Portfolio Choice with Housing as an Investment

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Abstract

First, we document several new facts: 1) During the last decade, there was a large shift in the age distribution of housing ownership in many European countries. Elder households dramatically increased the number of properties they own; 2) Elder households financed these purchases with savings; 3) Young households had less access to mortgage credit and reduced housing holdings. Second, we analyze a novel model of portfolio choice with housing as an investment asset. The model explains the previous facts with two complementary explanations: tighter credit standards towards the riskiest borrowers and housing investors searching for yield. We evaluate the liquidity risks that elder households are assuming by expanding their housing holdings.

Keywords: Age, Housing, Homeownership, Mortgages, Microdata, Housing Investment, Portfolio.

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1 Introduction

This project studies the dynamics and determinants of homeownership in Europe. We analyze data from several sources to study different European countries and demographic groups. Then, we discuss implications for the housing and mortgage industries and for policymakers.

Through the 1990s and beginning of the 2000s, most developed countries experienced a boom in homeownership. However, the later years, after the mid-2000s, saw a remarkable drop in homeownership rates. This drop coincided with the Global Financial Crisis. In fact, there are no strong signs that the homeownership rates are picking up. In many countries across the globe, fewer households own their home. House prices have recovered, but homeownership rates did not. There has been a decoupling between housing prices and homeownership rates.

In Section 2, using micro data from EU-SILC, we show the evolution of homeownership across age groups in different countries. We show that there has been a remarkable shift in the distribution of housing ownership in most countries. Homeownership rates substantially dropped for young households. For example, in Spain the share of households below 30 years old who own a house was cut in half. Households above 50 years old dramatically increased the number of properties they own. Using graphical analysis of the Spanish Survey of Household Finances, we show three key facts: first, mortgage demand for credit from young households is falling as they move from homeownership into rental markets. This fall is not replaced by the elder who now buy multiple properties and become landlords. Second, the elder households reduce their demand for financial products as they reallocate their savings to buy real estate. Third, those households who borrow, now borrow more. That is, the extensive margin of mortgage credit (number of borrowers per age group) collapsed for young households. However, the intensive margin (loan amount) increased.

Section 3 shows evidence of the previous facts using regression analysis of the Spanish Survey of Household Finances. With the previous portfolio reallocation, elder households become real estate investors. Since they increase demand for houses in the market, the prices of houses keep going up. This makes the price-to-income ratio for young households extremely high. Young households, entering an economy with very low starting salaries, find their income prohibiting to buy a house in a market where prices are high. The young are forced then to become renters. The young increase the demand for rentals, which matches the increased supply from investors in equilibrium.

Overall, mortgage credit was reduced because elder households did not increase mortgage credit much. That is, they financed new purchases of properties with savings. Hence, real

estate investment is crowding-out other financial savings options.

In Section 4, doing a cross-country regression analysis on the EU-SILC database, we show that the previous facts are due to 3 forces: 1) income dynamics hurting the young. That is, the endemic low growth of the economy is one of the drivers of the results. In particular, the recovery after the crisis is not effective for the young households. Housing prices recover, however unemployment for the young is still very high, and the labor income for those who work is not increasing at the same rate as housing prices. As a result, the price-to-income ratio for the young households is very high, forcing them to postpone purchasing their home. 2) Lower mortgage credit due to tighter standards towards the riskiest borrowers. 3) The emergence of housing investors due to chase for yield that crowds-out the traditional young buyers. As rents are mostly stable, housing becomes an investment asset and a close substitute to safe yield-earning investments (Jordà, Taylor and Shuclarik 2019).

Contribution to the literature This study contributes to the growing literature analyzing optimal macroprudential regulation. Gete and Reher (2016) characterize two extensive margins of credit, one demand- and the other supply-driven. The authors highlight the beneficial role of mortgage debt in providing access to homeownership, and the importance of loan-to-value and loan-to-income policies in the optimal allocation of credit. In an influential study, Iacoviello (2005) develops a monetary business cycle model that focuses on the intensive margin of credit. Lambertini, Mendicino and Punzi (2013), and Rubio and Carrasco-Gallego (2014) study monetary and macroprudential policies, and optimal loan-to-value regulation.

This study also relates to the recent quantitative literature studying mortgage markets. For example, Campbell and Cocco (2015) solve a dynamic model of households' mortgage decisions, and quantify the effects of loan-to-value ratios and mortgage affordability measures on default. Corbae and Quintin (2015) study a model of heterogenous agents, and show that exogenous changes in approval standards increased the number of high-leverage loans prior to the financial crisis in the U.S. This increase in high-leverage loans can explain over 60% of the rise in foreclosure rates. Chatterjee and Eyigungor (2015), using a model of heterogenous agents and long-term debt, study three shocks that can account for the dynamics of house prices and foreclosures. Gete and Zecchetto (2018) study quantitatively how loan guarantees affect credit supply and demand. Our analysis provides evidence for the recent changes in the extensive and intensive margins of mortgage debt, and offers new insights on how these are linked to new risks for the financial system.

Finally, this study is related to the recent literature on investors in housing markets. Following the last financial crisis, Quantitative Easing has made real estate an interesting investment

in the environment of low yields (Martìnez-Miera and Repullo 2017; Rodnyansky and Darmouni 2017; Campbell and Sigalov 2022). Daniel, Garlappi and Xiao (2021) document this portfolio channel, showing that investors search for income in stock investments. Consistent with this theory, De Stefani (2021) documents that the investment attitude towards housing increased significantly among the wealthy U.S. population following the financial crisis. Garriga, Gete and Tsouderou (2021) study the surge of local investors in the U.S. after the global financial crisis. Chinco and Mayer (2016), Cvijanovic and Spaenjers (2021), Davids and Georg (2020) and Favilukis and Van Nieuwerburgh (2021) analyze foreign and out-of-town investors.

2 Homeownership, housing holdings and wealth by age. New facts

In this section we study the time series of homeownership (HOR) for several European countries. We focus on France, Germany, Italy, Portugal, Spain, Netherlands and United Kingdom. We look at HOR dynamics for multiple age groups. This is the first time in the literature that these statistics are reported. Moreover, we computed the series for each wave of the EU-SILC database. EU-SILC is a cross-sectional and longitudinal sample survey, coordinated by Eurostat, based on data from the European Union member states.

Figure 1 shows how the homeownership rates by age group evolved in countries where there is large homeownership inequality related to age. For example, homeownership rate in Spain decreased significantly, from the year 2005 to 2017. Importantly, the homeownership rate collapsed for young households. While in 2005, 67% of households below 30 years old owned their main residence, this percentage was cut to 36% in 2017. As we explained in the data section, the homeownership rates come from a sample that overrepresents wealthy households, hence it is safe to say that the homeownership rates for this young age group are even lower, and the decrease over time could be even more dramatic.

Elder households in Spain, above 60 years old, have been historically owning their houses in vast majority. From 2005 to 2017 around 85% of households in the elder age groups are homeowners. The U.K., Italy and Portugal show similar patterns of homeownership to Spain. Thus, Figure 1 documents a significant redistribution of homeownership across age groups.

Figure 2 shows how the homeownership rates by age group evolved in countries where there was minimal change over time. For example, France seems to be an exception to the previous fact.

To understand the drivers of the homeownership dynamics shown before, now we delve into the analysis of the Spanish Survey of Household Finances, or Encuesta Financiera de las Familias (EFF). In this section we look at the empirical evidence, in the next one we use regression analysis to confirm the visual facts.

The EFF is an official survey undertaken by the Bank of Spain, in collaboration with the National Statistics Institute. This survey is conducted every three years, with the first wave being in 2002, and the last wave that is publicly available in 2017.

The original microdata are collected through a comprehensive and detailed questionnaire, by means of personal interviews, about the households' financial conditions. The questions concern housing, debt, labor and non-labor income, and other financial and non- financial assets. The purpose of the survey is to empower studies on the financing and investment decisions of Spanish households, and their financial position at each point in time.

The sample is selected from all adult ages and socioeconomic classes. Importantly, the surveys oversample the highly wealthy households. Such oversampling ensures that there is a sufficient number of households to study, with enough precision, the financial behavior of households at the top of the wealth distribution and to measure more accurately the aggregate wealth of the economy.

The survey waves create a dataset of mainly repeated cross-sectional survey data. That is, a different set of households is asked the same questions each wave, so the data are comparable over time. Each cross-section of households is representative of the overall sample. Our main analysis uses the full sample and treats the survey as repeated cross-section. Table 1 presents the summary statistics of the key variables in this study.

A typical household balance sheet has mortgage credit as the largest liability, and perhaps consumer credit as smaller liability. On the asset side, households hold real estate, deposits, stocks and other financial products (see Table 2). Elder households increased their holdings of real estate assets, while at the same time decreased their holdings of deposits, stocks and other financial products. Many young households, however, do not buy any houses or other real estate, and do not take on any mortgage credit.

Since homeownership rate is dropping in Spain for young households, then the question is: who buys the excess stock of houses? Figure 3 shows that post-financial crisis, the elder households not only own their main residence, but the recently have substantially increased their holdings of real estate. For example, 50% of households between 60 and 70 years old owned more than one properties in 2000, whereas this percentage exploded to 70% in 2014.

Figure 4 shows how much the average number of properties each household owns increased over time for the elder households, and that it remained unchanged or even decreased for the younger households.

The data in the previous figures corroborate that the elder (and wealthy) households buy the stock of houses that the young do not buy. These additional houses might be vacation homes, but they might also be used as investment assets. That is, the elder households now rent houses to the young and become landlords.

How did the previous dramatic changes in the ownership of real estate translate to the dynamics mortgage credit? Out of the households that become homeowners, the share that gets mortgage credit has increased over the years for some age groups but remained unchanged for most households. For example, about half of homeowners below 30 years old have debt outstanding for their main residence, both in 2002 and 2014. Since 60% of households in this age group are homeowners, 30% (half of 60%) of all households (homeowners and renters) in this age group have debt outstanding in 2002. With the same calculation, 18% (half of 36%) of all households below 30 years old have debt outstanding in 2014. This means that the extensive margin of mortgage credit has collapsed for young households. Households in the next age groups, especially 40 to 50 years old, seem to have increased their extensive margin of mortgage credit. The elder households naturally have very low outstanding debt from the purchase of their main residence, and this remained unchanged.

