-Siddiqui kurtosis is larger the fatter the tails of the distribution are. I refer to both as *robust* measures because they are less affected by outliers than standard skewness and kurtosis.

B Computational appendix

B.1 EGM method

For a given set of parameters, the model is solved using a combination of a nonlinear maximizer and the endogenous gridpoint method (EGM), following the algorithm described in Fella (2014).

The model has several discrete states (housing, aggregate state) and continuous states (safe assets, risky assets, earnings). After the last period of life (age $T+1$), utility is known as it can be directly derived from the bequest function (6). From then I proceed via backwards induction.

For any age t, given a set of states (y, a, f, h, m, Ω) we need to find the policy functions for the household for current period's consumption c and next period's safe assets a', risky assets f', housing h', and mortgages m'. Using standard methods, this would imply computing the value associated with each of the feasible choices and maximizing over the 4-D space (as we can always solve for one of the choices using the budget constraint) to find the optimal choice for each set of states.

Using the EGM method allows to substantially speed up the computation of a pair of these choices. For this paper, I use the EGM method to solve the (c, a') choice conditional on the f', h' choice. For computational purposes, $m = -a$, and I allow for the grid of f to include some points that correspond to possible positive holdings of a. Given f' and h', I use the inverted Euler equation to compute the consumption choice c that corresponds to each future choice of assets a'.

By the budget constraint, the sum of consumption and all savings must equal current cash on hand. This means that, given f', h' and the pair c, a' we have found with the Euler equation, we can interpolate the endogenous grid of consumption to the exogenous grid of cash on hand that is determined by the states in period t, and obtain the f', h'-conditional choices of c and a' for those particular states.

The only point left is to then run a nonlinear maximizer over the f' and h' choices, thus obtaining all required policy functions. Using this procedure, the nonlinear maximizer is only run over a 2-D space, which implies the algorithm is significantly faster.

The Euler equation does not necessarily hold in all scenarios for safe assets (for instance, when the household is borrowing constrained with no housing, or at the boundary of the condition that requires it to pay interest on its debt). These situations are dealt with specifically.

B.2 Global minimization

I solve the model using FORTRAN 2008. Due to the large state space, it is very computationally intensive - in a workstation with 44 cores it takes roughly 25 minutes to solve for a given parametrization. In order to find the parameter values that minimize the weighted square distance between the targets and their values in the data, I use a modified version of the NEWUOA numerical optimization algorithm.

I acknowledge the use of the UCL Myriad High Throughput Computing Facility (Myriad@UCL), and associated support services, in the completion of this work.

C Intergenerational differences: additional evidence

The changes across cohorts described in Section 2 are based on the SRC, which is the PSID's representative sample of the 1968 US population and their offpsring, are deflated with the CPI, and consider household earnings for all households, whether married or not. In this Appendix, I begin by comparing changes in male and household earnings (Appendix C.1.1) and showing the changes in higher-order moments of earnings risk (Appendix C.1.3), and then I describe the qualitative and quantitative implications of considering several alternative approaches: picking the whole PSID and weighting it (Appendix C.2.1), deflating with the PCE (Appendix C.2.2), selecting married households only (Appendix C.2.3), splitting by education (Appendix C.3.2) and geographical area (Appendix C.5.1).

C.1 Earnings dynamics

C.1.1 Male vs. household earnings

The earnings of the median male earner in the United States at age 25 have decreased from the cohort born in the 1940s, which entered the labor market in the early 1960s, to the cohort born in the 1960s by around 12% in real dollars (see top left panel of Figure 1). Similarly, Guvenen et al. (2017), using Social Security data, find that median income at labor market entry peaked for the generation born in 1947 and decreased thereafter. As the shape of the life-cycle profile of earnings has changed little, both median earnings at each age and median lifetime earnings are lower for younger generations.

However, during this period there was a significant increase in female labor force participation and women's wages, which acted as a counteracting force and almost completely reversed this decrease in terms of household earnings (bottom left panel of Figure 1). After age 30, when most household formation has taken place, median household earnings are higher for the younger cohort than for those born in the 1940s.

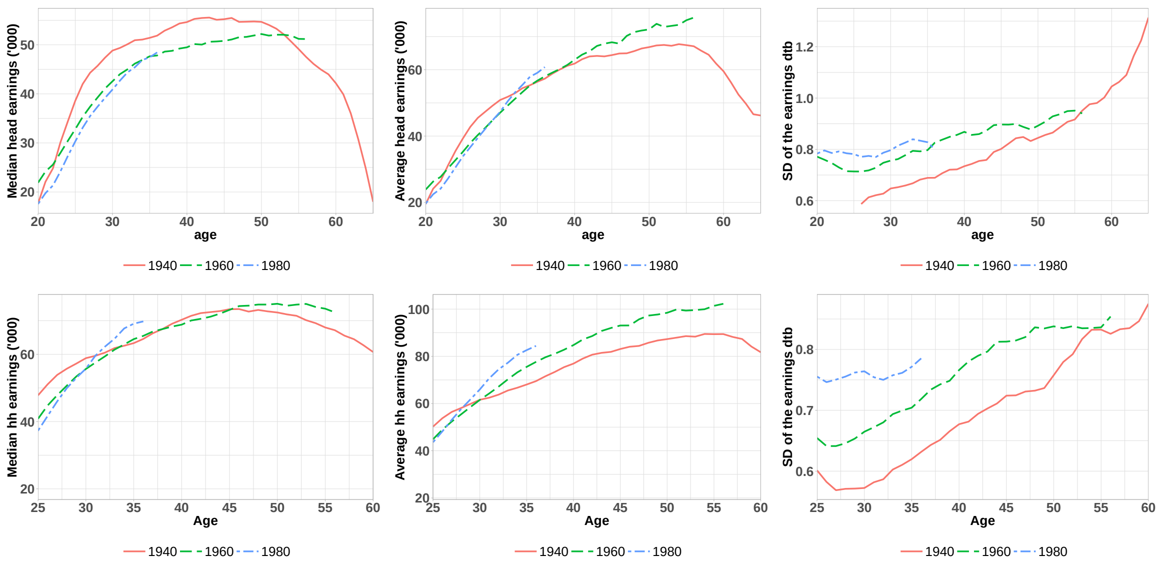

Figure 1: Changes in the earnings distribution over the generations. Top: household heads; bottom: household earnings. Left: median earnings, center: average earnings, right: standard deviation of the log earnings distribution. PSID data, deflated using the CPI.

C.1.2 Explaining the increase in earnings volatility

The variance of household earnings changes, which I report in the middle right panel of Figure 1, is determined by a plurality of factors: on-the-job earnings risk for both head and spouse, job finding and job separation rates, correlation of shocks within the household, the average duration of unemployment, etc. In this section I show how the variance of earnings fluctuations can have increased over time for younger generations, even if short duration jobs have become less frequent (Hyatt and Spletzer (2016)), by looking at the dynamics of unemployment.

In Figure 2 I report the counterpart of the middle right panel of Figure 1 for those households in which neither head nor spouse experienced any unemployment spell in the two years of reference for the computation of the variance. This selected group displays a much lower variance of earnings fluctuations than the overall population. However, whilst the variance increased significantly between the 1940s and 1960s cohort, it has stayed constant, or even decreased, between the latter two. This observation suggests that the increased volatility of the 1980s cohort was mostly driven by the households who are excluded from this graph: those who have experienced unemployment spells during the year, who are mostly located in the lower part of the income distribution.

However, Figure 3, left panel, shows that people in 1980s generation households are less

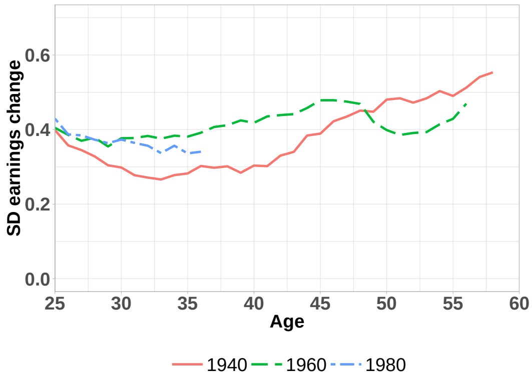

Figure 2: Standard deviation of log household earnings changes, excluding households where the head or the spouse have suffered an unemployment spell. PSID data.

likely to go through a spell of unemployment than the earlier two cohorts, implying that the share of households affected by unemployment in a given year has gone down over time. Absent any other changes, this development, together with Figure 2, should imply a reduction in the variance of log earnings changes. But, as the right hand panel of Figure 3 shows, the duration of unemployment increased significantly. The average 30 year-old head of household of the 1940s cohort that lost his job spent a bit more than a month on that state; for the 1980s cohort, the same person could expect to be unemployed for around 15 weeks.[28]

This evidence suggests that changes in the conditional duration of unemployment may have had a key role in pushing the variance of earnings up. I do not attempt, due to data limitations derived from the small sample in the PSID, to perform a full decomposition of the contribution of these different factors to the increase in earnings volatility, including for example female labor force participation or the role of shocks to the second earner in the household, but it is a very interesting avenue for future research.

[28]The measures reported in Figure 3 differ from standard measures of unemployment and unemployment duration because they impose the same sample selection measures as in my main sample (most importantly, that households have total labor income higher than $ 1,500, implying households who were unemployed for the whole year are not in the sample) and because I report average unemployment duration during the past year, which by construction is capped at 52 weeks. However, the increase in average unemployment duration is consistent with the historical increase documented on CPS data.

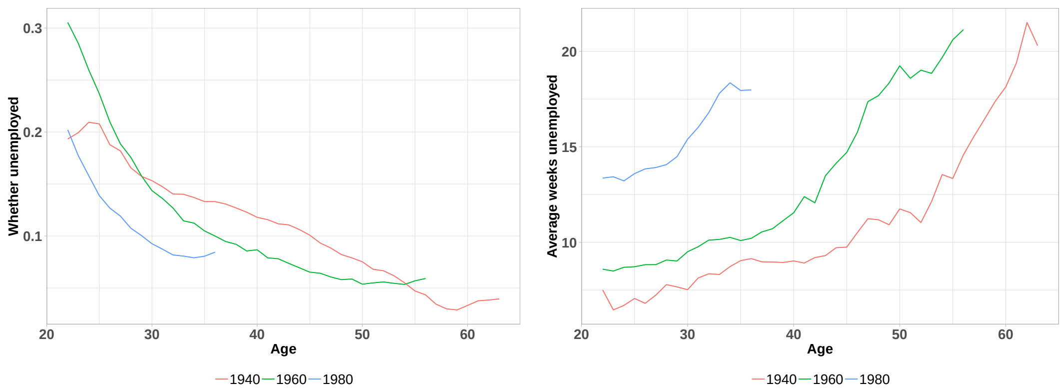

Figure 3: Left: whether head of household was unemployed at some point over past year, by age and cohort; right: average duration of unemployment during that year, conditional on having been unemployed. PSID data.

C.1.3 Higher order moments of earnings changes

As Figure 4 shows, earnings changes display negative skewness and high kurtosis for all cohorts, but there has been little change in those measures over time[29]. However, this observation does not imply that the tails of all three distributions are equally fat: given a level of kurtosis and skewness, increasing the variance makes large shocks more likely than before.

