Rental Markets and Wealth Inequality in the Euro Area

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Abstract

Wealth inequality and aggregate homeownership are negatively correlated across the Euro area. We explain this within a quantitative overlapping generations model, where households consume food and shelter and make portfolio decisions. Households purchase real estate for consumption purposes or rent it out to other households on the private rental market. A reduced form wedge – correlated with empirical measures of rent control – governs rental market efficiency. Rental market efficiency is crucial in explaining cross-country variation in aggregate homeownership. Wealth inequality, however, is mainly driven by mortgage market characteristics, most importantly an interest rate spread between deposits and mortgages.

JEL Classification: C68, D91, E21, R21

Keywords: housing investment, wealth inequality, OLG model, fixed costs

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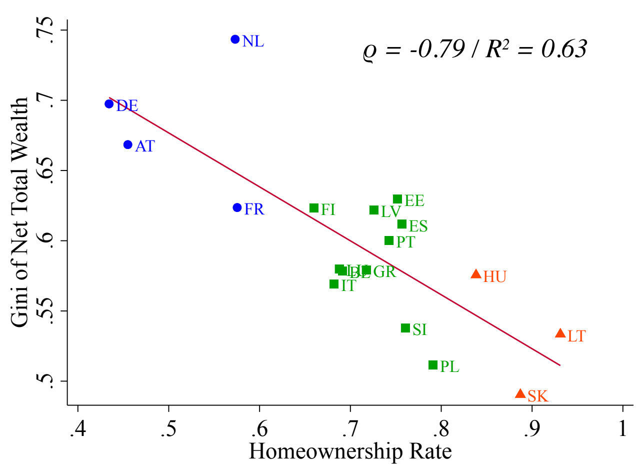
1 Introduction

Why are some households wealthier than others? And how much should we care about wealth inequality? As a buzzword, "inequality" is in high demand. Ever since Thomas Piketty's "Capital in the Twenty-First Century" climbed to the top of the New York Times Best Seller list, numerous studies have analyzed the sources and consequences of wealth inequality for both individuals and the economy at large.[1] Whether economists should view wealth inequality as a central problem largely depends on the underlying mechanisms. Is wealth inequality merely a byproduct of the labor earnings process? Is it driven by varying rates of return on investments? Or is it the result of wealth being passed down through generations? In this paper, we argue that high wealth inequality can emerge as a consequence of more efficient rental markets for housing. While reminiscent of Lucas (1992), our argument has nothing to do with agency considerations, but instead with how costly it is to rent out real estate to other households.

We start with the observation that wealth inequality and the aggregate homeownership rate are negatively correlated across Euro-area countries. Figure 1 shows the aggregate homeownership rate and the Gini index of net wealth inequality in 16 Euro-Area countries plus Poland and Hungary.[2] From this figure, we gain two important insights: First, differences in the aggregate homeownership rate are huge. In Germany and Austria, less than half of the population owns their main

Figure 1: Homeownership Rate and Wealth Inequality in the Euro Area



Explanations: blue: HR < 60%, green: 60% ≤ HR < 80%, red: HR ≥ 80%
Source: own calculations based on HFCS using all five implicates

residence. In Slovakia and Lithuania, the homeownership rate reaches 90 percent and more. Second, countries with many renters and few homeowners exhibit high

[1] We will discuss some of that literature below.

[2] Data come from the ECB's Household Finance and Consumption Survey. A data description and details on data selection can be found in Section 2.

wealth inequality. The cross-country correlation coefficient between homeownership and wealth inequality is $\varrho = -0.79$ and a simple regression explains more than 60 percent of the variation in wealth inequality across countries, measured by the R^2 value.

To get to the bottom of this relationship, we provide a set of stylized facts from the ECB's Household Finance and Consumption Survey (HFCS) about household wealth and homeownership. First, we find that renters often hold very small amounts of wealth and that wealth is much more unequally distributed within the group of renters than within the group of owners. This fuels wealth inequality in countries with many renters and few homeowners. Second, in countries with many renters, there are many people who never buy a house in their whole life. This means that when renting is common, households don't just buy houses later in life. Instead, many of them decide to stay renters forever. Third, the size of the rental market is related to rental market regulation. In particular, countries that had a low degree of rent control in the past have large rental markets today.

Next, we quantitatively assess the driving forces behind the wealth-inequality-homeownership relationship. Inspired by the stylized facts, we construct a general equilibrium life-cycle model with uninsurable idiosyncratic labor income risk and a housing tenure choice. Households consume both food and shelter and can save in a liquid, risk-free, low-yield financial asset. On top of that, they may purchase real estate both for consumption and investment purposes. Real estate provides shelter to the owner of a house, but owners can also rent out shelter to non-owners on a private rental market. Rental markets are not efficient. In particular, we assume that there is a (reduced form) wedge between the shelter supplied by landlords and the shelter received by renters. The housing market is frictional, too, in that there are both a minimum house size and non-convex adjustment costs. Owners can finance real estate purchases by mortgages that have age-specific loan-to-value (LTV) requirements. In addition, there is an interest rate spread between deposits and mortgage loans.