The previous evidence does not mean however that overall there was an increase in the extensive margin of real estate debt, since only elder households purchase additional properties and these households are precisely the ones with the lowest propensity for using debt.

The previous figures show that fewer and fewer young households in Spain take on mortgage debt over the last ten years. Those who do borrow, how much do they borrow compared to the previous decade? It seems that the young households take on much larger mortgages than before.

Figure 5 shows a substantial jump to the average outstanding mortgage amount for households between 18 and 50 years old. These increases in households' leverage might be related to increased risk of default and might raise concerns for the financial stability of the lenders.

Figure 6 shows the evolution of wealth of households of different ages. The young households have about the same wealth in 2017 as they had in 2002, whereas the older households increased their wealth substantially.

3 Estimating holdings of multiple housing properties and mortgages

The previous facts show striking changes in the households' property ownership and debt holdings. First, to understand the factors driving the households to own more properties, or take on more debt, we estimate the following logistic regression:

$$\log \frac{\pi_{i,t}}{1-\pi_{i,t}} = \beta_0 + \beta_1 A_{i,t} + \beta_2 I_{i,t} + \beta_3 P_t + \beta_4 P_t A_{i,t} + \beta_5 P_t I_{i,t} + \beta_6 A_{i,t} I_{i,t} + \beta_7 P_t A_{i,t} I_{i,t} C_t + u_{i,t}, \quad (1)$$

where i indexes the household and t the year of the survey wave. $\pi_{i,t}$ denotes the probability of household i owning multiple properties at time t. P_t is a binary variable that takes the value of one post-crisis, that is, for the survey waves 2011 and 2014, and the value of zero pre-crisis, that is, for the waves 2002, 2005 and 2008. $A_{i,t}$ is the age of the reference person of the household. The reference person is the one who chiefly deals with the household's finances. $I_{i,t}$ is the household's annual income. This is calculated as the sum of labor and non-labor income for all household members. We adjust the total income for inflation, so all values are in 2014 Euros. The final values of income are in thousand of Euros. C_t denotes the controls, which are dummies for each survey wave.

Part of the data are panel (the same household is interviewed over time), but the most part is repeated cross-section. That is, every survey wave the majority of households are different from the previous waves. Surveying different households reduces the serial correlation of the variables between survey waves.

The coefficient of interest, β_7 quantifies how much more one additional year of age and one thousand Euros additional annual income post crisis, contribute to increase the log-odds of owning multiple properties. We ran again the previous specification with a different dependent variable: In the second regression analysis $\pi_{i,t}$ denotes the probability of household i having outstanding debt from their main residence at time t.

To quantify the influence of age and income post-crisis on the value of the households' debt, we employ the following specification:

$$D_{i,t} == \beta_0 + \beta_1 A_{i,t} + \beta_2 I_{i,t} + \beta_3 P_t + \beta_4 P_t A_{i,t} + \beta_5 P_t I_{i,t} + \beta_6 A_{i,t} I_{i,t} + \beta_7 P_t A_{i,t} I_{i,t} C_t + u_{i,t}, \quad (2)$$

where $D_{i,t}$ is household's i value of outstanding debt in thousands of 2014 Euros, in the year t. The rest of the variables and controls are as before. We estimate (2) using ordinary least

squares regression (OLS).

To understand the different factors that affect the changes post crisis, we study whether the changes come from the ECB's large asset purchase program. Specifically, this unconventional enhanced credit support approach had a strong effect on risk-free rates, making these drop a lot, and eventually reaching the zero-lower bound. Accordingly, in the previous specification, we replace the post-crisis dummy with the average deposits interest rate in Spain. The specification becomes:

$$D_{i,t} == \beta_0 + \beta_1 A_{i,t} + \beta_2 I_{i,t} + \beta_3 R_t + \beta_4 R_t A_{i,t} + \beta_5 R_t I_{i,t} + \beta_6 A_{i,t} I_{i,t} + \beta_7 R_t A_{i,t} I_{i,t} C_t + u_{i,t}, \quad (3)$$

where $R_{i,t}$ is the average interest rate in Spain paid by commercial banks on savings deposits. If some of the effects from the time post financial crisis come from the ECB's monetary policy, we expect the coefficients of interest β_1 and β_2 estimated in (3) to be the opposite sign from the coefficients estimated in (2), since the time post-crisis is related to drop in deposit rates.

Table 3 shows the results of the estimation of the logit model (1). The likelihood of owning multiple properties increases with age, and increases even more post-crisis, as the interaction term of age with the post-crisis dummy is positive and significant. This likelihood increases additionally with the income of households, as the triple interaction of age, post-crisis dummy and income is positive and significant.

Table 4 shows the results of the estimation of the logit model (1) for having mortgage credit. This estimation uses only the sample of homeowners. The result show that the effect of the interaction of age with the post-crisis dummy is negative and significant. That is, post-crisis the likelihood of having mortgage debt decreases even more with age.

Table 5 shows the results of the estimation of (2), using the sample of homeowners. The negative and significant coefficient of the age main effect shows that, the lower the age, the higher the intensive margin of mortgage debt. The interaction term of age with the post-crisis dummy, and the triple interaction of age, post-crisis dummy and income are negative and significant. Post-crisis the intensive margin of mortgage debt decreases even more with age, and even more with income.

Lastly, Table 6 shows the results of the estimation of (3), using the sample of homeowners. The interaction term of age with the CD rate, and the triple interaction of age, CD rate and income are positive and significant. As CD rates drop, so does the intensive margin of mortgage debt by age, and by age and income. The previous results are robust to alternative specifications and controls.

4 Empirical analysis of potential causes

In this section, we run cross-country panel regressions to study what explains the changes in HOR documented above. We focus on three theories:

1) Income variables. The theory is that drops in income may explain the drop in HOR. The endemic low growth of the economy might be driving the results. In particular, the recovery after the crisis is not effective for the young households. Figures A1 and A2 plot the income data from EU-SILC for the countries in the sample.

2) Credit variables that we proxy with loans to households. The theory is that tighter credit access may explain the drop in HOR. Figures A3 and A4 report the credit data from EU-SILC. The data from EU-SILC report homeowners with mortgage from 2010 onwards. The drop in mortgage credit for younger households is dramatic in countries as Spain.

3) Portfolio variables. Specifically, we capture the "search for yield" motive of housing investors. These investors, once safe asset returns (that we proxy with the yield of government bonds) fall, then see housing as an interesting asset. Investors buying housing causes a crowding out effect and leads to lower HOR.

Table 7 contains the results from a cross-sectional regression for the sample of EU countries. It shows that the three theories outlined above are operating in Europe. Including country and year fixed effects or controlling for demographics do not alter the results.

5 Baseline model

We now analyze a dynamic, incomplete markets model of household consumption and housing investment. Households have finite lives and face uninsurable idiosyncratic labor income, and aggregate labor productivity, house value, and rent risk. The main distinguishing feature of the model is that households can trade houses both for housing services and for investment purposes. Both types of housing are subject to adjustment costs that give rise to housing illiquidity, and households can borrow against the value of their houses.

The formal recursive formulation of the household problem is contained in Section 5.6.

5.1 Demographics

Time is discrete and denoted by t. The economy is composed by a constant-population continuum of finitely lived households, each living for J periods. Households work during the first J_w periods, and are retired for the next J_r periods. Age is indexed by $j = 1, ..., J$.

5.2 Preferences

Households have preferences over non-housing consumption c and housing services s.[1] The per-period utility is $u(c, s)$. Preferences are time-separable and the future is discounted at rate β. The expected lifetime utility of a household born at time t is given by

$$\mathbb{E}_t \left[\sum_{j=1}^{J} \beta^{j-1} u(c_j, s_j) + \beta^J \upsilon(w_{J+1}) \right]. \tag{4}$$

where the expectation is taken over sequences of aggregate and idiosyncratic shocks, which we describe below. The utility from leaving bequests $w > 0$ is given by $\upsilon(w)$.

Households can obtain housing services by renting or owning a house. Moreover, there is an ownership utility benefit. That is, renting a house of size h generates a service flow of $s = h$, while owning a house of size h generates a service flow of $s = (1 + \chi)h$, where $\chi > 0$ captures the motives towards ownership beyond those explicitly modeled.

We assume a CRRA per-period utility function over a CES aggregator for non-housing consumption and housing services

$$u(c, s) = \frac{\left[(1-\eta)c^{1-\gamma} + \eta s^{1-\gamma}\right]^{\frac{1-\sigma}{1-\gamma}} - 1}{1-\sigma}, \tag{5}$$

where the parameters σ, γ, and η are the inverse of the intertemporal elasticity of substitution, the inverse of the intratemporal elasticity of substitution between non-housing consumption and housing services, and the share of housing services in total consumption, respectively.

The bequest function is given by

$$\upsilon(w) = \nu \frac{w^{1-\sigma} - 1}{1-\sigma}, \tag{6}$$

[1] We follow the common notation that aggregate variables have the time t subscript, while the state and decision variables in the household recursive problems do not. For the sake of simplicity, we also omit the dependence of variables on age j except where this omission may be misleading.

where the parameter ν measures the strength of the bequest motive.

5.3 Endowments

Working-age households receive an exogenous idiosyncratic labor income endowment y_j^w given by

$$\log y_j^w = \psi_j + z_j, \tag{7}$$

where ψ_j is a deterministic age-dependent parameter that is common to all households, and z_j is an idiosyncratic shock that follows an AR(1) process: $z_j = \rho_z z_{j-1} + \omega_j$. Income for retirees is given by a social security benefit $y^r = \rho_s y_{J_w}^w$, where ρ_s is the replacement rate and $y_{J_w}^w$ is labor income in the last working period, which proxies for heterogeneity in lifetime earnings. Thus, we abstract from uncertainty in pension income. We adopt the notation y_j for income, such that $y_j = y_j^w$ if $j \leq J_w$, and $y_j = y^r$ otherwise.