C.2 Sample and deflator choices

C.2.1 Sample composition

In this section, I make use of the whole PSID rather than the SRC. Because only the SRC is a random sample, this also requires making use of the PSID-provided weights. In the earlier years of the survey, this means considering the Survey of Economic Opportunity part of the PSID, that oversamples the poor; in later years of the survey, in particular after 1997, it implies taking into account the immigrant population that has arrived to the US since. Using the SRC rather than the whole PSID for the main results leads to a cleaner comparison - keeping the offspring of the same population of reference helps to ascribe the changes in labor market dynamics to structural changes in the labor market, opportunities, and family formation, rather than changing demographics across the whole society. However, it has the disadvantage on missing out on additional population growth of potentially different socioeconomic characteristics, which

[29] Appendix A.3 provides definitions for these.

Figure 4: Higher order moments of log earnings changes, by cohort

has implications for house prices and more broadly any general equilibrium effects.

Figure 5 shows median and average earnings for this broader sample. Including immigrants reduces the median earnings of younger cohorts with respect to the oldest generation.

Turning to distributional features, we observe in Figure 6 that considering all immigrants has the interesting implication that the difference between the 1940s and 1960s cohort is preserved, or even larger than before, but the difference between the 1960s and the 1980s cohort becomes almost insignificant. While earnings have become more unequal for the sons and daughters of the original PSID sample members, the entrance of immigrants has contributed to reduce the variance of the earnings distribution of the 1980s cohort with respect to the 1960s.

The measure of homeownership considered in this paper can also depend on sample choices, particularly if immigrants and newer incorporations to the PSID sample have substantially different homeownership patterns. Figure 7 shows the resulting comparison. All main patterns are similar: if anything, taking into account the whole population implies a marginally larger gap between the 1940s and 1960s cohort, and a marginally smaller gap between the 1960s and 1980s cohort, which is consistent with the smaller gap in earnings inequality and risk in this wider sample.

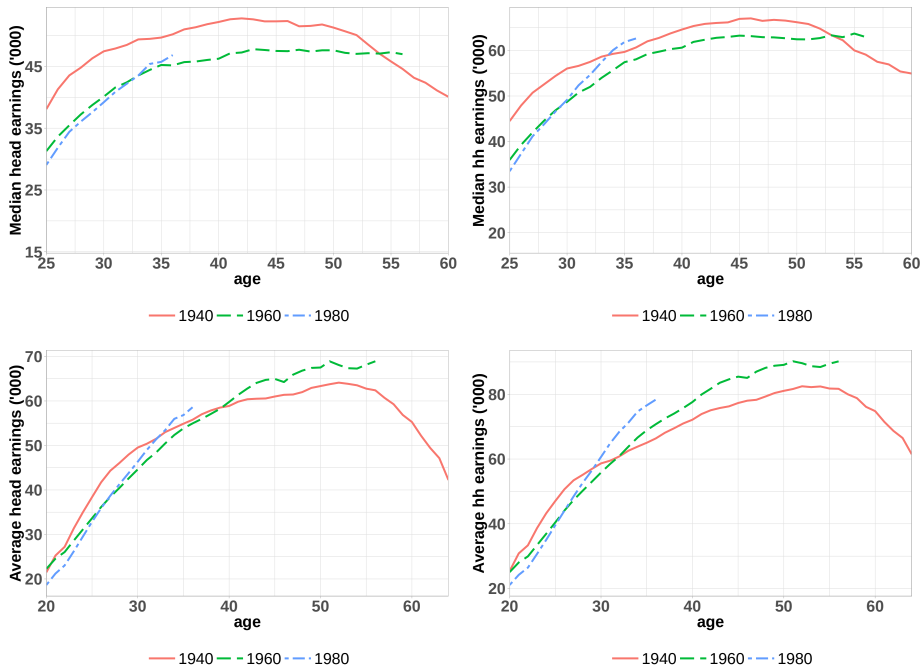

Figure 5: Median earnings (top) and average earnings (bottom), for household heads (left) and households (right), 2013 dollars, sample including SEO and immigrants.

C.2.2 Choice of deflator

In this section, I deflate earnings with the PCE or personal consumption expenditure deflator (U.S. Bureau of Economic Analysis, 2021) rather than the CPI. These two measures differ slightly on their scope and their computation procedure. While the PCE takes into account all expenditure made by households and also on behalf of households, such as total medical expenditures, the CPI only considers what households spend out-of-pocket. The PCE is based on business surveys, while the reference basket for the CPI is based on data from the Consumer Expenditure Survey or CEX. Given that the focus of the paper refers to the consumption and portfolio possibilities of all but the richest of households, the main results are deflated with the CPI, which more closely reflects the changes in prices of the goods and services that households actually pay. The PCE index is instead more frequently used when performing aggregate macroeconomic analysis.

In this sample period, the PCE implies overall lower cumulative inflation than the CPI and, therefore, implies that median and average earnings of younger cohorts have grown more than with the CPI. However, because cross-sectional inequality within a cohort-age cell is not affected

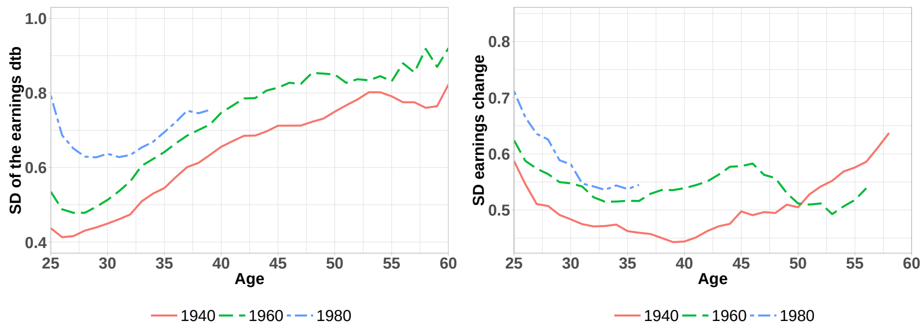

Figure 6: Standard deviation of log earnings (left) and earnings changes (right), sample including SEO and immigrants

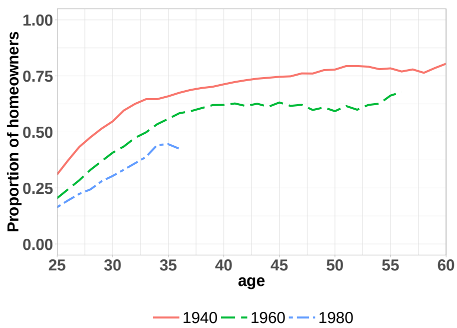

Figure 7: Homeownership, by cohort, sample including SEO and immigrants

by the choice of deflator, the facts regarding changes in the distribution of earnings that lie at the core of this paper are unchanged when considering the PCE.

Figure 8 shows median and average earnings by cohort, for male and head and spouse earnings. Deflating with the PCE increases the differences between cohorts, particularly for household earnings, which implies that it acts in the opposite direction as the inclusion of a broader sample described in Appendix C.2.1. Naturally, the choice of deflator does not affect earnings inequality within age and cohort, nor measures of earnings risk, nor homeownership.

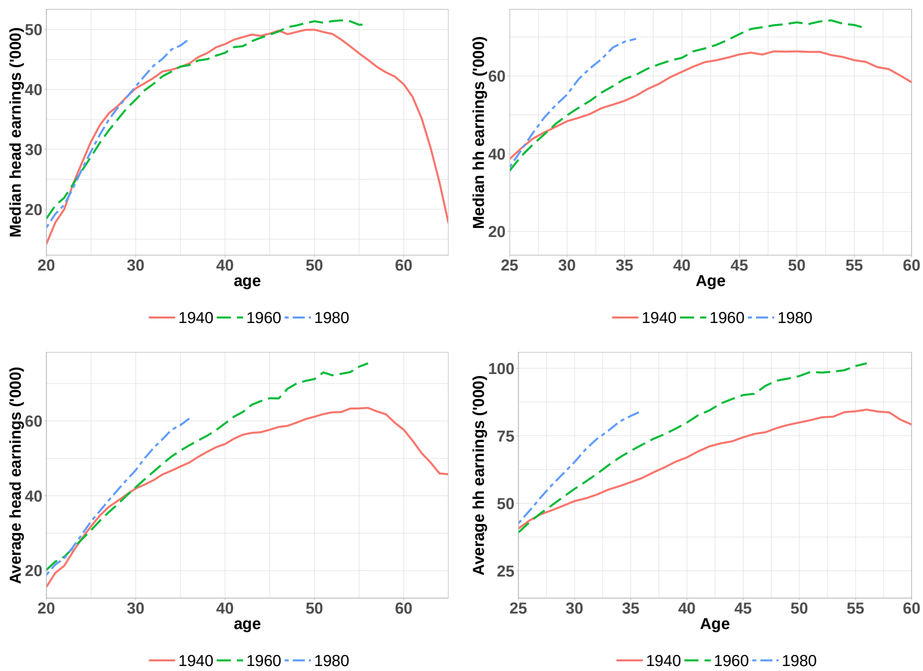

Figure 8: Median (top) and average (bottom) earnings, 2013 dollars. Left: household heads, right: households. PCE-deflated sample.

C.2.3 Marital dynamics and family composition

Figure 9 compares the profiles in Figure 1 with those for married households. While it is clear that family composition affects the profiles for the first ten years of age, and that earnings inequality is lower in the more homogeneous sample of married couples, the main picture is pretty similar, which suggests that there are differences in labor earnings across cohorts, particularly in distributional terms, which are not fully explained by the differential timing of marriage.

Figure 10 shows that there are also large differences in homeownership over different cohorts if we restrict the sample to married households or to households with children, which provides additional evidence to suggest that earnings dynamics are relevant over and above changes in family composition. Naturally, in these selected samples homeownership tends to be larger than in the general population.

Additionally, the main hypothesis proposed in this paper (changes in the earnings distribution and earnings risk affecting homeownership) can also partially operate via later marriage and/or fertility decisions.

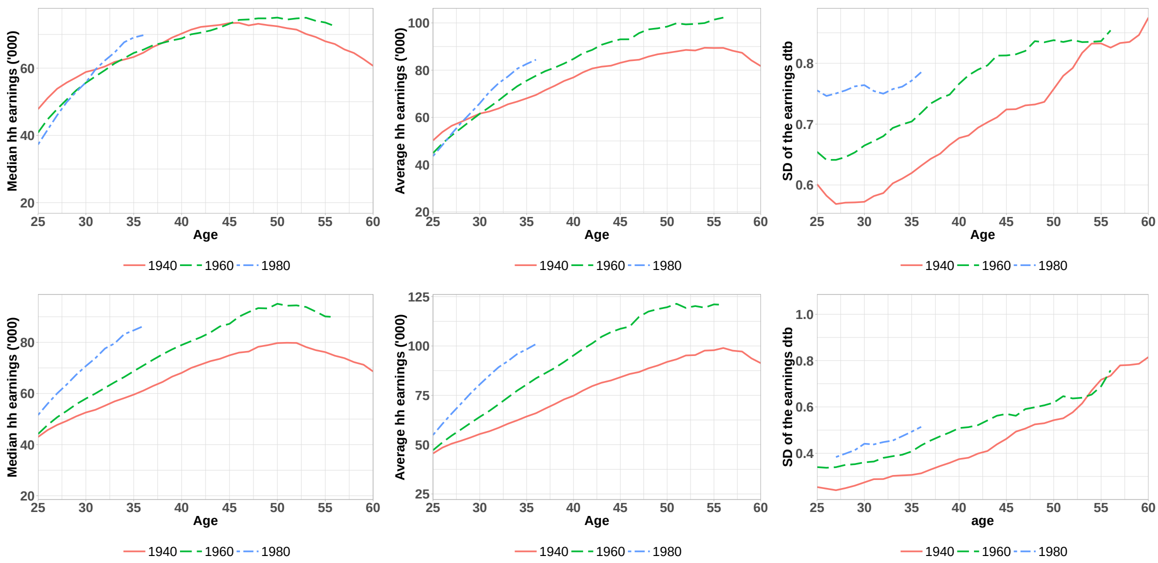

Figure 9: Changes in the earnings distribution over the generations. Top: household earnings; bottom: household earnings for married households. Left: median earnings; center, average earnings; right: standard deviation of the log earnings distribution.