Our ultimate goal is to simulate 18 different model economies, where each economy represents one of the countries in our sample. We parameterize our model in the following way: We first define a set of parameters that we consider *invariant across countries*. These include preference parameters, production parameters, the world interest rate, the aggregate stock of shelter, the minimum house size, and adjustment costs. We choose these parameters in accordance with the data. Those parameters that we cannot immediately read off from some data sources need to be calibrated. We use Germany as a baseline country for calibration. The remainder of parameters is assumed to be *country specific*, in particular the labor earnings process, tax and pension policies, the characteristics of the mortgage market (LTV ratios and interest rate spreads), and the efficiency of the rental market. Except for the last parameter, we take all country-specific parameters directly from the data. We finally calibrate the country-specific rental market efficiency to match a country's aggregate homeownership rate.

By construction, our model can match the homeownership rates in all 18 countries perfectly. Much more importantly, however, the model is consistent with the stylized facts. In particular, it predicts a steep negative relationship between wealth inequality and aggregate homeownership across the 18 different model economies. It correctly forecasts the share of low-wealth households in each country and features a much higher wealth inequality in the group of renters than in the group of owners. In countries with many renters, there are a lot of model households that decide to stay renters for their entire life. And the model-implied rental market wedge strongly correlates with real-life data on rent control.

Given the success of the model in matching the stylized facts, we use the model as a laboratory for investigating (i) the source of differences in homeownership across countries and (ii) the origins of the wealth-inequality-homeownership relation. Differences in aggregate homeownership across countries are mainly driven by rental market efficiency. Differences in age-earnings profiles, earnings risk, fiscal policies, or mortgage market characteristics across countries hardly play a role in shaping homeownership. In fact, varying only rental market efficiency across countries and keeping earnings, policies, and mortgage market characteristics constant, our model explains more than 85 percent of cross-country variation in homeownership rates.

The primary drivers of the relation between homeownership and wealth inequality across countries are, however, different. Wealth inequality is largely influenced by mortgage market characteristics: a spread in interest rates between mortgages and deposits alters the effective interest rate for young homeowners, prompting them to accumulate net wealth much faster than renters. Loan-to-value requirements throughout the life cycle further encourage homeowners to save. When these features are removed from the model, the homeownership-wealth-inequality relationship declines by about 40 percent. On top, housing market frictions, such as minimum house size requirements or non-convex adjustment costs, reduce wealth inequality in countries with high homeownership rates. In these countries, households must purchase real estate early in life, leading young buyers to save quickly to afford a substantial downpayment and to cope with infrequent house size adjustments. Housing market frictions account for about 23 percent of the homeownership-wealth-inequality relationship.

The key takeaway from our analysis is that wealth inequality in countries with many renters is not inherently negative. Given the numerous frictions in housing markets, a robust rental market allows individuals to plan their life-cycle more effectively. They can wait until their income uncertainty diminishes and they have saved enough for a downpayment on their desired house size. Meanwhile, income-poor individuals can choose to remain renters for life. Thus, it is not surprising that countries with less efficient rental markets exhibit lower wealth inequality but also lower individual welfare. This implies that, without a clear understanding of the causes of wealth inequality, wealth data alone can be misleading about household welfare.

Relation to the Literature Our paper builds on the literature studying cross-sectional heterogeneity and inequality in models with uninsurable idiosyncratic risk, such as Bewley (1986), Imrohoruglu (1989), Huggett (1993), and Aiyagari (1994). We enhance this framework with a life-cycle perspective and housing investment that also serves as a durable consumption good. Fernandez-Villaverde and Krueger (2011) showed that borrowing constraints and consumer durables lead young agents to accumulate durables early and increase non-durable consumption later. We extend this by demonstrating that incentives to accumulate housing early significantly affect wealth distributions, especially at the lower end. Following Yang (2009), we include transaction costs to prevent gradual housing sales as households age. Unlike other durables, housing can be rented, as discussed by Gruber and Martin (2003), Silos (2007), and Diaz and Luengo-Prado (2010). In contrast to these papers that assume efficient rental markets, we argue that varying rental market efficiency and housing market frictions are key elements.