5.4 Housing

Households can obtain housing services by owning or renting a house. The housing price per unit is p_t^h, which follows an exogenous AR(1) process: $\log p_t = (1-\rho_p)\mu_p + \rho_p \log p_{t-1} + \varepsilon_t$. Thus, buying a house of size h' costs $p_t^h h'$ units of the numeraire good. There is a minimum house size given by $\underline{h}$. There are adjustment (or transaction) costs of trading houses. In particular, if a household decides to sell a house of size h, it has to pay a proportion ζ of the value of the house sold, that is, $\zeta p_t^h h$. These transaction costs, along with other frictions that we will introduce below, give rise to housing illiquidity, which makes homeowners to adjust their house size (by moving out) infrequently, like in the data. Houses depreciate at rate δ. Households are required to cover per-period maintenance costs, which fully offset the physical depreciation of the house, $\delta p_t^h h$.

In contrast to owner-occupier housing, rental housing can be adjusted without any transaction costs but cannot be used as collateral. The rental price per unit is p_t^r, which also follows an exogenous AR(1) process: $\log p_t^r = (1-\rho_r)\mu_r + \rho_r \log p_{t-1}^r + \epsilon_t$. We allow the shocks to house prices ε_t to be correlated with the shocks to rental prices ϵ_t. Renting a house of size s costs $p_t^r s$ units of the numeraire good. Tenants must pay rent in each period.

Homeowners can also become landlords by purchasing a second house for rental. We assume that the price of investment houses is equal to that of owner-occupied houses. Thus, buying an investment house of size $\tilde{h}'$ costs $p_t^h \tilde{h}'$ units of the numeraire good. Investment houses are also

subject to the adjustment cost ζ and depreciation rate δ. There is a minimum investment house $\underline{\tilde{h}}$, which we allow to be be different from that of owner-occupied houses, in order to match the life-cycle profiles of investment housing in the data. Landlords that have an investment house of size $\tilde{h}$ receive per-period rental income of $p_t^r \tilde{h}'$. Households cannot be renters and landlords simultaneously. However, a household that enters the period as a renter can become a landlord in the current period if it also purchases an owner-occupier house.

5.5 Liquid Savings and mortgages

Households can invest in one-period bonds b'. This asset is perfectly liquid and pays a constant real risk-free interest rate r_f between time t and $t+1$.

In addition to providing housing services and serving as investment instruments, owner-occupied and investment housing can be used as collateral for borrowing. In particular, households can borrow the amount m' subject to an exogenous loan-to-value (LTV) cap θ

$$m' \leq \theta p_t^h (h + \tilde{h}), \tag{8}$$

thus, the maximum amount that a household can borrow is a fraction θ of the combined current value of housing holdings. Our model captures the fact that, in reality, mortgages are long-term amortizing loans and the LTV constraint only holds at origination. Households that adjust owner-occupier or investment housing have to prepay the mortgage and take a new loan subject to (8), if any. Non-adjusting households also have the option to refinance subject to (8), which involves a refinancing cost equal to a proportion f of the outstanding mortgage debt. However, non-adjusting households also have the option of keeping the mortgage, subject to

$$m' \leq \lambda m, \tag{9}$$

where λ is the minimum amortization rate. The mortgage interest rate is constant and given by r_m. Thus, when not refinancing, non-adjusting households have to make a minimum payment equal to $(1-\lambda)m + r_m m$, but can also prepay costlessly. Unsecured borrowing is not allowed.

5.6 Household Decision Problems

Here we formalize the household decision problems in recursive form. Let $\Omega = (p^h, p^r)$ summarize the aggregate state. A household enters the period with states $(h, \tilde{h}, m, b, z, \Omega)$. Households with $h = 0$ enter the period as renters. The value function of a household of age j

at the start of the period is $V_j(h, \tilde{h}, m, b, z, \Omega)$. Households choose between: (i) adjusting both owner-occupier and investment housing, (ii) adjusting only investment housing, (iii) adjusting only owner-occupier housing, (iv) not adjusting any house, (v) refinancing, and (vi) renting

$$V_j(h, \tilde{h}, m, b, z, \Omega) = \max \left\{ J_j^{AA}(\cdot), J_j^{NA}(\cdot), J_j^{AN}(\cdot), J_j^{NN}(\cdot), J_j^{F}(\cdot), J_j^{R}(\cdot) \right\}. \tag{10}$$

The value function for a household that adjusts owner-occupier and investment housing is

$$J_j^{AA}(h, \tilde{h}, m, b, z, \Omega) = \max_{c, h', \tilde{h}', m', b'} \left\{ u(c, h') + \beta \mathbb{E}_{z,\Omega} \left[V_{j+1}(h', \tilde{h}', m', b', z', \Omega') \right] \right\} \quad \text{s.t.} \tag{11}$$

$$c + p^h(h' + \tilde{h}') + \delta p^h(h + \tilde{h}) + (1 + r_m)m + b' = y_j(z) + (1 - \zeta)p^h(h + \tilde{h}) + p^r \tilde{h}' + m' + (1 + r_f)b,$$

$$m' \leq \theta p^h(h' + \tilde{h}').$$

The value function of a household that adjusts only its investment housing is

$$J_j^{NA}(h, \tilde{h}, m, b, z, \Omega) = \max_{c, \tilde{h}', m', b'} \left\{ u(c, h) + \beta \mathbb{E}_{z,\Omega} \left[V_{j+1}(h, \tilde{h}', m', b', z', \Omega') \right] \right\} \quad \text{s.t.} \tag{12}$$

$$c + p^h \tilde{h}' + \delta p^h(h + \tilde{h}) + (1 + r_m)m + b' = y_j(z) + (1 - \zeta)p^h \tilde{h} + p^r \tilde{h}' + m' + (1 + r_f)b,$$

$$m' \leq \theta p^h(h + \tilde{h}').$$

The value function of a household that only adjusts owner-occupied housing is

$$J_j^{AN}(h, \tilde{h}, m, b, z, \Omega) = \max_{c, h', m', b'} \left\{ u(c, h') + \beta \mathbb{E}_{z,\Omega} \left[V_{j+1}(h', \tilde{h}, m', b', z', \Omega') \right] \right\} \quad \text{s.t.} \tag{13}$$

$$c + p^h h' + \delta p^h(h + \tilde{h}) + (1 + r_m)m + b' = y_j(z) + (1 - \zeta)p^h h + p^r \tilde{h} + m' + (1 + r_f)b,$$

$$m' \leq \theta p^h(h' + \tilde{h}).$$

The value function of a household that does not adjust any housing is

$$J_j^{NN}(h, \tilde{h}, m, b, z, \Omega) = \max_{c, m', b'} \left\{ u(c, h) + \beta \mathbb{E}_{z,\Omega} \left[V_{j+1}(h, \tilde{h}, m', b', z', \Omega') \right] \right\} \quad \text{s.t.} \tag{14}$$

$$c + \delta p^h(h + \tilde{h}) + (1 + r_m)m + b' = y_j(z) + p^r \tilde{h} + m' + (1 + r_f)b,$$

$$m' \leq \lambda m.$$

The value function of a household that refinances $J_j^F(\cdot)$ is identical to $J_j^{NN}(\cdot)$ but with the constraint (8) instead of (9) and the refinancing cost equal to fm entering the budget constraint.

Finally, the value function of a household that chooses to rent is

$$J_j^R(h,\tilde{h},m,b,z,\Omega) = \max_{c,s,b'} \left\{ u(c,s) + \beta \mathbb{E}_{z,\Omega}\left[V_{j+1}(0,0,0,b',z',\Omega')\right] \right\} \quad \text{s.t.} \tag{15}$$
$$c + p^r s + \delta p^h(h+\tilde{h}) + (1+r_m)m + b' = y_j(z) + (1-\zeta)p^h(h+\tilde{h}) + (1+r_f)b.$$

Note that if the household enters the period as a renter ($h = 0$), then the options of not adjusting owner-occupier housing (that is, $J_j^{NA}(\cdot)$, $J_j^{NN}(\cdot)$, and $J_j^F(\cdot)$) are not feasible. Moreover, in the last period of life ($j = J$) the continuation value is given by the bequest motive. The bequest left in $J+1$ is given by $w = (1-\zeta-\delta)p^h(h+\tilde{h}) + (1+r_f)m$, and we assume that in $j = J$ the household repays any outstanding mortgage debt. Also note that the refinancing cost implies that a non-adjusting household will refinance only when it wants to increase its debt.

6 Model results

Figure 7 shows the life-cycle profiles of homeownership, share of landlords, and average share of investment housing in the portfolio, for different levels of: (i) the unconditional mean rent, which proxies for the "search for yield" motive, (ii) the mortgage interest rate and loan-to-value limit, which proxy for credit conditions, and (iii) the mean income for households with age less or equal to 50 years. In all experiments, we compute the life-cycle profiles at the corresponding stochastic steady states.[2] Our quantitative model generates strong life-cycle effects that are consistent with the empirical findings. Panel (a) shows that the homeownership rate increases with age, but that it reaches a plateau as households retire from work (when they turn 60 years old), like in the data. Panel (a) also reveals that households respond to higher average rents by becoming homeowners. Panel (b) shows that higher rents, which increase the rental yield spread[3] and the "search for yield" motive, dramatically raises the share of landlords. Moreover, panel (c) reveals that households rebalance their portfolios away from risk-free bonds towards housing investment. Therefore, as the rental yield spread increases, not only are there more older households becoming landlords, but their exposure to housing risk also increases.

Panels (d), (e), and (f) examine the effect of changes in lending conditions. Tighter credit reduces the homeowership rate, the share of landlords, and the average share of investment housing in the portfolio. Panels (g), (h), and (i) show the effect of changes in the mean labor income for households younger than 50 years. Lower labor income prospects drastically reduce

[2] One implication is that changes that directly affect young households (like a reduction in credit availability or labor income prospects when young) will have an impact on older households in the long run.