C.3 Other factors related to the labor market

C.3.1 Intergenerational mobility patterns

There is a close link between job insecurity, earnings volatility, and mobility. A generation like that of the 1980s, with more earnings instability, might be more ready to move, which in turn would be an additional factor to contribute to the drop in homeownership rates that we observe. There is limited data on mobility in the PSID, particularly within narrow geographical regions. However, there is information, which I report in Figure 11, about whether individuals have ever moved state. According to this measure, younger generations do not seem to be more likely to move than older ones: if anything, we observe a drop in the interstate mobility patterns of the 1960s generation with respect to those of the 1940s, and a recovery for the 1980s that brings them in line with the oldest generation.

However, interstate mobility does not paint the whole picture, as workers are also likely to move within shorter distances that might also imply that they need to quit their homes and rent or buy in a different location. Johnson and Schulhofer-Wohl (2019) use the National Longitudinal Survey of Youth (NLSY), confirm the finding that interstate migration has gone down for younger cohorts, and show that shorter-distance mobility changed little between the

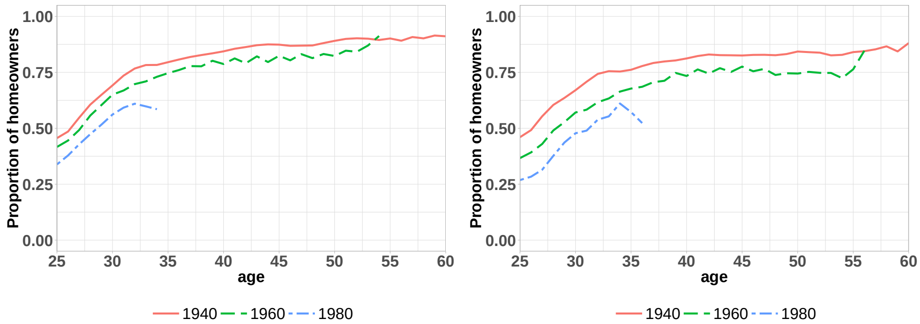

Figure 10: Homeownership by cohorts, PSID data. Left, sample restricted to married couples; right, sample restricted to households with at least one child.

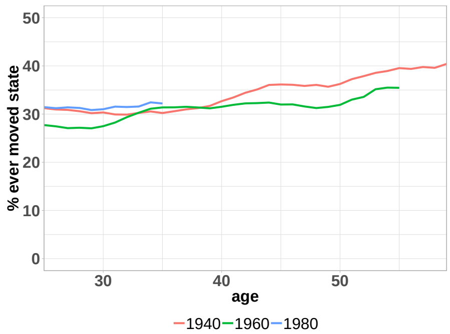

Figure 11: Share of heads of household that have ever moved state, by cohort

cohorts, although there are some compositional effects (the mobility of college graduates went down, but some age-education groups of the most recent cohort are more mobile). However, shorter-distance moves represent a small share of all moves (around 20%).

C.3.2 Education

As shown in the previous section, the gap in homeownership rates is not driven by pure compositional effects due to later marriage or childbearing. The same is true for the case of education. As Figure 12 shows, the drop in homeownership rates has happened both for non-college graduates and for college graduates. The drop is more salient for households whose head does not have college education, which have lower homeownership rates throughout. Although education is not explicit in the model, it captures these differences to the extent that they are embedded in household income.

Given that there has been an increase in the number of college graduates, who are also more likely to be homeowners, if anything changes in education would be a force in the opposite direction to my main results and increase the homeownership rates of the youngest cohort. Additionally, highly educated people display higher homeownership rates even at age 25, thus suggesting that their delayed entry to the labor market is not the key driver of the results either.

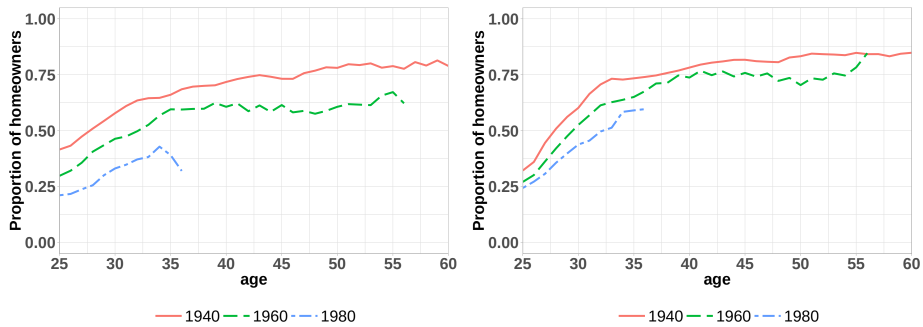

Figure 12: Homeownership by cohorts, PSID data. Left, high school graduates and lower education; right: college graduates

C.4 Equivalence scales by generation

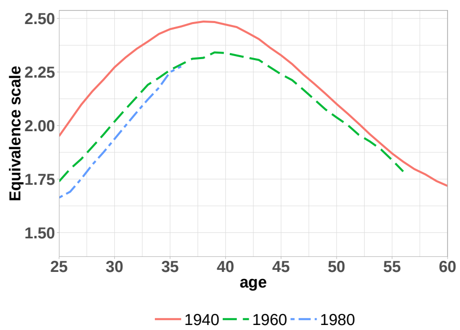

Figure 13: Average OECD equivalence scale, by cohort

C.5 Homeownership and portfolio composition

C.5.1 Census data: aggregation and geographical differences

The PSID has limited geographical information about households, and it is not a frequent source of aggregate homeownership rates. Thus, I turn to IPUMS data (Ruggles et al., 2020) from the American Community Survey and other comparable historical samples for these two purposes.

I begin by comparing the evidence it provides with the PSID. The data for older generations is noisier, given that the data is only available every 10 years before 2000, but it also shows an intergenerational drop in homeownership rates which is broadly consistent with PSID evidence (Figure 14).

This alternative data source also allows me to show how the contribution of different cohorts has aggregated into the national homeownership rate over time (Figure 15). Although the level of the aggregate homeownership rate has been quite stable over time, this apparent stability masks slow-moving developments that have affected the age distribution of homeowners, which I show with the different colors. For instance, in 1960 households over 60 (red and brown areas) were less than a third of all homeowners; in 2018, households over 58 (green and blue areas) are almost half of all homeowners.

The drop in homeownership rates is true for both urban and rural areas (Figure 16). In the framework in this paper, increased urbanization is reflected in higher average house prices faced by households. To the extent that this is driven by transformations in the labor market, the main message in the paper still holds true. However, an interesting future avenue for research could add geographical heterogeneity to this framework, and explicitly study the role of urbanization.

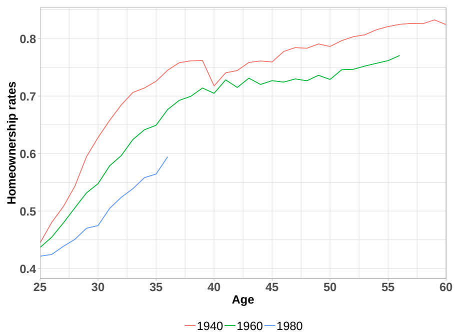

Figure 14: Homeownership rates by age and generation, IPUMS data

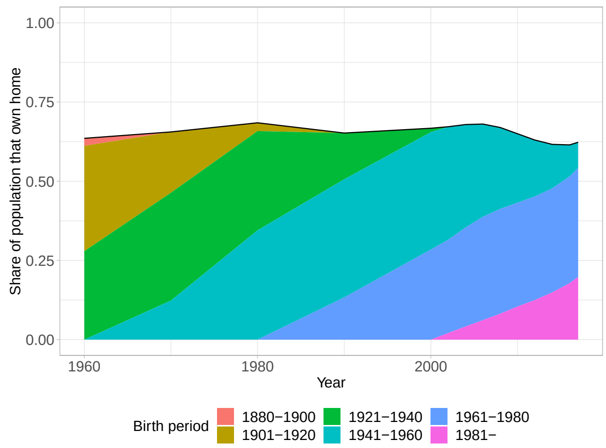

Figure 15: Aggregate homeownership rate by year (black line), and decomposition of homeowners by decade of birth. At each given year (x-axis), each colored area represents the share of the total population that was born in a given period and who owns a home. Source: IPUMS census data. See Figure 14 for homeownership rates by cohort with the same data.

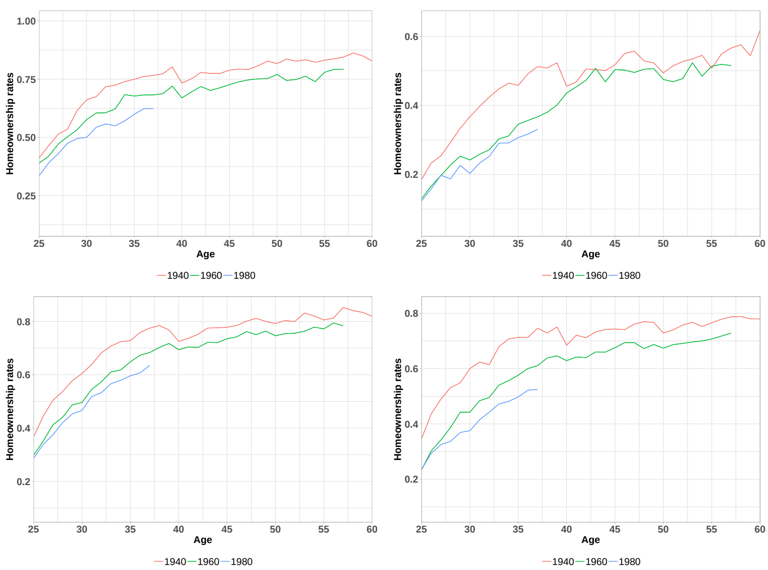

Figure 16: Homeownership rates by age and generation, IPUMS data. Top left: not in metropolitan area; top right: in central/principal city; bottom left: not in centra/principal city; bottom right: intermediate status.

C.5.2 Portfolio composition, additional Figures

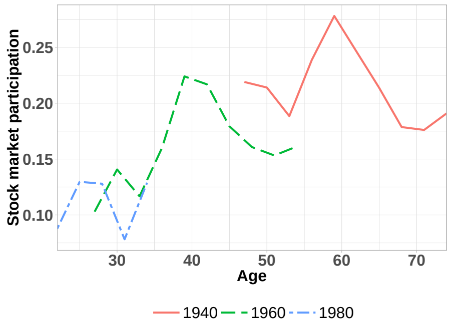

Figure 17: Direct stock market participation, three generations. SCF data.