Following up on the insights of Piketty (2014), a body of literature has studied the emergence of high wealth inequality in quantitative macroeconomic models. Jones (2015) provides an early overview of the consequences of Piketty's findings for macro models. Recent research has explored mechanisms like large earnings shocks (Castaneda et al., 2003; Diaz and Luengo-Prado, 2010; Kindermann and Krueger, 2022), bequest transmission (De Nardi and Yang, 2016; De Nardi and Fella, 2017), and heterogeneous returns and savings rates (Benhabib et al., 2019; Fagereng et al., 2019, 2020) to generate realistic wealth inequality levels. Unlike these studies, we focus on how rental market efficiency as well as housing and mortgage market frictions, contribute to wealth inequality.

There is a substantial literature on housing in macroeconomics. Piazzesi and Schneider (2016) and Davis and Van Nieuwerburgh (2015) provide excellent reviews of this literature. Ioannides and Ngai (2025) focus on the relationship between housing and inequality. Notable studies related to our work include Cocco (2005) and the works of Flavin and Yamashita (2002, 2011), and Flavin and Nakagawa (2008), who explore household portfolio composition in the context of housing. Gervais (2002) examines the link between the after-tax return on housing, capital accumulation, and inequality. He argues that the preferential tax treatment in the U.S. gives housing a higher return than business capital, which helps homeowners to build wealth. However, Cho and Francis (2011) find that eliminating such tax treatments hardly changes wealth inequality.

Why do households become homeowners at all? In a simple model where the rental price just equals the user cost of housing, households would be indifferent between owning and renting in equilibrium. Therefore, many papers simply assume that households have a preference for owner-occupied housing over renting. This modeling shortcut can be rationalized by non-consumption-related benefits of homeownership. DiPasquale and Glaeser (1999) and Rossi and Weber (1996), for example, suggest that homeowners are more likely to invest in their local neighborhoods. Alternatively, one could assume that the price of rental property is higher than the user cost, as proposed by Campbell and Cocco (2007). Henderson and Ioannides (1983) already argued that the incompleteness of rental contracts for durable goods leads to an "over-utilization" of rental properties, making renting inherently more costly than owning. Lastly, house price beliefs may shape individuals' desire to buy houses, like in Le Blanc et al. (2025). In our model, we adopt the approach of Campbell and Cocco (2007) but allow rental market efficiency to vary across countries. To validate our measure of rental market efficiency, we show that it strongly correlates with real-life data on rent control.

Some research has delved deeper into the institutional framework of rental and housing markets, and how it influences the homeownership decision. In a sequence of papers, Chambers et al. (2009a; 2009b; 2009c) consider the U.S. mortgage market and tax treatment and its effect on homeownership. Kaas et al. (2020) argue that an extensive social housing sector, high transfer taxes, and the absence of a tax-deductibility of mortgage interest payments are responsible for a very low homeownership rate in Germany. Bontemps et al. (2024) show that high transaction taxes lead to low transaction volumes in France. In a more descriptive vein, Andrews et al. (2011) and Cuerpo et al. (2014) provide extensive overviews of the regulations and housing policies in place in OECD and Euro Area countries. Important for motivating this project are Voigtländer (2009) and Hubert (1998), who explore how the rental market's institutional framework in Germany was shaped by the historic sequence of policy choices and how it may still affect aggregate homeownership rates today.

Homeownership significantly influences savings behavior. For instance, Boar et al. (2021) demonstrates that four-fifths of U.S. homeowners face liquidity constraints, although they can access liquidity through mortgage refinancing. Paz-Pardo (2024) contends that evolving earnings dynamics have made it increasingly difficult for young households to purchase homes. As a result, they accumulate less wealth. Nakajima and Telyukova (2020) examines renters' savings profiles and finds that homeowners deplete their wealth at a much slower rate. Lastly, Wold et al. (2024) argue that homeownership is a key factor in the intergenerational persistence of wealth. The presence of liquidity constraints, earnings risk, and retirement savings motives also play a central role in our study.

So far, we are aware of three papers that study wealth inequality and homeownership based on the same data as we do. Pham-Dao (2016) also observes that there is substantial variation in wealth inequality in Europe. She finds that a significant part of the variation in wealth inequality can be explained by differences in social safety net policies, most importantly means-tested subsistence benefits. We view her findings as complementary to ours. Kaas et al. (2019) empirically investigate the cross-country relationship between wealth inequality and homeownership. Similar to our results, they find that wealth inequality is largely driven by wealth differences between renters and owners. They also confirm that differences in wealth inequality emerge from the bottom half of the wealth distribution. Finally, Mitman et al. (2024) allow for endogenous family formation and argue that informal rental and credit markets that emerge from cohabitation across generations interact with housing tenure choice.[3] Like in our study, they find that a tenure wedge between renting and owning is important in explaining cross-country differences in homeownership. While similar in the modeling approach, we focus on the implications of homeownership for wealth inequality.