[3] Yield-to-maturity of housing investment (assuming a holding period of 10 years) minus the risk-free rate.

the homeownership rate, particularly for younger households, as they need to save more for the downpayment. Lower labor income also reduces housing investment.

Figure 8(a) examines the impact that different levels of house price and rent risk have on the average share of investing housing in the portfolio by age. As risk increases, households reduce the exposure to investment housing. This result has strong life-cycle effects: investment in housing by retirees is the most sensitive to changes in housing risk, while that of young households is the least sensitive. Panel (a) also shows that our quantitative model is consistent with the empirical finding that the share of households with multiple properties increases with age and then declines at the end of life. Figure 8(b) reveals that the average share of investing housing in the portfolio among retirees increases with the rental yield spread.

7 Implications and conclusions

The novel results of this paper have important implications for the economy, policymakers, Central Banks, and for the banking industry. Here we highlight four implications:

First, banks may face more difficulty to generate lending revenue. Traditionally the main borrowers from banks have been the young households buying their homes. Decreased demand from young households means that banks face a decrease in their income from lending.

Second, banks may face problems to raise deposits or sell financial products to elder households. Elder households buy increasingly more real estate and have much greater scope to invest in real estate. Rental yields from their additional properties replace the income from more traditional investments. Demand for financial products drops as well as deposits.

Third, leverage is increasing among those households borrowing. As the loan-to-value and loan-to-income indicators increase, so is the default risk of the loans. To the extent that banks are taking on higher default risk, this puts at risk the financial stability of the banking industry.

Finally, from a macroprudential point of view, the transmission channel of monetary policy may change. Garriga, Kydland and Šustek (2017) describe two channels through which monetary policy can affect housing investment and the economy. The transmission mechanisms work through the cost of new mortgage borrowing and real payments on outstanding debt. The authors find that persistent monetary policy shocks affecting the level of the nominal yield curve have large real effects. In this new economic reality, the young households are renters. Renters are not sensitive to interest rates as young homeowners are. For example, changes to interest rates do not affect the consumption of young households who do not have a mortgage.

This makes the transmission channels of monetary policy less effective.

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Figures

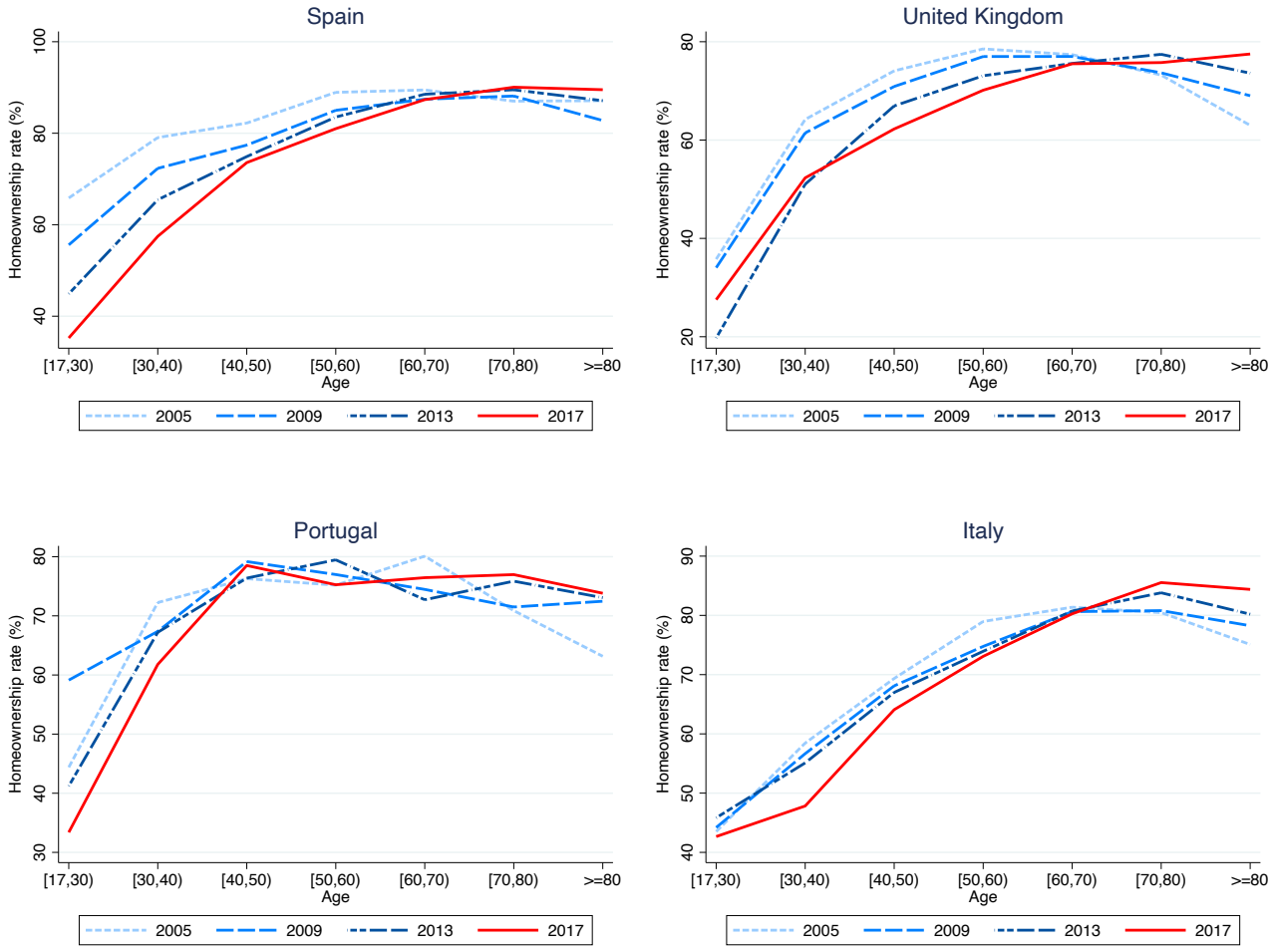

Figure 1: **Homeownership by age over time. Countries with large changes.** Source: EU-SILC and authors' calculations using the survey waves 2005, 2009, 2013 and 2017.

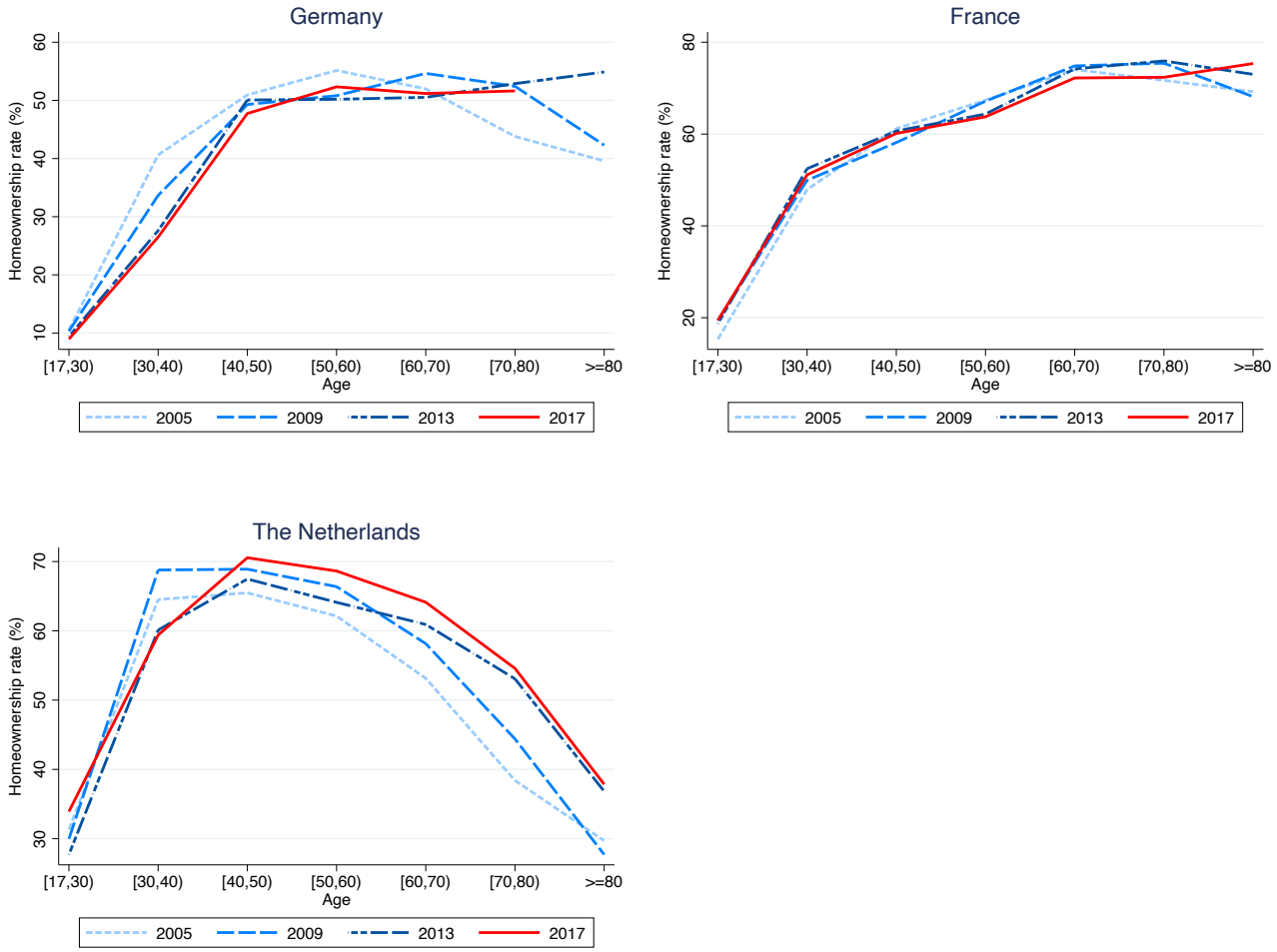

Figure 2: **Homeownership by age over time. Countries with large changes.** Source: EU-SILC and authors' calculations using the survey waves 2005, 2009, 2013 and 2017.