D Earnings process

D.1 Implementation

I estimate the earnings process described in Section 3 by parameterising the quantile functions with a set of Hermite polynomials:

$$Q_{\eta}(q|\eta_{i,t-1}, age_{it}, c_i, \Omega_t^y) = \sum_{j=0}^{J} a_j^{\eta}(q, c_i, \Omega_t^y)\psi_j(\eta_{i,t-1}, age_{it}) \tag{1}$$

$$Q_{\eta_1}(q|age_{i1}, c_i, \Omega_1^y) = \sum_{j=0}^{J} a_j^{\eta_1}(q, c_i, \Omega_1^y)\psi_j(age_{i1}) \tag{2}$$

$$Q_{\epsilon}(q|age_{it}, c_i) = \sum_{j=0}^{J} a_j^{\epsilon}(q, c_i)\psi_j(age_{it}) \tag{3}$$

where the coefficients a_j^i, $i = \epsilon, \eta_1, \eta$, for all states are modelled as piecewise-linear splines on a grid $\{q_1 < \ldots < q_L\} \in (0, 1)$.[30] The intercept coefficients $a_0^i(q)$ for q in $(0, q_1]$ and $[q_L, 1)$ are modelled as the quantiles of an exponential distribution with parameters λ_1^i and λ_L^i respectively. All coefficients are allowed to differ across cohorts.

If one could directly observe the two components ϵ_{it} and η_{it}, it would be possible to find the coefficients above by quantile regression at each point of the quantile grid q_j. However, both components are latent. To deal with this, the estimation starts at an initial guess for the coefficients and iterates between draws of the posterior distribution of the latent persistent components and proceeds to find the coefficients by quantile regression. The process is repeated until convergence of the sequence of coefficient estimates.

D.2 Fit of life-cycle variances

Figure 1 shows how the earnings process fits the changes in cross-sectional variances of log earnings for these three different generations at each age.

D.3 Canonical earnings process

This process nests more standard earnings process such as that proposed in Storesletten et al. (2004), which I refer to as *canonical process*:

[30] Following Arellano et al. (2017), I use tensor products of Hermite polynomials of degrees (3,2) in $\eta_{i,t-1}$, and age for each state k of $Q_{\eta,\Omega}(q|\eta_{i,t-1}, age_{it})$ and second-order polynomials in age for $Q_{\epsilon}(q|age_{it})$ and $Q_{\eta_1,\Omega}(q|age_{i1})$.

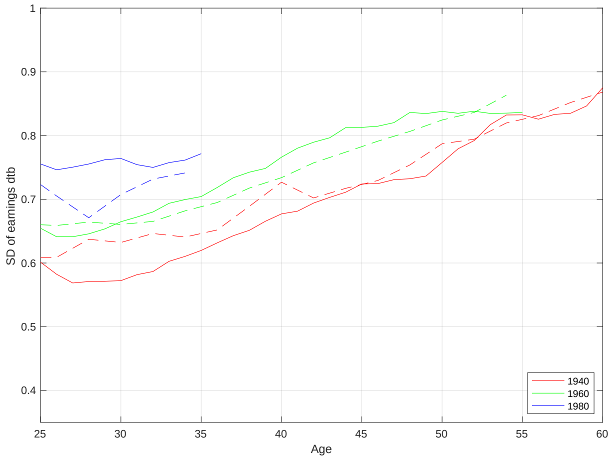

Figure 1: Variance of log earnings over the life cycle, PSID data vs model-implied

$$y_{it} = \eta_{it} + \epsilon_{it} \tag{4}$$

$$\eta_{it} = \rho\eta_{it-1} + \xi_{it} \tag{5}$$

with $\xi_{it} \sim N(0, \sigma_t^2)$, $\epsilon_{it} \sim N(0, \sigma_\epsilon^2)$ and

$$\sigma_t^2 = \begin{cases} \sigma_{r,c}^2 \text{ if } \Omega^y = \text{Recession} \\ \sigma_{b,c}^2 \text{ if } \Omega^y = \text{Boom} \end{cases} \tag{6}$$

where usually $\sigma_{r,c}^2 > \sigma_{b,c}^2$. Unlike in this process, my procedure implies that there is no need to assume age-independence or normality of earnings shocks, nor linearity in the dependence of the persistent component on its past realizations.

I obtain its parameters by fitting the cohort-conditional profiles of variances and autocovariances over the life-cycle. Figure 2 shows the fit of the life-cycle variances, and Table 1 shows its estimated parameters.

The estimates for the 1940s cohort are more precisely estimated and thus as expected (variances are larger in recessions than in expansions). For the 1960s cohort, the difference between expansions and recessions is quite imprecisely estimated, but the model succesfully replicates the higher level of earnings inequality that the cohort faces. Finally, for the 1980s cohort there are very few years of observations - whilst the process matches the variance profiles well, the

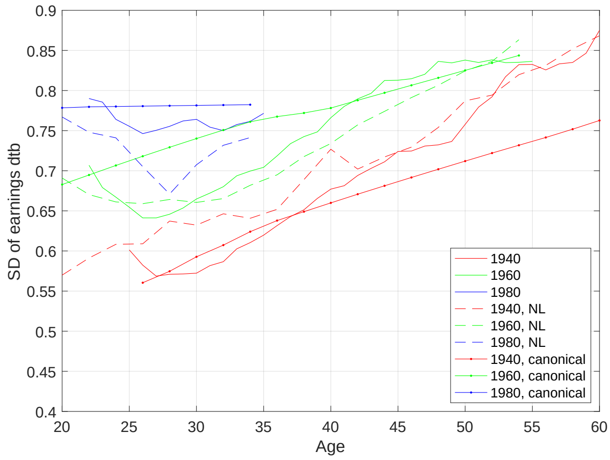

Figure 2: Variance of earnings over the life cycle. Sold lines: data; dashed lines: NL process; dash-dot lines: canonical process

Cohort	ρ	$\sigma^2_{r,c}$	$\sigma^2_{b,c}$	σ^2_{ϵ}
1940	1.0	0.027	0.0112	0.13
1960	0.99	0.0010	0.0205	0.16
1980	0.61	0.34644	0.38276	0.0001

Table 1: Parameter estimates, business-cycle varying canonical process

persistence parameters and the variances for shocks are very noisily estimated.

The canonical process relies on the sequences of variances and autocovariances faced by each of the sub-cohorts that form a broad generation, and thus uses, for example, 122 observations. On the other hand, the NL process relies directly on pairs of observations for earnings in t and $t+1$, and uses 7500 such observations for the 1980s cohort.

D.4 History-dependence of the earnings process

The Markov-switching earnings process captures history dependence of each household's earnings. In particular, the recovery from recessions is usually sluggish. A broad literature has studied both the large negative long-run effects of displacement for individual workers (e.g. Jacobson et al. (1993)), that are particularly severe within recessions (Davis and Von Wachter, 2011), and the slow recovery of employment after downturns like the Great Recession (Ravn and Sterk, 2017). Figure 3, left panel, shows that the earnings process I propose replicates this feature without large increases in the state space. It represents, for the simulated earnings process of the 1940s cohort, the percentage difference in average earnings between a cohort that underwent a single recession at age 44 ("NL process") and one that never lived through a recession throughout its entire labor market history. Suffering one recession has important effects on impact that last for relatively long. In contrast, the canonical earnings process generates a counterfactual *increase* in average earnings because higher variances in logs, at a constant average, imply higher averages in levels. The purple line represents it for the estimated parameters in Storesletten et al. (2004), while the yellow line represents the canonical counterpart to the process I estimate for the 1940s cohort (see Appendix D.3 for details).

The rich earnings process also captures differential impacts by initial position in the earnings distribution (right panel). Recessions affect the earnings of the lowest and highest earners by more than those around the median. By construction, the canonical earnings process does not replicate either of this facts.

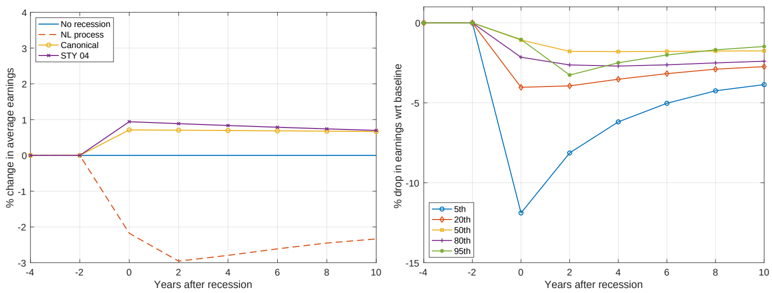

Figure 3: Earnings by age with respect to the counterfactual in which a recession never occurs. Left: average earnings, recession at age 44. Right: by initial earnings percentile, recession at age 44.

E Model, additional elements

E.1 Household's problem

The state variables are labor market income y_{it}, risk-free asset holdings a_{it}, housing status h_{it}, financial assets f_{it}, age t and the aggregate state Ω_{it}.

At the beginning of period, shocks to labor market income, risky asset returns, and house prices (i.e., shocks to y_{it} and Ω_t) realize, together with the moving shock with probability π_t. Then, households who still have a mortgage decide whether they want to default or continue repaying. Finally, households make consumption, savings, and portfolio decisions.

Thus, utility at the beginning of period U_t is:

$$U_t(y, a, h, f, m, \Omega) = \begin{cases} \tilde{U}_t(y, a, h, f, m, \Omega) & \text{if } h = 0 \\ (1 - \pi_t)\tilde{U}_t(y, a, h, f, m, \Omega) + \pi_t \tilde{U}_t(y, a + p_t^h(1 - \kappa^h), 0, f, m, \Omega) & \text{if } h > 0 \end{cases} \tag{1}$$

After the moving shock, households with a mortgage decide whether to Default or Repay:

$$\tilde{U}_t(y, a, h, f, m, \Omega) = \begin{cases} \max_{D,R}\{U_t^R(y, a = 0, h = 0, f = 0, m = 0, \Omega) + \chi^{bk}, U_t^R(y, a, h, f, m, \Omega)\} & \text{if } m < 0 \\ U_t^R(y, a, h, f, m, \Omega) & \text{if } m = 0 \end{cases} \tag{2}$$

where χ^{bk} is a utility penalty, and utility after the moving shock and the repayment decision U_t^R is:

$$U_t^R(y, a, h, f, m, \Omega) = \max_{c, a', h', f', m'} \left\{ [(\theta_t c_t^{\nu} s_t^{1-\nu})^{\frac{(\psi-1)}{\psi}} + \beta(\mathbb{E}_t U_{t+1}(y', a', h', f', m', \Omega')^{1-\gamma})^{\frac{1}{1-\gamma}\frac{\psi-1}{\psi}}]^{\frac{\psi}{\psi-1}} \right\} \tag{3}$$

subject to the no-shorting condition for safe and risky assets (8, 9), LTV and LTI constraints when buying a home (11 and 12), the requirement to at least pay interest on debt in every period

(13), the restriction on holding both risky and safe assets while having a mortgage (15), and the budget constraint (4):

$$\begin{aligned} p_t^h(\Omega_t^h)h_{t+1} + \kappa^h p_t^h(\Omega_t^h)h_{t+1}\mathbb{I}(h_{t+1} \neq h_t) + r_t^s(\Omega_t^h)\mathbb{I}(h_t = 0) + \\ f_{t+1} + \kappa^f \mathbb{I}(f_{t+1} > 0, f_t = 0) + a_{t+1} + m_{t+1} + c_t = \\ p_t^h(\Omega_t^h)h_t + (1 + r_t^f(\Omega_t^f)(1 - \tau_a))f_t + (1 + r^a(1 - \tau_a))a_t + \\ (1 + r^b)m_t + T(y_t(\Omega_t^y), m_t) \end{aligned} \tag{4}$$

where $T(y, m)$ represents the tax system described in Section 4.4.