This paper is structured as follows: Section 2 presents the data and stylized facts. In Section 3 we develop the quantitative life-cycle model, and we discuss its calibration in Section 4. Section 5 shows simulation results and Section 6 offers some concluding remarks.

2 Data and stylized facts

Our main data source is the *Household Finance and Consumption Survey* (HFCS) run by the Household Finance and Consumption Network of the Eurosystem, see EHFCN (2013). The HFCS provides harmonized, high-quality household level data on wealth and consumption in the 20 Euro area countries plus Hungary and Poland, who are not part of the Euro system. In this section, we first describe the data as well as our sample selection method. We then derive a set of stylized fact that will be informative for understanding the roots of the relationship between wealth inequality and homeownership in the Euro area.

2.1 Data description

Assets, liabilities and total net wealth The HFCS asks households detailed question on the entirety of their wealth. For each household, we observe a full breakdown of their *real assets* (real estate, other durables, valuables and self-employment businesses), *financial assets* (from simple deposits over equity investments up to pension plans), and *liabilities* (outstanding mortgage and non-mortgage debt). Our central measure of interest is a household's *net wealth*, meaning the sum of the market values of all real and financial assets minus outstanding liabilities.[4] We standardize net wealth by the standard OECD equivalence scale in order to account for differences in the demographic composition across different entities. For calculating aggregate statistics, we apply sample weights in order to account for non-response as well as the fact that the HFCS oversamples rich households.

Homeownership We declare a household to be a *homeowner*, if she owns her main residence at least partly. The majority (86%) of non-homeowners has rented

[3] This idea is also explored by Grevenbrock et al. (2024).

[4] Real assets are valued at current market prices as estimated by the respondent or imputed if necessary. In the latter case, the survey provides 5 different imputations. A detailed description of the survey methodology of the HFCS can be found in EHFCN (2013).

their main residence, the remainder lives in a "free use" arrangement. We therefore refer to the group of non-homeowners as *renters*. We define the household's age as the age of the household head according to the UN/Canberra definition.

Sample selection For the sake of a cleaner cross-country comparison, we exclude Malta, Cyprus, Croatia, and Ireland from our sample. The economies of the former two are substantially smaller than any of the other countries and structurally different. Croatia is not a member of the OECD, which makes it hard to generate comparable external data especially for policy parameters. Finally, Ireland experienced some serious turmoil in housing markets in recent decades.[5] Our final sample consequently comprises data from 18 countries in continental Europe. We restrict our attention to the third wave of the survey, which was conducted in 2017. However, we find the same stylized facts for previous waves, which included only a subset of countries.[6] Finally, we drop the top 1% wealth-richest households from the sample in order to create a better match between the data and our quantitative simulation model.[7] A more detailed data description and summary statistics can be found in Appendix A.1.

2.2 Stylized facts

We now provide a set of stylized facts regarding the relationship between homeownership and wealth inequality in the Euro Area. In particular, our data suggest the following:

1. There is a negative relationship between the aggregate homeownership rate and wealth inequality across countries. This means that in countries with many renters, wealth is quite unevenly distributed.

2. Renters often only hold very small amounts of wealth. In addition, wealth is much more unequally distributed within the group of renters than within the group of owners.

3. In countries with many renters, there tend to be a lot of people that never buy a house in their entire life.

4. The size of the rental market is related to rental market regulation. In particular, countries that had a low degree of rent control in the past have large rental markets today.

We now discuss these stylized facts in detail.

[5]Including these four countries into our sample would not change our main stylized facts, see Appendix A.2 for details. Moreover, Woloszko and Causa (2020) show that the negative relationship between wealth inequality and homeownership holds in an even larger sample of OECD countries.

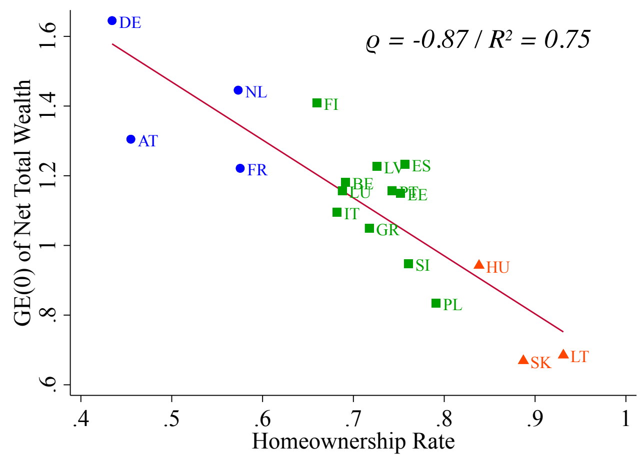
[6]Details can be found in Appendix A.3.