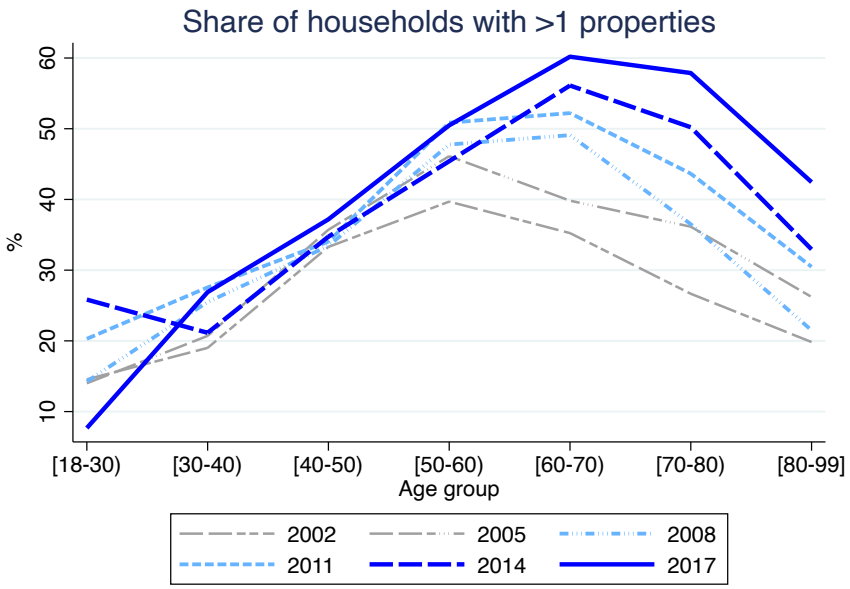

Figure 3: **Households owning multiple properties. Share by age groups.** The figure plots the share of households in Spain by age group who own additional properties, apart from their main residence, for the survey waves 2002 to 2017. Source: Spanish Survey of Household Finances.

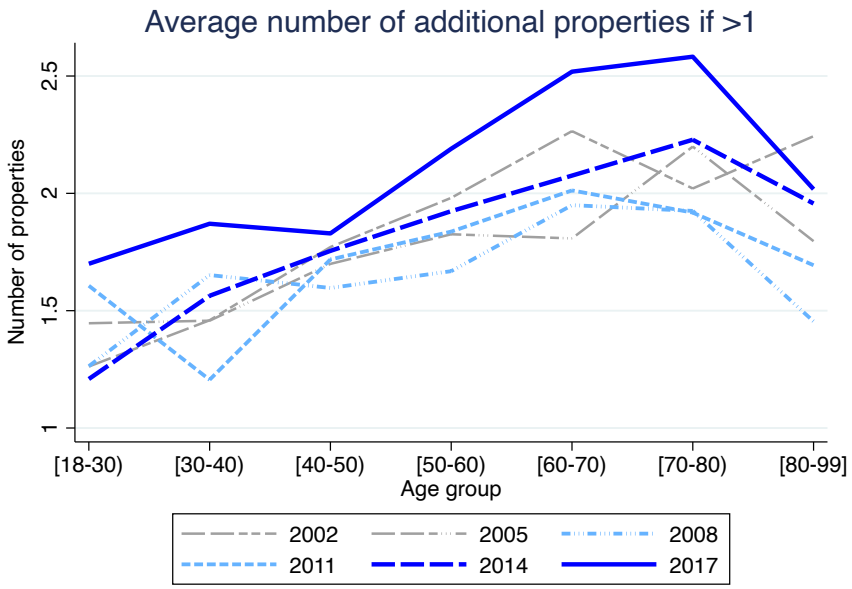

Figure 4: **Number of properties in addition to main residence by age, conditional on owning more than the main residence.** The figure plots the average number of properties in addition to the main residence each household in Spain owns, conditional on owning more than their main residence, in each age group, for the survey waves 2002 to 2017. Source: Spanish Survey of Household Finances.

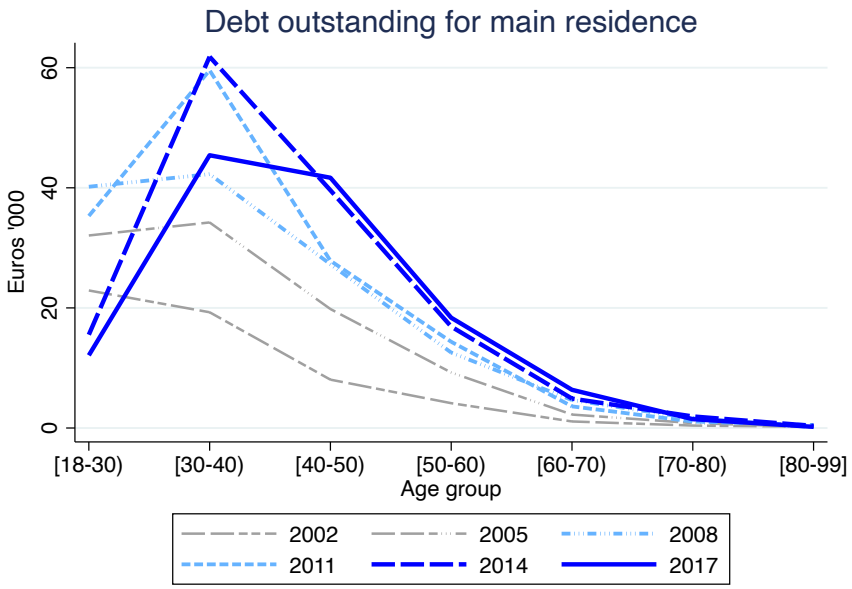

Figure 5: **Debt outstanding for main residence of each household in Spain by age.** The figure plots the average amount of the debt outstanding for the main residence of households by age group, for the survey waves 2002 to 2017. Source: Spanish Survey of Household Finances.

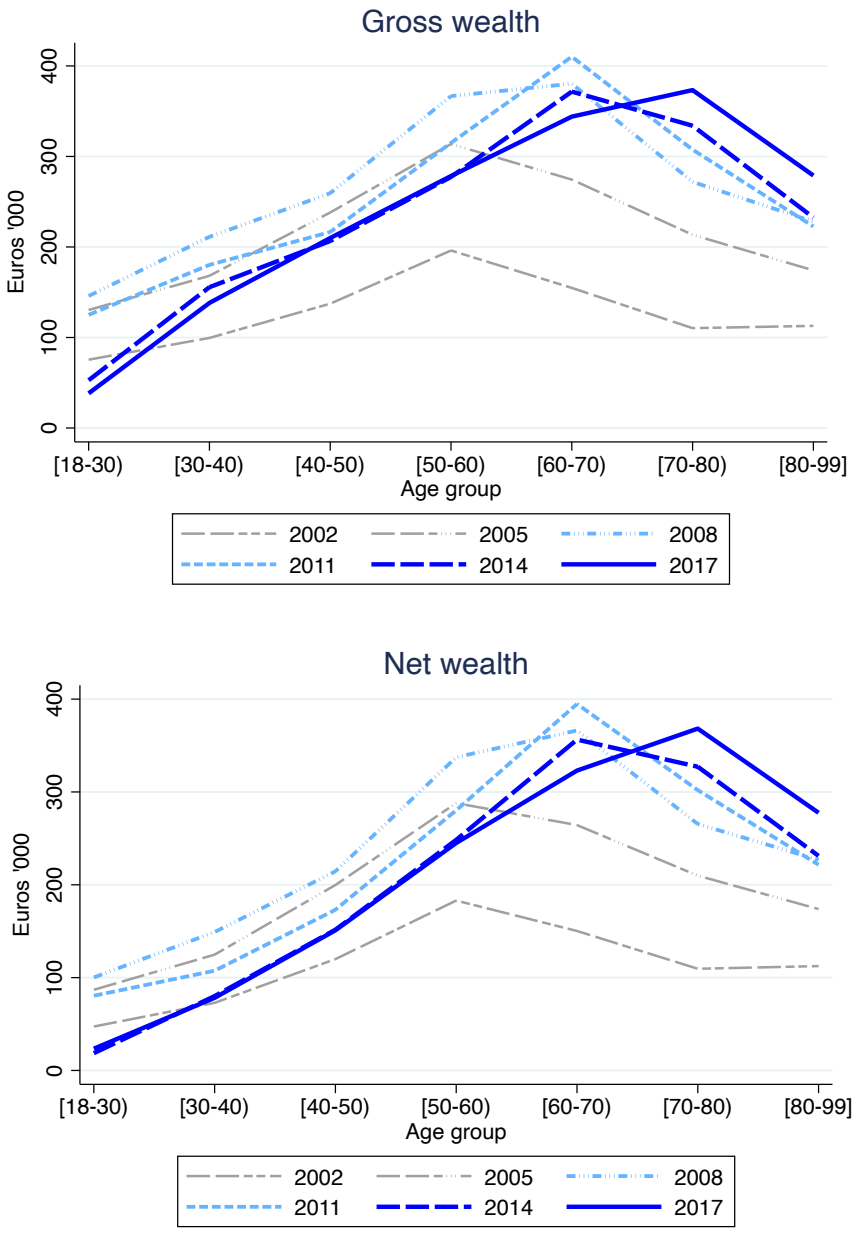

Figure 6: **Gross and net wealth of households in Spain by age.** The top figure plots the average gross wealth amount and the bottom figure the average net wealth amount of households by age group, for the survey waves 2002 to 2017. Source: Spanish Survey of Household Finances.