Retired households. Their social security income p is a function of their last realization of labour earnings before mandatory retirement (they cannot retire before 65). They solve the following problem (where y_l is their last realization of income before retirement):

$$\begin{aligned} U_t^R(y_l, a, h, f, m, \Omega) = \max_{c,a',f',h',m'} \Big\{ [(\theta_t c_t^\nu s_t^{1-\nu})^{\frac{(\psi-1)}{\psi}} + \\ \beta\xi_t(y_l)(\mathbb{E}_t U_{t+1}(y_l, a', h', f', m', \Omega')^{1-\gamma})^{\frac{1}{1-\gamma}\frac{\psi-1}{\psi}} + \\ (1 - \xi_t(y_l))v(b))]^{\frac{\psi}{\psi-1}} \Big\} \end{aligned} \tag{5}$$

where $v(b)$ is determined by Equation 6, and $\xi_t(y_l)$ are income-dependent survival rates, taken from Bell et al. (1992) and De Nardi et al. (2010). Their maximization problem is subject to the no-shorting condition for safe and risky assets (8, 9), LTV and LTI constraints when buying a home (11 and 12), the requirement to at least pay interest on debt in every period (13), the restriction on holding both risky and safe assets while having a mortgage (15), and a budget constraint with no income risk (6). Additionally, I assume that retired households cannot buy a bigger home than the one they currently live in ($h_{t+1} \leq h_t$).

$$\begin{aligned} p_t^h(\Omega_t^h)h_{t+1} + \kappa^h p_t^h(\Omega_t^h)I_t^h + f_{t+1} + \kappa^f I_t^f + a_{t+1} + m_{t+1} + c_t + r_t^s(\Omega_t^h)\mathbb{I}(h_t = 0) = \\ p^h(\Omega_t^h)h_t + (1 + r_t^f(\Omega_t^f)(1 - \tau_a))f_t + (1 + r^a(1 - \tau_a))a_t + (1 + r^b)m_t + T(p(y_l), m_t) \end{aligned} \tag{6}$$

where $p(\cdot)$ represents social security.

Retired households with a mortgage can default in a similar manner to working-age households.

E.2 Fit of the aggregate state

Figure 1 shows how biennial stock returns (left) and housing price-to-income (PTI) ratios in the model compare with the data.

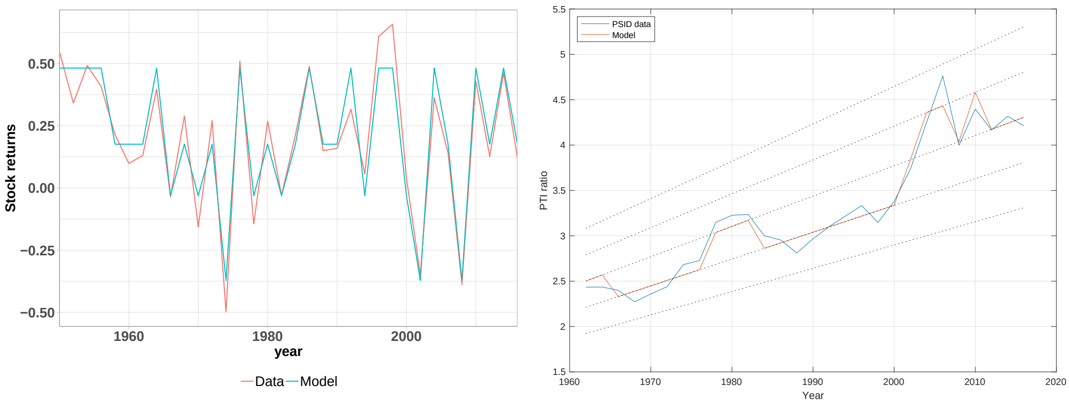

Figure 1: Stock market returns, housing median price-to-income ratio

E.3 Standard earnings process counterfactual

Figure 2 represents an alternative way of measuring the role of earnings dynamics in explaining lower homeownership rates. It shows the changes predicted by the model if we attribute the earnings process of the 1940s generation to the younger generations, whilst keeping all other factors constant. This experiment differs from the previous decomposition because it also incorporates possible interaction effects between factors, which make the effect of the changes in labor market income dynamics even larger.

E.4 Adjusting housing prices

My main counterfactual experiments abstract from general equilibrium effects. However, as the earnings process for the 1960s and 1980s cohort counterfactually changes, so do household decisions, which may impact the evolution of aggregate prices in the economy. It is likely that the increase in housing demand would have had equilibrium effects manifested in an increase in house prices, which could dampen the increase in homeownership rates implied by the experiments.

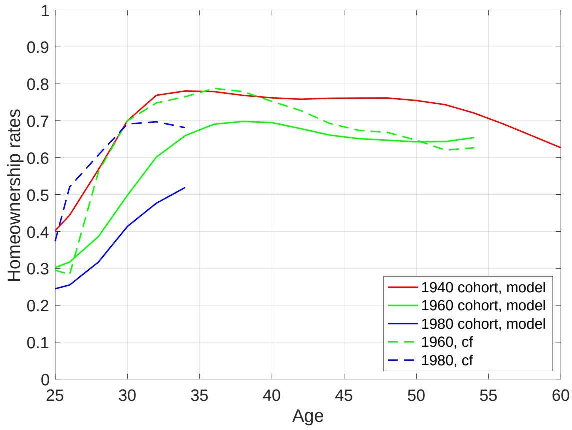

Figure 2: Homeownership by cohorts, the role of earnings dynamics.

As such, all results so far can be seen as an upper bound of the possible effects of income dynamics on homeownership, calculated under two equivalent assumptions: either housing supply is perfectly elastic or a non-modelled investor owns all rental housing and is willing to sell or buy any of it at the observed prices.

In this section, I provide an approximation to these equilibrium effects. I assume alternatively that housing supply is fully inelastic and that housing supply can be summarized by an isoelastic supply function with elasticity of 1.75, an empirical value estimated for the average U.S. metropolitan area by Saiz (2010). Then I compute the variation in housing prices induced by the increase in housing demand, and find homeownership rates for each cohort under those new prices.

First, I begin by defining the *baseline stock of housing* H_t^s as the total number of houses that are occupied by thier owners, which is equivalent to the number of households that live in owner-occupied housing. In order to aggregate across cohorts, I simulate a total of 31 birth-year cohorts (born in all even years from 1930 to 1990), and I attribute the earnings process of the 1940s cohort to the group 1930-1949, the earnings process of the 1960s cohort to the group 1950-1969, and the earnings process of the 1980s cohort to the group 1970-1990. Like in the main experiment, each birth cohort experiments aggregate shocks as they happened in the data in each calendar year, that corresponds to a specific age for each of the 32 cohorts. I use data from the U.S. population pyramids (US Census Bureau, 2021) to take into account relative cohort sizes in the aggregation.

Given that I do not have information on the earnings processes of the relevant years for the cohorts born before 1930s, I make the simplifying assumption that their homeownership profiles are not impacted by any of the changes introduced in the paper and they hold a constant amount of housing. The impact of this assumption would depend on the reaction of these non-modelled cohorts, but it is only particularly restricting for the earlier cohorts when they are relatively young. Additionally, for this experiment I assume that households are born with zero initial wealth.

Thus, H_t^s is computed as summarized in Equation 7, where I am aggregating over all households i that belong to each of these 31 birth-year cohorts. I then assume that, at given prices p_t^h, H_t^s is the total amount of housing supplied for these cohorts; which implies that p_t^h is the price that clears the market given housing supply and demand.

$$\int_i H_i^d(p_t^h) = H_t^s \tag{7}$$

Then, I am interested in computing how the quantities of housing bought by each of the different cohorts change as external factors, such as the earnings process, change. A change in the earnings process will induce a change in the housing demand functions H_i^{d*} for each household. To which extent this gets translated into changes in quantities exchanged and changes in prices depends on the elasticity of housing supply.

Assuming a fully inelastic housing supply implies fixing H_t^s at every year t and finding p_t^{h*} such that Equation 8 holds. I do so sequentially for $t = 1, \ldots, Y$, where Y is the total amount of years in the simulation, and to that extent the model continues to capture history dependence of past prices. Furthermore, the slow-moving nature of these changes and the definition of H_t^s, which captures cyclical variations which the model is attributing to housing supply or other non-modelled factors, implies that the housing growth aggregate state is still consistent with the evolution of house prices.

$$\int_i H_i^{d*}(p_t^{h*}) = H_t^s \tag{8}$$

Assuming an elastic housing supply implies, at a given (empirical) housing supply elasticity η, that the price that clears the market $p_t^{h'}$ satisfies:

$$\int_i H_i^{d*}(p_t^{h'}) = H_t^{s'} \tag{9}$$

such that

$$\frac{\frac{p_t^{h'} - p_t^h}{p_t^h}}{\frac{H_t^{s'} - H_t^s}{H_t^s}} = \eta \tag{10}$$

By substituting 10 into 9, one can solve for $p_t^{h'}$ in every period.

These experiments represent an approximation to actual equilibrium determination of housing prices. On the one hand, I do not model the agents that make housing supply decisions and approximate them with an isoelastic function (with elasticity which is either zero or 1.75). On the other hand, from the perspective of households, housing prices are still exogenous shocks with the same process as in the main version of the model. They are not aware that house prices are determined in equilibrium in a way that depends on total housing demand, and they do not perceive that intergenerational changes could be affecting house prices.

Figure 3 compares the homeownership rates by age and cohort between the baseline (solid lines), the counterfactual with fully elastic housing supply (dashed lines), and the counterfactual with empirically determined housing supply elasticity (dash-dot lines). For the 1960s cohort, I also represent the counterfactual with financial conditions becoming more flexible in the early 2000s (dotted lines). Although naturally homeownership is a bit lower for most cohorts and ages, the joint effect of earnings inequality and risk is still very relevant even if we allow for adjustments in average house prices.[31]

Figure 4 shows the results for the case in which housing supply elasticity is assumed to be zero.

All results in this section still assume that stock market returns and income dynamics are exogenous. The stock market is very integrated internationally, so it is less harmful to assume that changes in domestic household demand for stocks do not impact stock returns. With respect to income dynamics, the model is already capturing very well their changes over the cohorts and the business cycle, and endogeneizing them would imply losing much of this richness. However, both are interesting questions that are left open for future research.

[31] A more detailed approach could imply modelling the housing supply and rental market sectors, together with a realistic representation of housing devaluation and renovation, and thus obtaining a more flexible formulation of the housing supply function. While such a study could shed light on slow-moving dynamics of housing prices, it is beyond the scope of the model presented in this paper given current computational constraints.

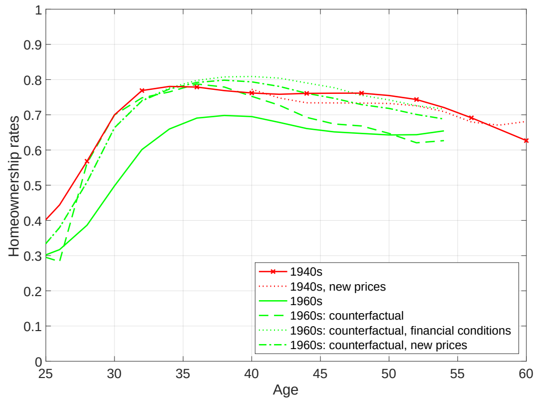

Figure 3: Homeownership by cohorts, benchmark vs. counterfactual earnings processes, empirical housing supply elasticity. Left: 1960s generation, right: 1980s generation.