[7]In Appendix A.2, we show that this selection does not impact significantly on our results.

2.2.1 Homeownership and wealth inequality

Figure 2 shows the cross-country relationship between the aggregate homeownership rate and wealth inequality. In contrast to the graph in the introduction we measure wealth inequality using a Generalized Entropy Index of degree zero, in short the $GE(0)$. We prefer to use this index for two reasons: (i) the index allows for additive decomposition and (ii) it is easy to compute in a stochastic simulation model. The $GE(0)$ is a member of a more general class of Generalized Entropy Indices the properties of which we discuss in Appendix A.4. Note that our choice of index has no impact on the stylized fact itself.

Figure 2: Homeownership rate and wealth inequality across countries



Explanations: blue: HR < 60%, green: 60% ≤ HR < 80%, red: HR ≥ 80%
Source: own calculations based on HFCS using all five implicates

We find a clear and strong negative relationship between a country's aggregate homeownership rate and wealth inequality within this country. The correlation coefficient between the two is remarkable and amounts to $\varrho = -0.87$. A simple linear regression delivers an R^2 value of 0.75. Our finding implies that in countries with many homeowners, wealth tends to be quite equally distributed. In countries with many renters, on the other hand, wealth is distributed very unequally.

2.2.2 Renters often hold very low wealth

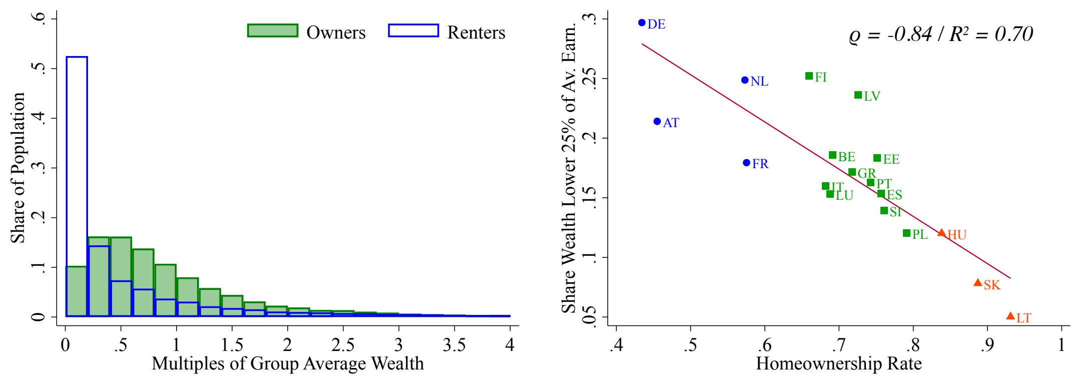
We now want to dig deeper into the origins of the negative relationship between homeownership and wealth inequality. To this end, we pooled all the data from our 18 countries and constructed histograms of the group-specific wealth distributions of renters and owners, see the left panel of Figure 3.[8] To control for

[8]We also constructed histograms separately for each country, which showed the same results. We therefore only report one aggregate histogram for reasons of expositional clarity.

different average wealth levels across the groups of renters and owners, we measure net wealth in relation to group specific average wealth. The histograms show substantial differences between the wealth distributions of renters and owners. While owners exhibit a distribution that looks somewhat log-normal, the wealth distribution of renters has a large mass-point around zero and is then strictly decreasing. We can draw two conclusions from this: First, renters often tend to hold only very small amounts of wealth. Second, the wealth distribution within the group of renters is much more unequal than the wealth distribution in the group of owners.

Figure 3: Wealth inequality and low-wealth households

(a) Histogram (pooled sample) (b) Fraction of Low-Wealth Households



Source: Own calculations based on HFCS data using all five implicates.

The right panel of Figure 3 elaborates on the first conclusion. It plots the share of households with a net wealth of less than a quarter of average annual labor earnings against the aggregate homeownership rate in each of our sample countries. The relationship is strongly negative with a correlation coefficient of -0.84. This means that in countries with many renters, we tend to see a lot of households with very low levels of wealth.

To get a clearer picture of the second conclusion, we decompose the $GE(0)$ index as

$$GE_c = \underbrace{(1 - HR_c) \cdot WR_{c,r} + HR_c \cdot WR_{c,o}}_{\text{between group inequality}} + \underbrace{(1 - HR_c) \cdot GE_{c,r} + HR_c \cdot GE_{c,o}}_{\text{within group inequality}} \quad (1)$$

with

$$WR_{c,g} = -\log\left(\frac{\bar{w}_{c,g}}{\bar{w}_c}\right) \quad \text{and} \quad GE_{c,g} = -\frac{1}{N_{c,g}} \sum_{i \in \mathcal{N}_{c,g}} \log\left(\frac{w_{i,c,g}}{\bar{w}_{c,g}}\right).$$

GE_c denotes the $GE(0)$ index of wealth inequality in a country c and HR_c that country's aggregate homeownership rate. We let $g \in \{o, r\}$ indicate the subgroups of owners and renters, respectively. Then, $WR_{c,g}$ is the log-ratio between group-specific average wealth $\bar{w}_{c,g}$ and country-wide average wealth $\bar{w}_c$. $GE_{c,g}$ indicates wealth inequality within the groups of renters and owners, respectively. Appendix A.4 provides a formal derivation of this relationship.