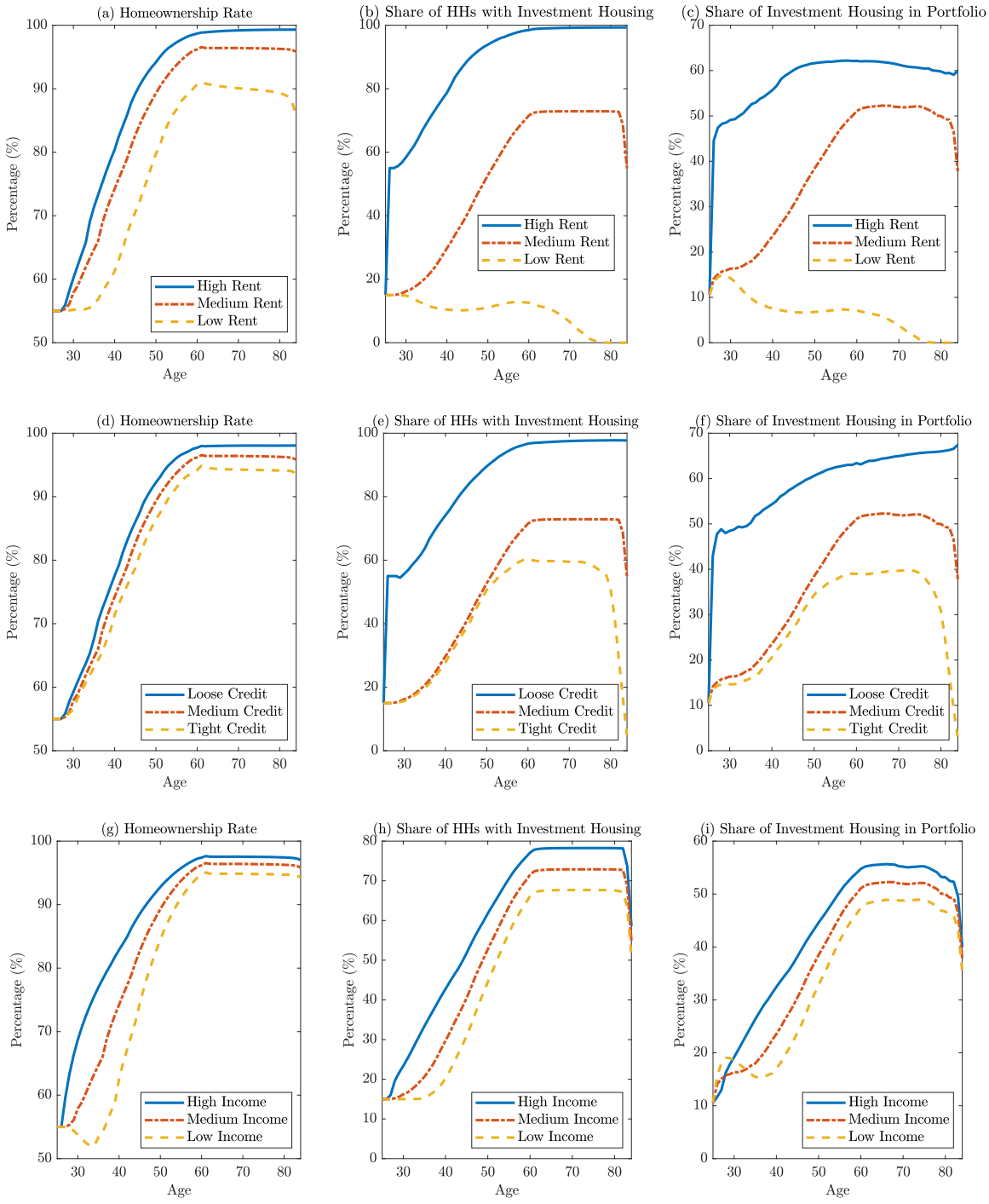

Figure 7: **Drivers of Homeownership and Investment Housing over the Life-cyle.** The panels compare the life-cycle profiles of homeownership, share of households with investment housing, and average share of investment housing in the portfolio, for different levels of: (i) unconditional mean rent (which proxies for the "search for yield" motive), (ii) mortgage interest rate and loan-to-value limit, (iii) mean income for households with age less or equal to 50 years.

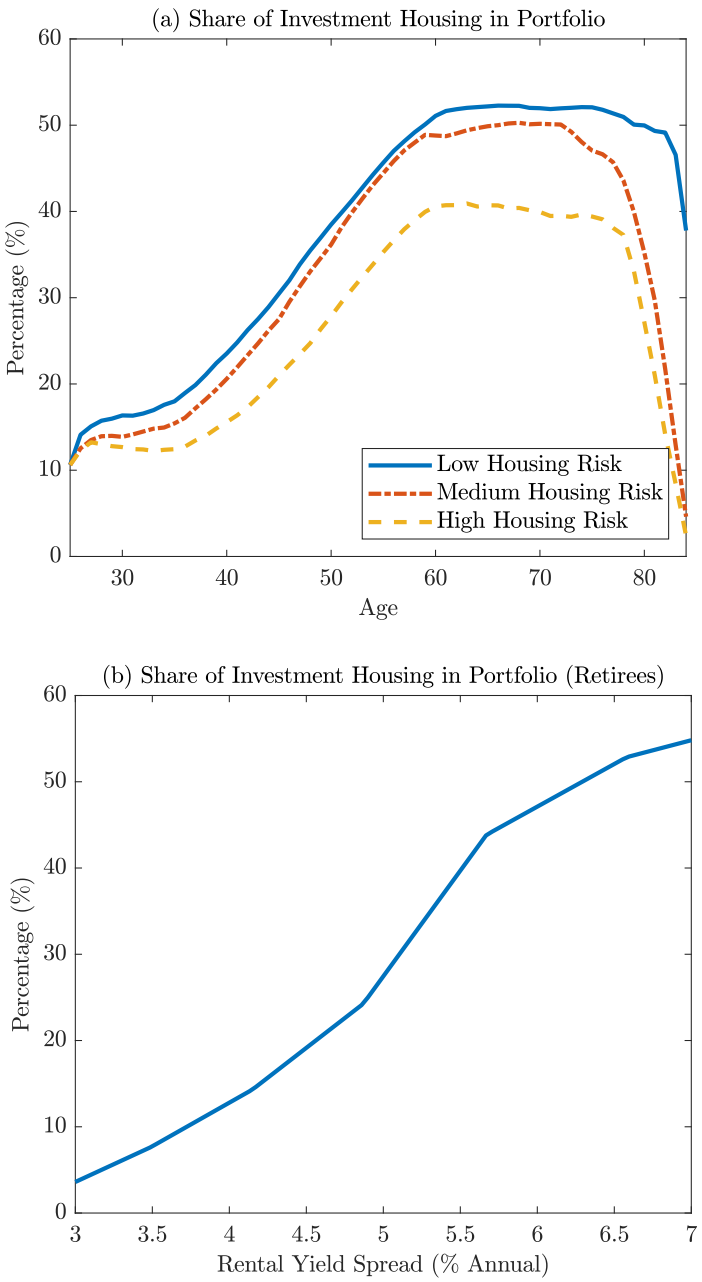

Figure 8: **Share of Investment Housing in Portfolio.** Panel (a) plots the average share of investing housing in the portfolio (that is, owner-occupied housing, investment housing, and bond holdings). We compute the average share among households with positive portfolio positions, conditional by age, and for different levels of house price and rent risk. Panel (b) plots the average share of investment housing among retirees (households with age greater or equal to 60 years) against the rental yield spread, which we define as the yield-to-maturity of housing investment (assuming a holding period of 10 years) minus the risk-free rate.

Tables

Table 1. Summary statistics

	Mean	SD	P1	P99
Age	59.25	15.36	26	86
Homeownership rate	0.86	0.35	0	1
Share of households who own additional properties	0.51	0.50	0	1
Number of additional properties	1.28	2.91	0	11
Share of households with debt for main residence	0.18	0.38	0	1
Share of households with debt for other properties	0.09	0.29	0	1
Outstanding debt for main residence ('000 Euros)	14.98	56.33	0	220.00
Outstanding debt for other properties ('000 Euros)	16.55	242.18	0	260.38
Annual income ('000 Euros)	56.35	148.10	2.46	420.35

Number of observations: 29,528. The sample consists of all households in all triennial survey waves, from 2002 to 2014. All Euro values are inflation adjusted to the equivalent of 2014 Euros. P1 means the first percentile, and P99 the 99th percentile of each distribution.

Table 2. A typical household balance sheet

Assets	**Liabilities**
Primary residence	Mortgage debt
Other real estate	Consumer debt
Deposits	
Stocks	
Other financial assets	

Number of observations: 29,528. The sample consists of all households in all triennial survey waves, from 2002 to 2014. All Euro values are inflation adjusted to the equivalent of 2014 Euros. P1 means the first percentile, and P99 the 99th percentile of each distribution.

Table 3. Probability of owning multiple properties

	Own properties in addition to main residence			
Age	0.025***	0.025***	0.012***	0.012***
	(0.001)	(0.001)	(0.002)	(0.002)
Age × Post-crisis	0.005***	0.005***	0.001	0.001
	(0.002)	(0.002)	(0.003)	(0.003)
Age × Post-crisis × Income			0.0003***	0.0003***
			(0.0001)	(0.0001)
Post-crisis	0.070	0.315***	0.027	0.280*
	(0.105)	(0.110)	(0.162)	(0.165)
Income	0.021***	0.021***	-0.001	-0.001
	(0.0004)	(0.0004)	(0.002)	(0.002)
Dummies for survey waves	No	Yes	No	Yes
Observations	29,528	29,528	29,528	29,528

Standard errors are in parentheses. Post crisis years include the survey waves 2011 and 2014, while pre-crisis the waves 2002, 2005 and 2008. Each observation is a household. ***sig. at 1%; **sig. at 5%. Source: Spanish Survey of Household Finances.

Table 4. Probability of outstanding mortgage from main residence: Homeowners.