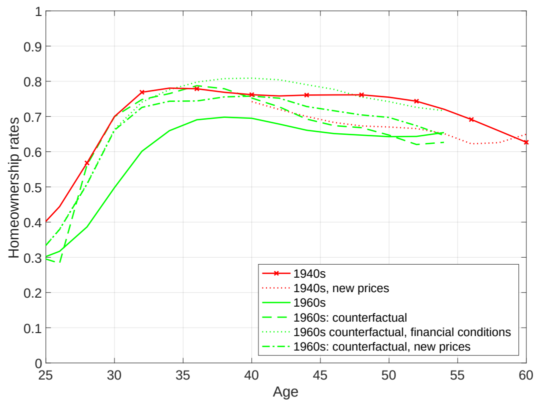

Figure 4: Homeownership by cohorts, benchmark vs. counterfactual earnings processes. Assuming fully inelastic housing supply.

F Robustness checks and extensions

F.1 Initial zero wealth

Figure 1 (left panel) shows the fit of the model with respect to homeownership in the case in which I assume that all households are born with zero wealth and recalibrate parameters accordingly. To give agents some more time to build up wealth, for this experiment I start them out at age 20 rather than 25. Although the fit of homeownership at earlier ages is not as good, it is still true that the model can reconcile the changes in homeownership rates across generations without resorting to changes in preferences. The right panel of Figure 1 shows that, without taking into account the initial condition, the model underpredicts stock market participation at earlier ages.

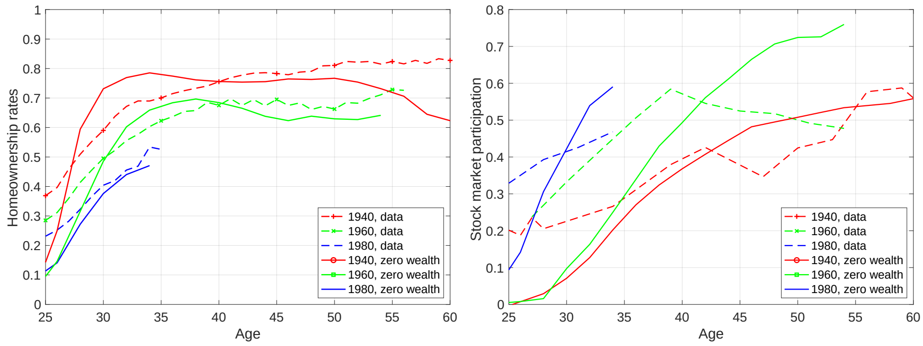

Figure 1: Homeownership (left) and stock market participation (right) by cohorts, data vs. model. Model with zero initial wealth.

F.2 Robustness to earnings process

F.2.1 Canonical process

I now to turn to evaluating to which extent a *canonical* earnings process, such as that described by Equations 4-6 in Appendix D.3, with changes over generations, can explain the observed changes in homeownership.

I recalibrate the model for the 1940s cohort following the same procedure as in my main results, and then simulate the model for the 1960s and 1980s cohort changing only earnings process, asset returns, and financial conditions. Figure 2 shows that the model also generates a decrease in homeownership rates across cohorts, which supports the argument that changes in earnings inequality and earnings risk are key drivers of the observed changes. However, the canonical process substantially overestimates the decrease for the 1960s generation. Earnings are estimated to be a random walk or close to it, and thus the effects of large initial inequality are more persistent than in the more flexible process proposed in this paper.

Additionally, as argued in Section 3.1, this process has a set of counterfactual implications. It does not replicate the countercyclical skewness of earnings and it implies increases of average earnings when recessions hit. Besides, as shown in Gálvez (2017), it also generates counterfactual implications for stock market participation decisions.

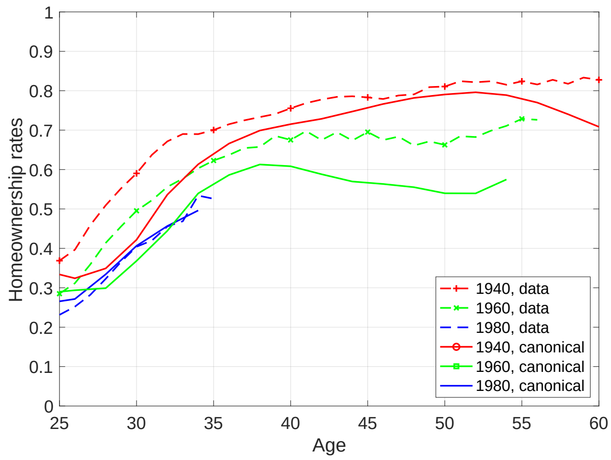

Figure 2: Homeownership by cohorts, data vs. model, canonical earnings process

F.2.2 Marital dynamics and family sizes

Over the past few decades, marriage rates have fallen, fertility has decreased, and the average age of women at both marriage and first childbearing has steadily increased (Lundberg and Pollak (2007)). These developments offer a possible alternative explanation for the reduction and delay in homeownership.

In the framework proposed in this paper, all of those changes are implicitly considered in the earnings process, which is estimated in all households (married or not) and thus embeds marriage and divorce risk into earnings risk. In order to disentangle these two effects, the left panel Figure 3 replicates the analysis by replacing the earnings process by one estimated only on continuously married couples. Given that this subset of households have on average higher and more stable earnings, their implied homeownership rates within the model are larger, particularly at older ages. However, differences across cohorts are comparable. This suggests that, while family dynamics can play a relevant role (e.g., Chang (2018) shows that marital and divorce risk is a relevant force to explain changes in homeownership of singles versus couples), the increase in inequality and earnings risk seems to be of first order to explain the changes in homeownership. To verify this hypothesis, the right hand side of Figure 3 replicates the counterfactual in which the 1940s earnings process is attributed to younger generations within the subsample of married households. Effects are similar to those in the main results.

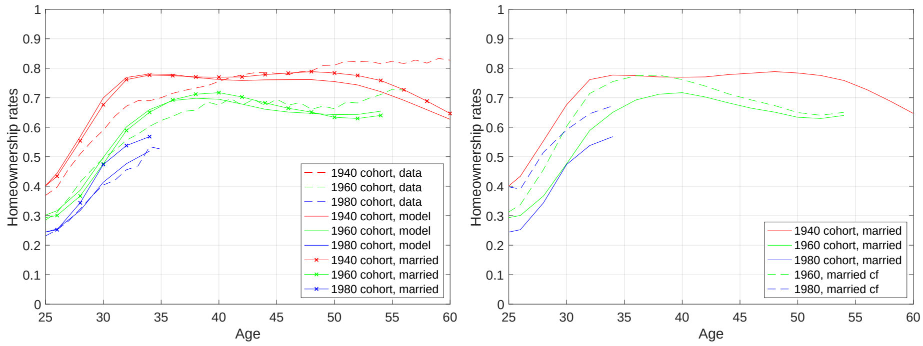

Figure 3: Homeownership by cohorts, married people only.

F.3 Robustness to asset structure

F.3.1 House sizes

In the main version of the model, households can choose to own two types of housing, which I denote h_1 and h_2. This reflects that houses are lumpy and have limited divisibility, and that frequently households cannot access their optimal house size and quality because it is scarcely available or disadvantageously priced on the market. In this section, I check the robustness of my results with respect to different specifications of house sizes. There are three main assumptions that I now turn to discuss: (1) the size of the minimum house, (2) the changes over time in the relative sizes of the different types of housing, and (3) the assumption that there are only two types of houses.

The size of the small house h_1 conditions who is the marginal person who is indifferent between buying a house and renting, and thus homeownership rates. As described in the calibration section, in current U.S. dollars, for the latest periods in the model, the price of a small house is around \$120,000 in 2015 dollars, which corresponds to about twice median household income, or alternative half the median value of a home in my PSID sample during that period. This assumption is conservative with respect to what is standard in the literature. For example, Doepke et al. (2015) set their minimum house size at \$150,000 and Garriga and Hedlund (2020) at 2.75 times average income.

Besides, very few households live in houses that are cheaper than that. For instance, looking at the 1980s generation, only 9.7% of households lived in a house with a price lower than h_1, with most of them concentrated nearby.

With respect to the changes over time in the relative sizes of houses and, in particular, of the smallest house, Figure 4 shows that younger generations are not buying cheaper (left) or smaller (right, measuring size as the number of rooms) houses to compensate for the increased average house price. This provides support to the assumption that the two house types available do not vary over time, and that their price is a constant fraction of the median house price.

A relevant question, beyond the scope of this paper, is why younger generations haven't bought smaller homes, which could be driven by demand or supply considerations. For instance, it could be that households really dislike housing units below a certain size, quality, or level of amenities. On the other hand, it could be that there are market imperfections preventing the supply of smaller, cheaper houses. Glaeser et al. (2005) point out that housing supply regulations have become more stringent over time. Falcettoni and Schmitz (2018) argue that regulations and monopoly power have reduced the production of prefab or factory-built houses below its efficient level, thus reducing the number of cheap houses available on the market.

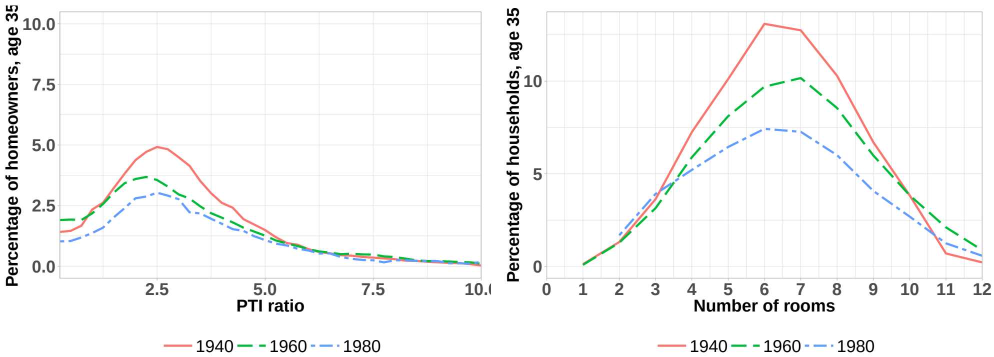

Figure 4: Share of households with a certain housing price-to-income ratio (left) and number of rooms excluding bathrooms (right), at age 35, by decade of birth. For clarity, non-homeowners are not reported, but they are taken into account to compute shares. PSID data.

For further robustness, I report in the left panel of Figure 5 what the model would deliver if h_1 were set to be 25% smaller and cheaper than in the baseline. Although in that case the model would overestimate how many households live in the small, cheap house compared with the data in Figure 4, it still delivers a reduction in homeownership rates across generations that is in line with what occurred in reality.

In order to compensate for the multiple factors that pushed down the howeownership rates of the young, one would have to assume that the minimum house size has dropped for younger generations (right panel, Figure 5). In particular, for this particular illustration I assume that the price of h_1 dropped by 25% for the 1960s and 1980s cohorts, without changing how much enjoyment these cohorts obtained from living in these properties. This would counterfactually generate no change in homeownership rates, but at the cost of significantly increasing the share of households living in smaller houses within younger generations (blue line with crosses in Figure 6), which is at odds with Figure 4.