Equation (1) shows that wealth inequality, as measured by the $GE(0)$ index, is a composite of *between group inequality* and *within group inequality.* Between group inequality measures inequality that arises from the average wealth being different between the groups of renters and owners. Within group inequality measures inequality within the two subgroups. To understand how a changing homeownership rate influences overall wealth inequality in a country, we shall hence look at the different sub-components $WR_{c,g}$ and $GE_{c,g}$ across our sample countries.

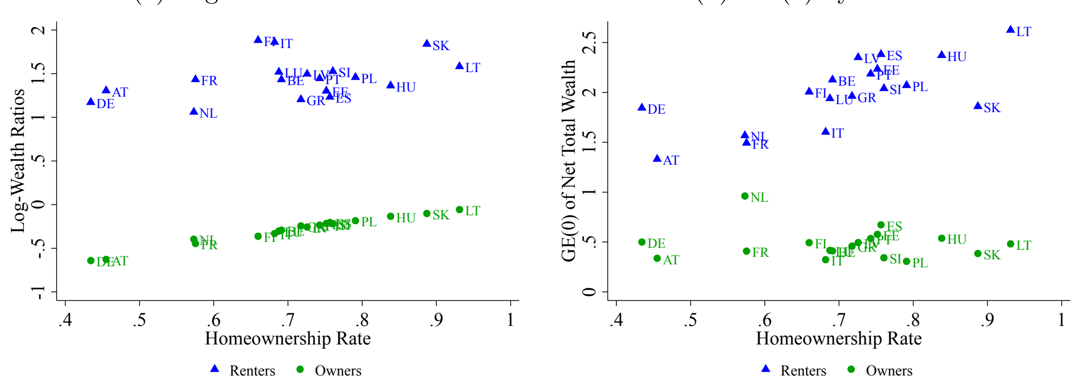
The results are shown in Figure 4. We find that both average log-wealth ratios as well as within group inequality are remarkably stable across the 18 sample countries. This means that in any of these countries

1. renters on average have much less net wealth than owners, and
2. wealth is much more unequally distributed within the group of renters than within the group of owners.

It is hence not surprising that a higher share of renters in the economy implies a larger degree of wealth inequality.

Figure 4: Decomposition of inequality into sub-group components

(a) Log-Wealth Ratios (b) $GE(0)$ by tenure

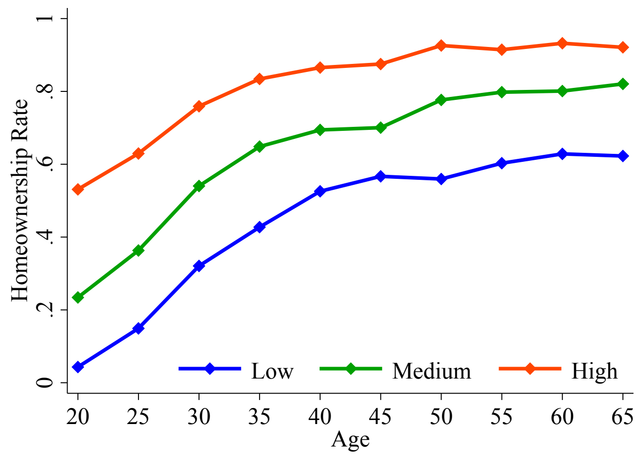


Source: Own calculations based on HFCS data using all five implicates.

2.2.3 Renting and age

What does it mean to have many renters in an economy? Do people just buy houses later in life? Or is renting a phenomenon we can see for all age groups. To answer this question, Figure 5 shows age-specific homeownership rates by five-year age bins of the household head. To keep the picture simple, we formed three country groups: those with a low homeownership rate (less than 60%), those with a medium range homeownership rate (between 60 and 80%) and those with a high homeownership rate (80% and above). The figure shows no age-specific trends in

Figure 5: Investment patterns across countries



Explanations: blue: HR $<$ 60%, green: 60% $\leq$ HR $<$ 80%, red: HR $\geq$ 80%
Source: Own calculations based on HFCS data using all five implicates.

tenure across country types. Instead, homeownership rates are almost shifted in parallel between the three country groups. This suggests two things that are relevant for our quantitative theory. First, in countries with high homeownership rates, all households – including the young ones – tend to own their primary residence more frequently. Second, in countries with many renters, there is a substantial share of households that never own but stay renter for their entire life.