	Have outstanding debt from main residence			
Age	-0.099***	-0.100***	-0.100***	-0.101***
	(0.002)	(0.002)	(0.002)	(0.002)
Age × Post-crisis	-0.017***	-0.015***	-0.015***	-0.015***
	(0.003)	(0.003)	(0.004)	(0.004)
Age × Post-crisis × Income			-0.00002	0.00002
			(0.00003)	(0.00003)
Post-crisis	1.232***	1.604***	1.165***	1.556***
	(0.172)	(0.178)	(0.191)	(0.196)
Income	-0.0002	-0.0001	-0.002	-0.001
	(0.0002)	(0.0001)	(0.001)	(0.001)
Dummies for survey waves	No	Yes	No	Yes
Observations	29,528	29,528	29,528	29,528

Standard errors are in parentheses. The sample includes only the households who are homeowners. Post crisis years include the survey waves 2011 and 2014, while pre-crisis the waves 2002, 2005 and 2008. Each observation is a household. ***sig. at 1%. Source: Spanish Survey of Household Finances.

Table 5. Value of outstanding debt from main residence: Homeowners

	Outstanding debt of homeowners from main residence			
Age	-1.068***	-1.075***	-0.998***	-1.003***
	(0.031)	(0.031)	(0.035)	(0.035)
Age × Post-crisis	-0.548***	-0.540***	-0.449***	-0.443***
	(0.050)	(0.050)	(0.054)	(0.054)
Age × Post-crisis × Income			-0.002***	-0.002***
			(0.0004)	(0.0004)
Post-crisis	40.237***	44.651***	34.289***	39.024***
	(3.096)	(3.211)	(3.402)	(3.508)
Income	0.009***	0.009***	0.099***	0.103***
	(0.002)	(0.002)	(0.021)	(0.021)
Dummies for survey waves	No	Yes	No	Yes
Observations	25,318	25,318	25,318	25,318

Standard errors are in parentheses. The sample includes only the households who are homeowners. Post crisis years include the survey waves 2011 and 2014, while pre-crisis the waves 2002, 2005 and 2008. Each observation is a household. ***sig. at 1%. Source: Spanish Survey of Household Finances.

Table 6. Value of outstanding debt from main residence: Effects of CD rate

	Outstanding debt of homeowners from main residence			
Age × CD rate	0.171***	0.168***	0.028	0.022
	(0.028)	(0.028)	(0.032)	(0.032)
Age × CD rate × Income			0.003***	0.003***
			(0.0003)	(0.0003)
Age	-1.657***	-1.663***	-1.193***	-1.189***
	(0.066)	(0.066)	(0.078)	(0.078)
CD rate	-13.186***	-11.857***	-3.090	-1.229
	(1.732)	(1.868)	(2.041)	(2.169)
Income	0.008***	0.009***	0.698***	0.716***
	(0.002)	(0.002)	(0.060)	(0.060)
Dummies for survey waves	No	Yes	No	Yes
Observations	25,318	25,318	25,318	25,318

Standard errors are in parentheses. The sample includes only the households who are homeowners. Each observation is a household. The certificate of deposits (CD) rate from Spain comes from the World Bank. ***sig. at 1%; **sig. at 5%. Source: Spanish Survey of Household Finances.

Table 7. Cross-country analysis of drivers of homeownership

	Homeownership rate change				
Household debt	0.249***	0.303***			
	(0.085)	(0.114)			
Income growth			0.026***	0.030***	
			(0.008)	(0.009)	
Government bond rate change					0.089**
					(0.044)
Economic controls	Yes	Yes	Yes	Yes	Yes
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects		Yes		Yes	
Observations	229	229	364	364	317
Number of countries	25	25	30	30	26

Standard errors are in parentheses. This table shows factors that are related to the change in homeownership rates in European countries. The household loans are the log value of the total household loans in a country-year. Income is the net household income. Government bonds are 10-year bonds. Economic controls are the unemployment rate change and population growth. All independent variables and controls are lagged for one year. The sample consist of European countries for the years 2008 to 2020. Source: EU-SILC.

NOT FOR PUBLICATION
ONLINE APPENDIX

A Figures for the Appendix

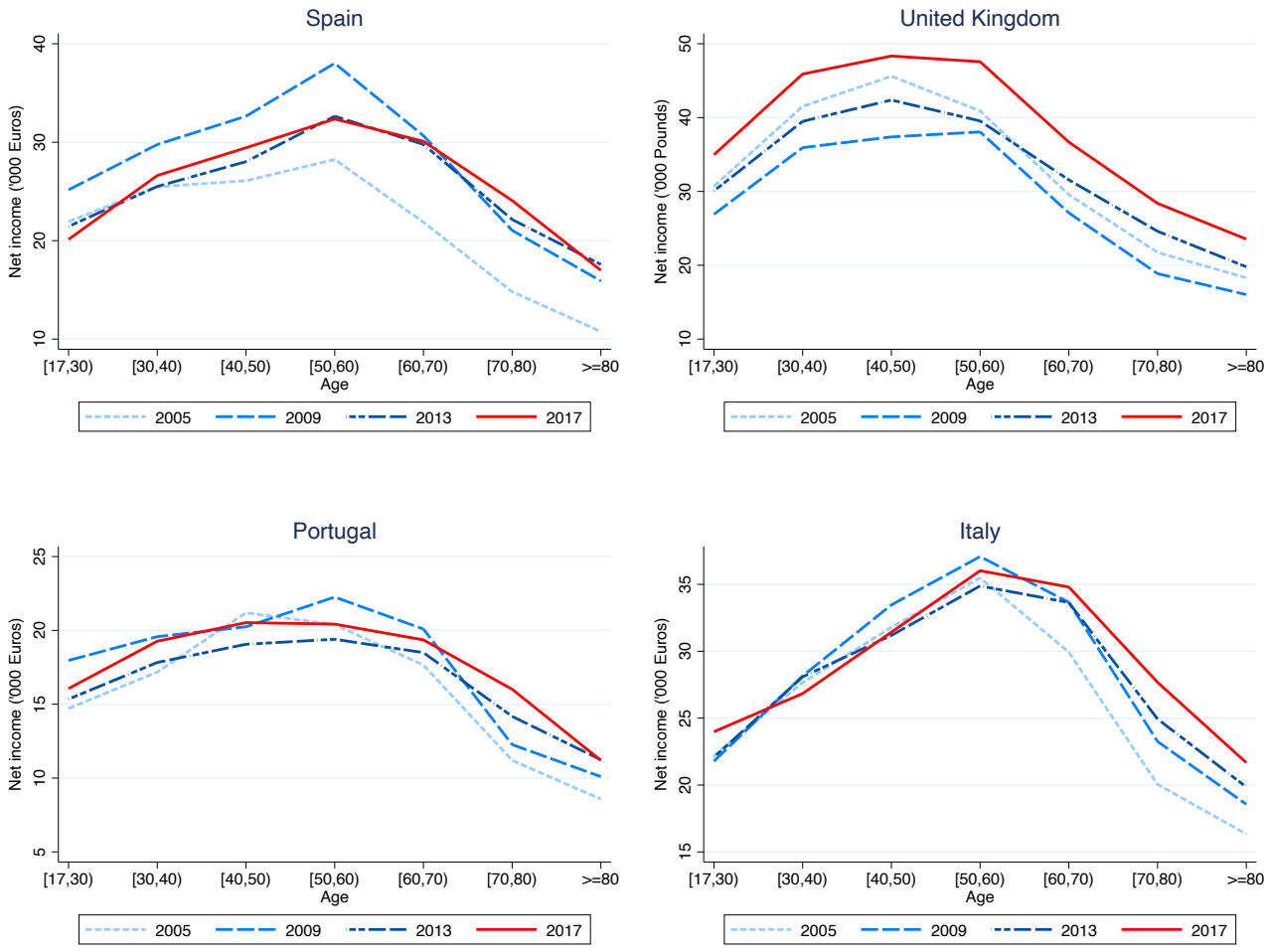

Figure A1: **Income by age in countries with large age inequality of homeownership.** Source: EU-SILC and authors' calculations using the survey waves 2005, 2009, 2013 and 2017.