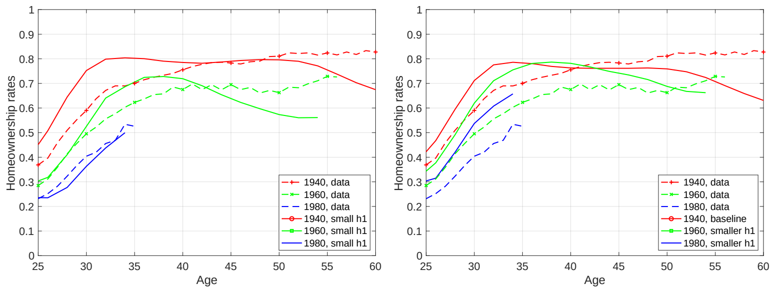

Figure 5: Alternative house size for h_1, main experiments

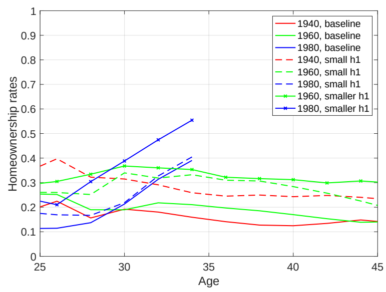

Figure 6: Percentage of households owning the small house by age: baseline vs. small h_1 vs. case in which h_1 becomes smaller over time.

Finally, although there is large heterogeneity in the size, quality, and price of housing units in the data, I set the total amount of housing qualities in the main version of the model to $H = 2$. This choice is mostly driven by computational considerations, and also by taking into account that the key element that determines homeownership, which is my main object of interest, is the size of the cheapest of those houses available. However, in order to verify that this does not impact my results, I have conducted several robustness checks, which I report in Figure 7, in which I set the number of housing qualities to $H = 3$. In the left panel, I do so by allowing for a middle-sized house exactly between the prices of the small house and the big house. In the right hand side panel, I allow for a large house, twice the size of the big one. In all cases I recalibrate housing preference parameters accordingly so that homeownership for the 1940s cohort at age 40 is within the ballpark of the data.

Results are almost identical with either of the $H = 3$ assumptions, thus suggesting that the choice of $H = 2$ is not key in driving the results I obtain. Setting $H = 3$ and allowing for a large house does improve the fit of the model in terms of the portfolio composition of the richest, which slightly underestimates their housing share (see Figure 5).

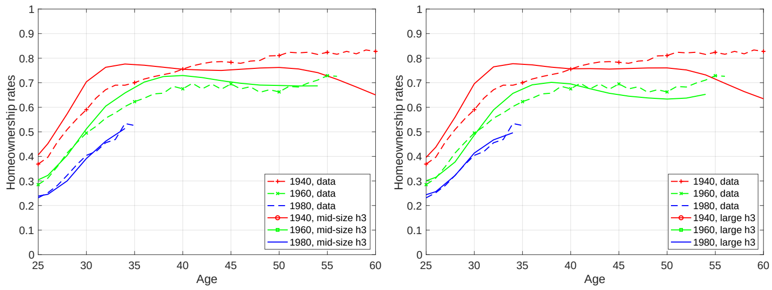

Figure 7: Specifications with $H = 3$. Left: intermediate house; right: large house.

F.3.2 Free housing adjustment during retirement

In the main version of the model, households are not allowed to move to larger houses during the retirement period. Assuming that, instead, they can freely optimize and acquire mortgages leads to a worse fit of homeownership rates during this period (left panel of Figure 8): many households take advantage of the relatively high period of house prices between their 55-60 years of age to sell, release equity, and many of them buy again when houses become cheaper. As a result, counterfactually too many houses are bought during the retirement period, although the spike before age 60 disappears (central panel of Figure 8) However, under this more flexible assumption the implications in terms of both model fit during the working age period and intergenerational differences are unchanged (right panel of Figure 8).

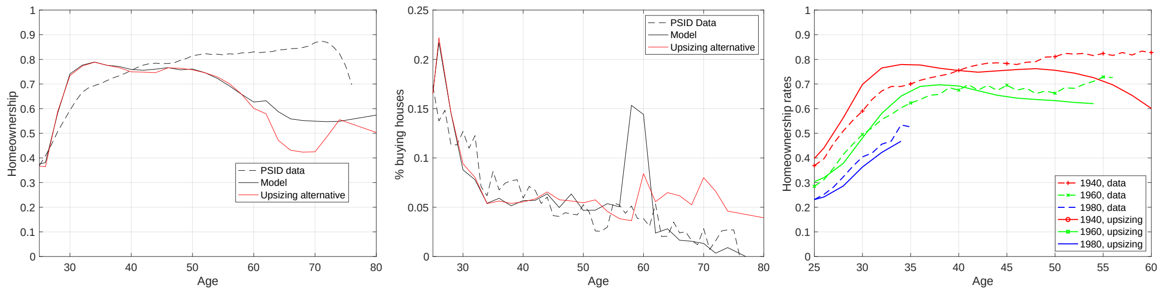

Figure 8: Homeownership rates if households are allowed to freely adjust housing and acquire mortgages during retirement. Left, whole life-cycle, 1940s generation; right: intergenerational comparison, working-age period.

F.3.3 Per-period participation costs

There is a long standing discussion in the household finance literature about whether one-off entry costs, which I consider in the main version of this model, or per-period participation costs rationalize better the patterns of stock market participation that we observe in the data. While the former is used in studies like Cocco (2005) or Gomes and Michaelides (2005), Vissing-Jorgensen (2002), Gálvez (2017), or Bonaparte et al. (2018), amongst others, find that the latter seems to be the most promising avenue to explain the observed patterns of stock market participation. However, the estimated value for the per-period participation cost is frequently relatively high (for instance, Bonaparte et al. (2018) estimate it to be around 3.2% of average household income every year).

Figure 9 shows that the implied profiles for an alternative version of the model with only per-period participation costs are very similar to the baseline model. As in previous studies, the estimated cost which is necessary to reconcile the low levels of stock market participation is quite high (around 5% of average household income for the 1940s cohort), but decreases down to 1% for younger cohorts.

F.3.4 Stocks as 401(k)

In order to investigate whether the fiscal incentives associated with IRAs and 401(k)s could be an alternative explanation for the increase in stock market participation, Figure 10 represents the results of a counterfactual exercise in which participation costs are kept constant, but I modify the nature of the financial asset or stock f_t in the model to closely replicate a 401(k). I keep participation costs constant across generations, but assume that contributions to the account

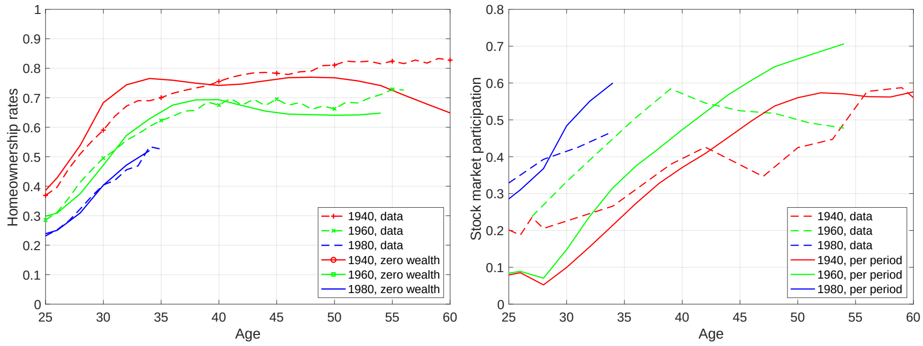

Figure 9: Homeownership (left) and stock market participation (right) over the life-cycle, by cohorts, case with calibrated per-period participation costs

are tax-exempt below a certain limit, the interest it generates is tax free, households pay income tax on all amounts withdrawn, and there are penalties for withdrawal before age 60 (10%).

As a result, households in the model would actually invest less in these accounts. This reaction is related to the illiquidity of 401(k)s, which makes it costly for househols to withdraw from their stocks in response to a bad labor income shock, and suggests that the ease of access and auto-enrolment were the key features that explained the success of these accounts.

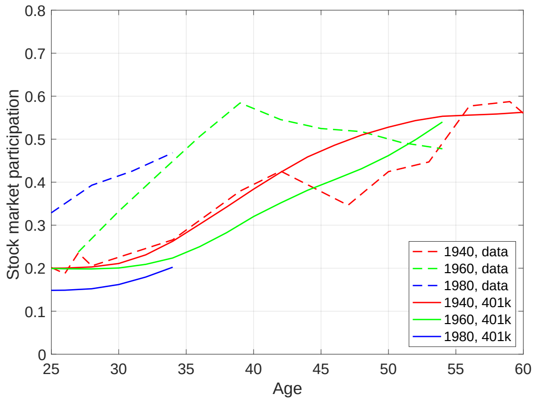

Figure 10: Stock market participation: model with constant participation costs and stocks with 401(k) tax properties

F.3.5 Costs of bankruptcy

In the model, the possiblity of bankruptcy is key to determine how households form expectations when are thinking about buying a house and take into account the possible future realizations of house prices and labor market income that might occur. If the model does not allow households to ever foreclose or go bankrupt, they might perceive that houses are too risky of an investment; if it assumes that it is easy and costless, it might underestimate the risk associated with homebuying.

I model default as a choice that implies that households that don't pay back their mortgages forego all of their assets and suffer a utility cost. This framework is closest to the regulation in recourse states, where lenders may have a claim to the borrower's assets even after the house has been sold. For simplicity and computational feasibility I do not explicitly model the difference between foreclosure and bankruptcy, the possibility of renegotiating debt with the bank, or the decision to file for bankruptcy under either Chapter 7 or Chapter 13. However, in the model households can choose to delay the payment of the principal of their mortgage, which already captures some of this flexibility.

There is limited information about foreclosure and bankruptcy in my survey data. In the SCF, there is a question since 2001 on whether the household has ever gone through bankruptcy, without reference to the reasons. However, many households file for bankruptcy because of reasons not related to housing, such as medical expenditures or consumer debt. Indeed, Domowitz and Sartain (1999) found that homeownership was actually negatively associated with the probability of going bankrupt.

In the model, even at zero bankruptcy penalties χ^{bk}, there are very few households in the 1940s and 1960s generations who choose to default (see Table 1). This occurs because they bought their houses under a 20% downpayment constraint, they face the evolution of average national house prices, which did not suffer large drops, and if they default they lose all of their assets. However, in the 1980s cohort many had little equity in their homes when they went through the 2000s housing boom and bust episode: a zero bankruptcy penalty would vastly overestimate how many choose this option. I choose $\chi^{bk} = -5$ as a compromise between keeping the 1980s cohort bankruptcy rates positive but below the data. In Figure 11 I show that, whilst the model with no bankruptcy cost would overstate the amount of homeowners in the 1980s cohort, results are robust to increasing or decreasing χ^{bk} by 50% and repeating the main analysis, recalibrating the preference parameters for the 1940s cohort and keeping them fixed through the generations. The main difference between all three cases is the number of households who file for bankruptcy in the 1980s generation, which is closer to the data in the baseline case.

Given the limited availability of data and these features of the model, I do not explore the possibility that the stigma of default has changed over the generations, but it is an interesting avenue for future work.