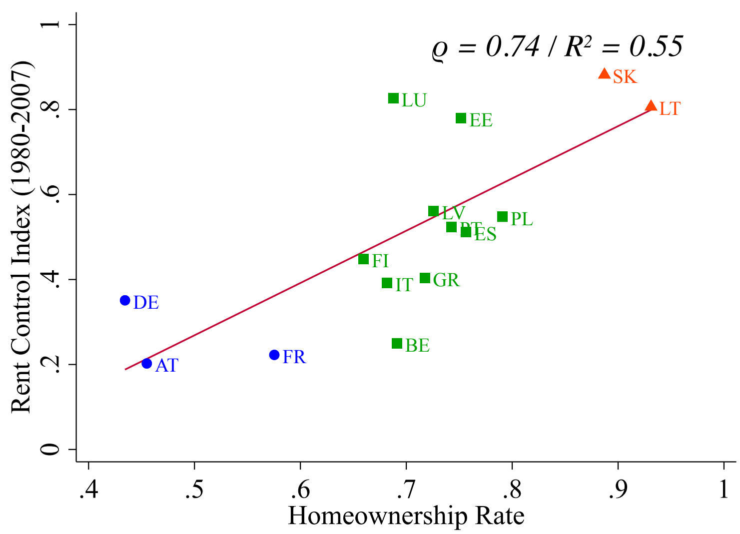
2.2.4 Rental market regulation and homeownership

A well-working rental market needs a well-designed market regulation, especially when renting contracts are written between two private households. Of course, rental market regulation is inherently hard to measure in physical units. Still, we want to give an example of how rental market regulation may interplay with a country's aggregate homeownership rate. To do this, we use data from the Rental Market Regulation Index, short ReMaIn, assembled by Weber and Lee (2018). ReMaIn is an effort to code laws and regulations into indices on a scale of 0 to 1, where 0 means a very loose regulation and 1 a very tight one. We focus on *rent control laws*, as they have been shown to matter significantly for the performance of rental markets, see for example Voigtländer (2009), Cuerpo et al. (2014), or Diamond et al. (2019).

The ReMaIn database provides us with index measures of rent control (informed by legislation on real and nominal rent freezes, intertenancy decontrol, etc.) for 15 of our 18 sample countries starting in 1899 and ending in 2017. We use data from 1980 to 2007. We therefore take a longer run perspective, as the size of rental and housing markets will typically not change instantaneously to regulatory policy. However, we exclude data from after the financial crises, which triggered (short-run) regulatory changes in some countries.[9]

Figure 6 shows the cross-country correlation between the average rent control index in the period 1980 to 2007 and aggregate homeownership in 2017. Rental

Figure 6: Rental market regulation and homeownership



Source: Own calculations based on HFCS and ReMaIn data.

market regulation and homeownership are clearly and strongly positively correlated with a correlation coefficient of 0.74. This means that a tighter rental market regulation comes with a smaller size of the rental market. This is not surprising, of course. A well working rental market needs to be accompanied by a well-designs regulatory balance between the interests of tenants and landlords (investors). While a tight rent control may shield tenants from price increases and therefore may keep rental housing affordable, it severely limits the payoff from real estate as an investment opportunity for landlords. If investing into residential property with the intention to rent it out to others is not attractive enough, the size of the rental market will remain small.

2.3 Earnings inequality and intergenerational transfers

Before working out a quantitative theory of savings and real estate investment that helps explain the inverse cross-country relationship between wealth inequality and homeownership, we want to clarify the role of some obvious candidate

[9]Using data until 2017 will still give the same results, yet with less precision.

solutions to the problem. The first is related to the observation that wealth inequality is often a reflection of earnings inequality. However, when plotting the cross-country relationship between labor earnings inequality and the aggregate homeownership rate, we find no systematic relationship between the two, see Figure A.4 in Appendix A.5. This rules out earnings inequality as a potential driver of results.

The second potential channel that might explain variation in homeownership and wealth inequality across countries is related to inheritances and intergenerational transfers. In high ownership countries, one could think that there is more intergenerational support between parents and children to acquire homes. This support might take the form of children inheriting their houses or parents giving more intergenerational transfers to support children in financing the downpayment of their house. Yet, our data do not show any systematic cross-country relationship between the fraction of owners who inherited their home and the aggregate homeownership rate. Neither do we find a relationship between the amount of monetary transfers received by households under the age of 40 and aggregate homeownership, see Figure A.5 in Appendix A.5. While inheritances and intergenerational transfers may of course play a role in the process of acquiring a primary residence on the individual level, they do not seem a promising channel in explaining the cross-country relation between homeownership and wealth inequality.