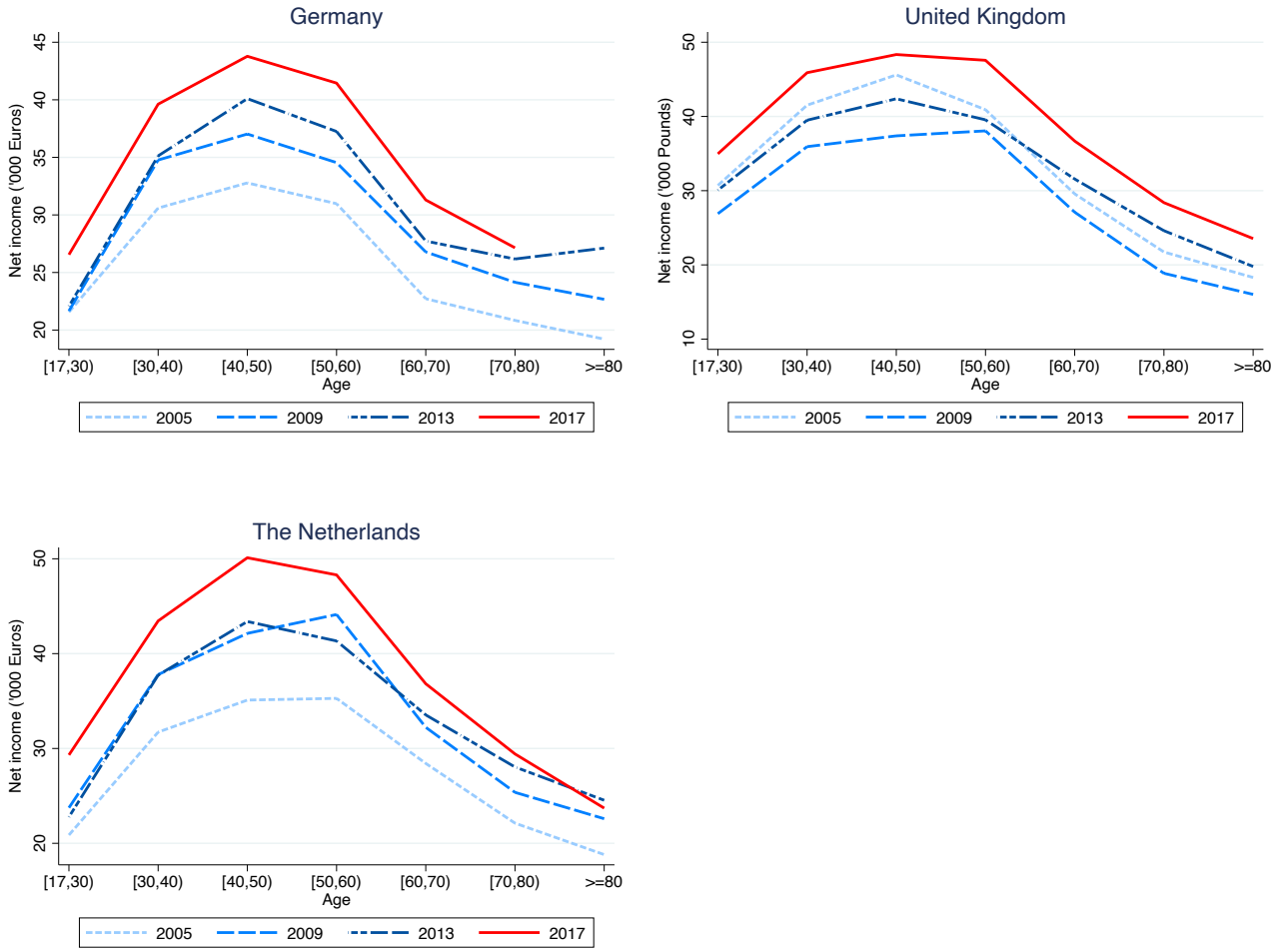

Figure A2: **Income by age in other countries.** Source: EU-SILC and authors' calculations using the survey waves 2005, 2009, 2013 and 2017.

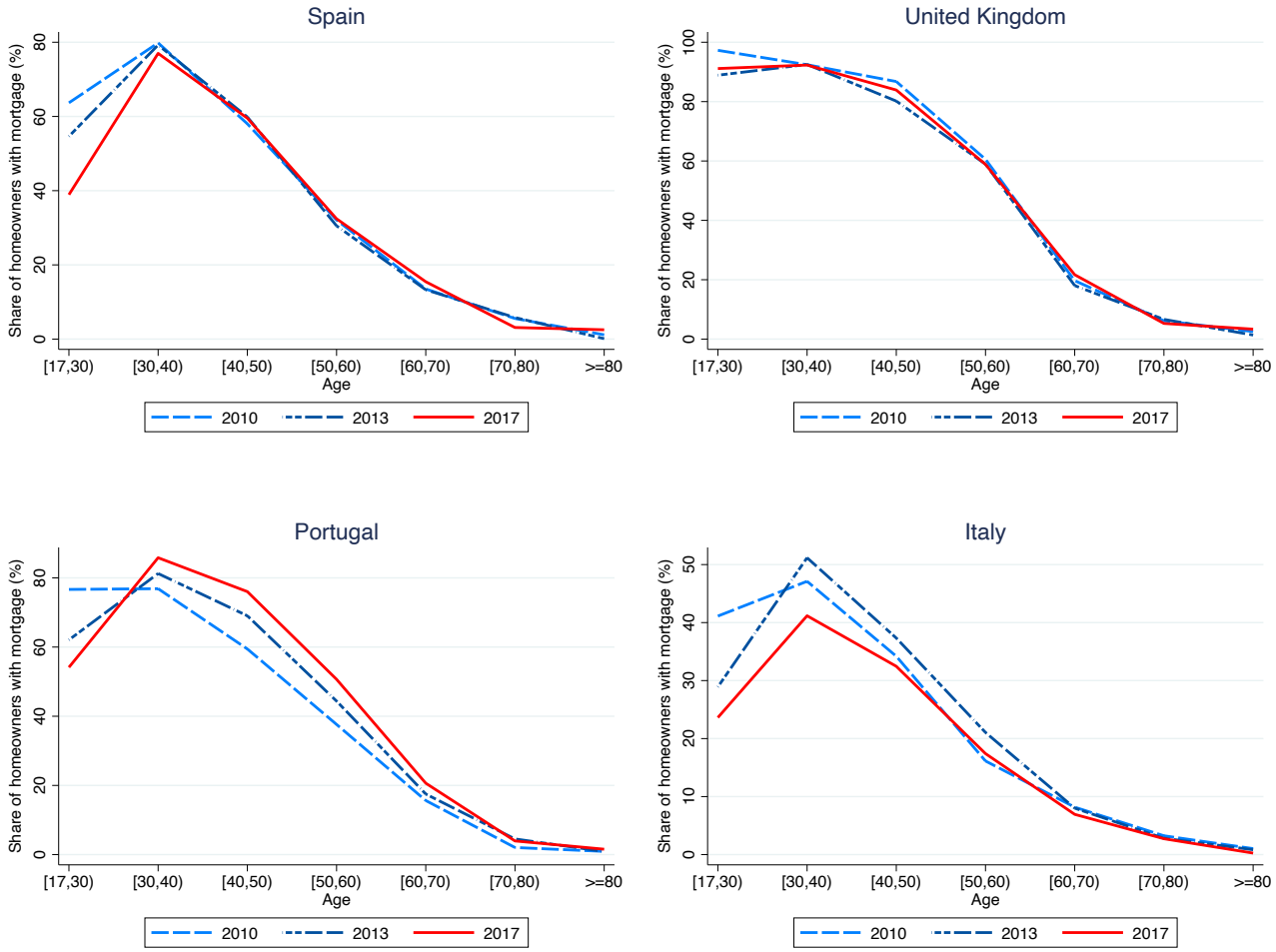

Figure A3: **Share of homeowners with mortgages by age in countries with large age inequality of homeownership.** Source: EU-SILC and authors' calculations using the survey waves 2010, 2013 and 2017.

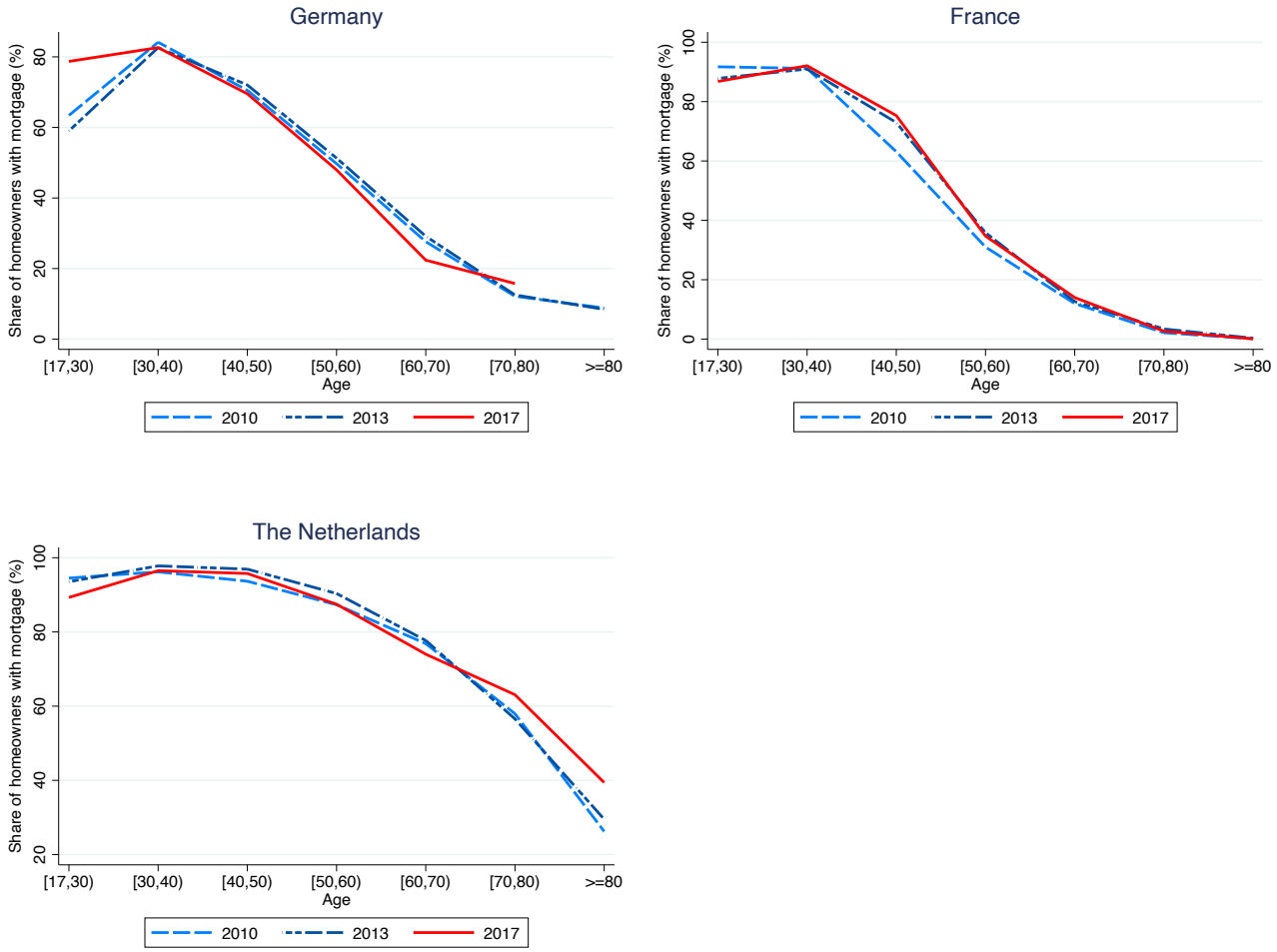

Figure A4: **Share of homeowners with mortgages by age in other countries.** Source: EU-SILC and authors' calculations using the survey waves 2010, 2013 and 2017.