Generation	Age	SCF data	Model			
			Baseline	$\chi^{bk} = 0$	$\chi^{bk} = -2.5$	$\chi^{bk} = -7.5$
1940s	54	8.6%	0%	0.1%	0.1%	0%
1960s	54	19.08%	0.01%	0.2%	0.1%	0%
1980s	34	8.15%	4.06%	29.29%	14.33%	2.37%

Table 1: Share of households that have ever filed for bankruptcy

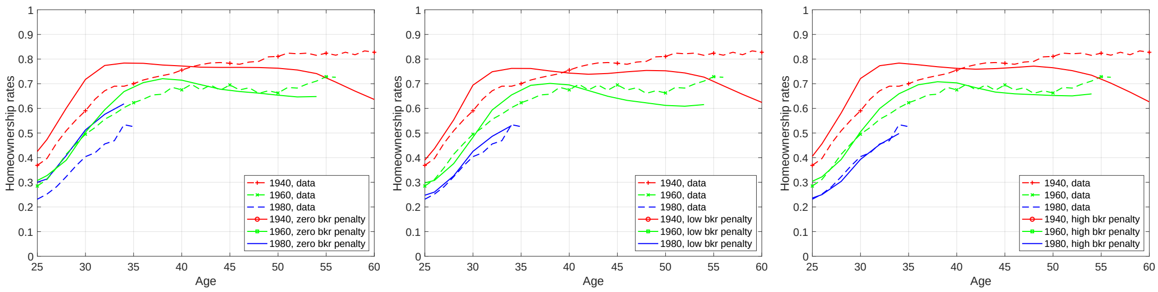

Figure 11: Homeownership by generation: no cost of bankruptcy (left), low cost of bankruptcy (middle), high cost of bankruptcy (right)

F.4 Robustness to the specification of the aggregate state

F.4.1 Stock market predictability and correlations

As argued in the main text, households expect stock market returns to be correlated with the state of the labor market, which in itself is persistent. However, this introduces little predictability in stock returns. First, given that the model period is two years, the persistence of the labor market state is not very high. For example, conditional on being in an expansion, the probability of staying in one in two years is 0.72. Second, the conditional distribution of stock returns in expansions and recessions has large variance. Joining together both factors, less than 1% of the variance of stock market returns can be explained by the recession/expansion dummy I take into account, implying that over 99% of the variation of stock returns in $t+1$ is not predictable in the model.

In Figure 12 I show that, in the case in which I assume that stock market returns are i.i.d and keep all preference parameters constant, stock market participation is almost identical. That said, the assumption that stock market returns are correlated with labor market income shocks impacts portfolio decisions. From a cyclical perspective, in the baseline model a reduction of 16 percentage points in the probability of a recession (as an economy exits one) generates an increase in stock market participation of 0.6 percentage points and an increase in the risky share of financial assets (unconditional on participation) of 6 percentage points. This effect is not present in the version of the model where stock market returns are uncorrelated with the labor market state.

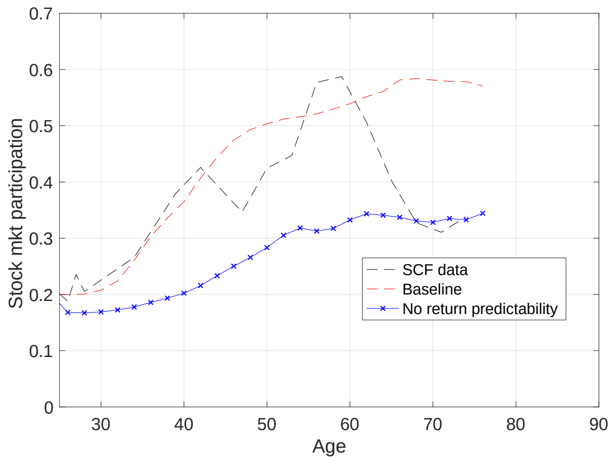

Figure 12: Stock market participation for the 1940s cohort, comparing main case against case in which stock returns are uncorrelated with labor market state

F.4.2 Cyclical dynamics of house prices

An additional assumption in the main version of the model is that there is autocorrelation in the house price process: house price growth is persistent. This assumption is important from a cyclical perspective: without it, housing sales would be more countercyclical: households would sell more housing when house prices are relatively high, which is at odds with what we observe in the data. In the left panel of Figure 13 I compare my baseline model with a version in which there is no persistence in house price growth. Such a model would underestimate homeownership rates for the 1940s generation during all house price growth periods, and conversely overestimate their stock market participation by about the same amount. For instance, it would be around 2 percentage points lower during the 2000s house price boom.

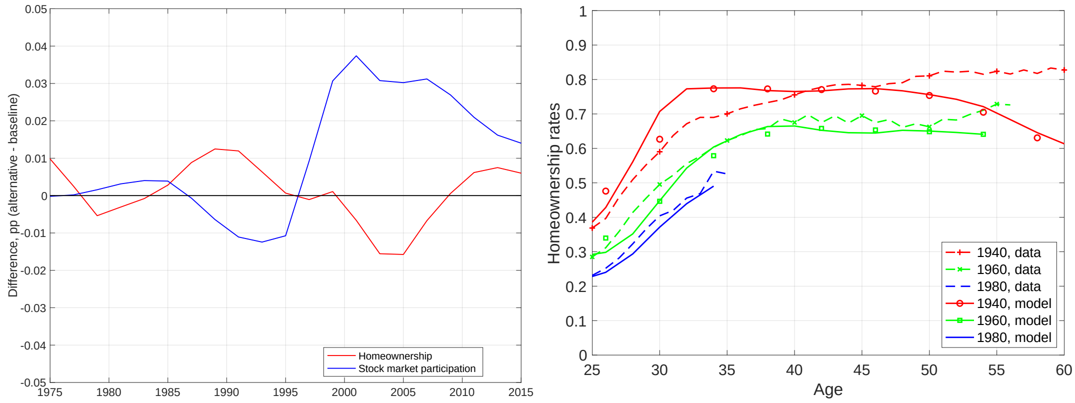

Figure 13: Role of autocorrelation in house prices. Left: difference in homeownership and stock market participation for the 1940s generation between a case with no persistence in house price growth and baseline case; right: homeownership over the generations with no persistence in house price growth.

F.4.3 Local correlation of income shocks and house prices

An additional element that increases the riskiness of housing is the correlation at the local level between house prices and income changes. For instance, in areas that benefit in particular from an expansion it is likely that both incomes and house prices go up. When households incorporate this information into their decision making, it influences both homeownership and portfolio choices.

To approximate this effect, I allow for income shocks to be correlated with housing price shocks at the idiosyncratic level. Given that in the baseline version of the model both are exogenous, this correlation can be directly imposed from data estimates. I rely on Davidoff (2006) for the empirical quantification of this correlation and fix it at 0.29. This correlation affects household expectations, but it also affects the realization of the shocks that households face as I simulate them. Thus, in this case, unlike in the baseline model, I allow for house price heterogeneity within a year-age-cohort.

I then recalibrate the main preference parameters. In order to fit the profile for the 1940s generation (Figure 14), the homeownership taste parameter and the stock market participation cost must be adjusted upwards. The reason is that the correlation of housing price shocks with income shocks raises the riskiness of housing as an asset, which also increases the attractiveness of stocks in relative terms. However, as Figure 14, the intergenerational implications of this alternative specification are very similar to that of the baseline model.

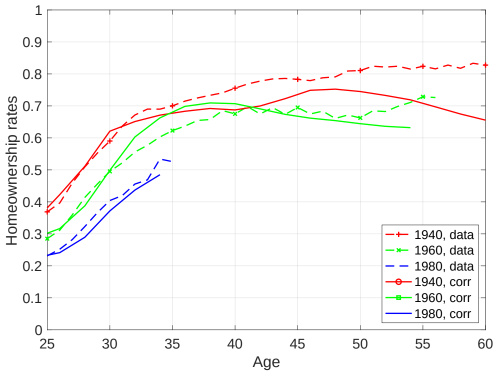

Figure 14: Homeownership by cohorts, local correlation of house price shocks with income.

This experiment abstracts from important elements such as endogenous determination of local house prices or endogenous mobility, which are beyond the scope of this project and are left for future research.

F.5 Future projections

In order to compute future homeownership rates for the 1980s cohort, I assume that house prices will continue to grow on average with respect to median income at a rate of 1.8% per year, and that the earnings process of the 1980s cohort will be that of the 1960s cohort for all unobserved years. I then simulate 1000 possible histories of the realizations of house price shocks and aggregate states, consistently with their conditional probabilities in the sample I observe, and plot the median homeownership rates in Figure 15. The dotted lines are percentiles 2.5 and 97.5 within the simulations. Broadly, the model predicts that the 1980s generation will almost catch up with the 1960s, but not with the 1940s, in terms of homeownership.

Looking at the retirement period, the median projection for these two younger generations shows a lower drop in homeownership rates than that observed in Figure 4 for the 1940s generation. The reason is that in the median simulation, unlike in the period 2000-2010, there is no big jump in house prices that leads households to sell their houses to release equity, and so they continue holding on to them for most of the retirement period. Although naturally the data counterpart for these cohorts is not yet available, this is likely to be a realistic feature, given that the data tends to show low decreases in homeownership rates after households retire.

The reduction in homeownership for younger generations can be related with an increase in wealth inequality if fewer households accumulate housing wealth and financial assets are still

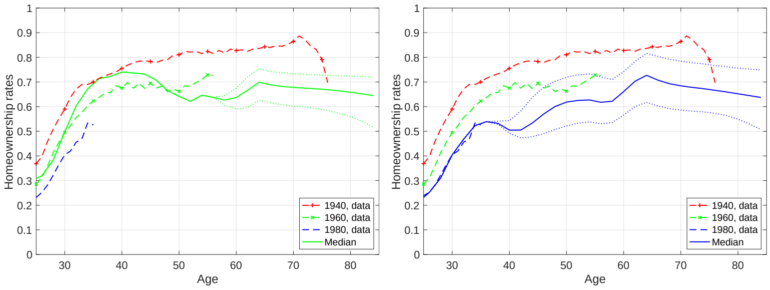

Figure 15: Projecting the 1960s and 1980s cohorts into the future: homeownership

Generation	1960	1980	
Reduction in k^f	-	0%	75%
Implied participation at 60	77%	83%	97%
Wealth Gini, data	0.83	-	-
Wealth Gini, model	0.51	0.55	0.51
		(0.019)	(0.014)

Table 2: Wealth Gini at retirement, data vs model. The data is obtained from people aged 55-64 in the SCF (2001 and 2016 SCF for the 1940s and 1960s cohort respectively). For the model, standard errors from simulation are in parentheses.

concentrated amongst the rich. Table 2 shows the wealth Gini index at retirement for the 1960s generation and for two different simulations for the 1980s cohort, which differ only in stock market participation costs k^f. The model predicts that wealth inequality will grow, unless stock market participation costs are reduced such that almost all of the population accesses the stock market by age 60. The larger the share of households that participate in the stock market, the stronger the negative effect on wealth inequality.

In any case, the model underestimates total wealth inequality, as it does not include a set of elements that are important to explain it, such as entrepreneurship or intergenerational links (De Nardi and Fella, 2017). The extent to which these vary over the generations will also have a determinant effect on the evolution of wealth inequality. These results also abstract from possible general equilibrium effects on stock returns induced by the increased accumulation of financial wealth.

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