2.4 Summary of empirical analysis

Overall, our data has shown that there is a strong and negative correlation between a country's aggregate homeownership rate and this country's wealth inequality. The source of this relationship appears to lie at the bottom end of the wealth distribution. In countries populated by many renters there is a larger fraction of households with negligible amounts of wealth. These households who only have a small amount of wealth are typically renters, leading the wealth distribution within the group of renters to be much more unequal than in the group of owners. On top, in countries with a vivid rental market, renting is a viable option for individuals of all ages. Last but not least, rental market regulation seems to play an important role in governing the homeownership rate of a country, as countries with a tighter rental market regulation typically exhibit higher homeownership rates.

3 A quantitative model

In this section, we develop a general equilibrium life-cycle model that will help us rationalize the empirical facts and understand the origins of the negative relationship between wealth inequality and homeownership. In our model, households have to decide *how much* and *where* to save facing uninsurable idiosyncratic labor earnings risk. Households can invest either in a low-yield, risk-free financial asset or in real estate.[10] Real estate can be bought for consumption purposes if used as the household's main residence. Alternatively, it serves as an investment vehicle, if rented out to other households through the private rental market. Buying real estate comes with certain frictions: non-convex adjustment costs, a minimum housing size, and minimum downpayment requirements if the house is financed through a mortgage.

The economy has a financial sector that intermediates household savings, collateralized household borrowing, and firm capital usage. We introduce a spread between the interest households earn on savings in financial assets and the interest rate they have to pay on mortgages. This spread is supposed to capture the costs of intermediation. We model the economy as a small open economy subject to a fixed world market interest rate, which is a reasonable assumption for most Euro-Area countries.

The efficiency of rental markets varies across countries, depending on the quality of market regulation. To govern rental market efficiency in our model, we employ a reduced form specification by assuming a wedge between the amount of real estate that is rented out by landlords and the amount of shelter tenants get to consume. The smaller the wedge, the more efficient is a country's rental market and the smaller will be that country's aggregate homeownership rate.

3.1 Firm technology

A continuum of identical firms produce a single good Y under perfect competition. They hire both capital K at the world interest rate r_w and labor L at price w on competitive spot markets. Firms operate a constant returns to scale technology

$$Y = \Omega K^{\epsilon} L^{1-\epsilon}. \tag{2}$$

Ω denotes the aggregate level of productivity, whereas ϵ is the elasticity of output with respect to capital. In the process of production, a fraction δ_k of the capital stock depreciates. Given the assumptions about competition and technology, we can safely assume the existence of a representative firm that takes prices as given and operates the aggregate technology in (2). Profit maximization leads to the usual marginal pricing conditions

$$r_w = \epsilon\Omega \left(\frac{L}{K}\right)^{1-\epsilon} - \delta_k \quad \text{and} \quad w = (1-\epsilon)\Omega \left(\frac{L}{K}\right)^{-\epsilon}. \tag{3}$$

In steady state, financial investment equals capital depreciation, i.e. $I_k = \delta_k K$.

[10] Note that these two assets are the predominant assets in Euro area economies. In all of our sample countries, 85 to 95% of all private wealth is held in either low-yield safe financial assets or real estate.

3.2 Real estate and the rental market

Let H be the total amount of available real estate in the economy. Every unit of real estate must be owned by a household. In each period, households can buy and sell real estate h on a competitive market at some unit price p_h. Buying or selling real estate is costly: it typically comes at search costs, costs for realtors and real estate transfer taxes. We model such costs as non-convex adjustment cost

$$\gamma(h, h^+) \begin{cases} = 0 & \text{if } h = h^+ \text{ and} \\ > 0 & \text{if } h \neq h^+, \end{cases}$$

where h^+ denotes the amount of real estate a household intents to hold in the next period. In each period, a share δ_h of real estate depreciates and it needs to be replaced instantaneously by its owner. The economy's aggregate housing investment consequently is $I_h = p_h \delta_h H$.

One unit of real estate produces one unit of shelter in every period. Owners of real estate must decide whether to consume the shelter themselves or whether to rent it out at a unit price p_s to others on the rental market. Whenever shelter gets rented out, a fraction τ of every unit is lost in the renting process. We interpret the wedge τ as a country's rental market efficiency that is determined by regulation. We assume that households cannot be real estate owners and renters at the same time.

3.3 Financial markets

Financial markets are incomplete. Like in Bewley (1986), Imrohoruglu (1989), Huggett (1993), and Aiyagari (1994), households cannot insure against idiosyncratic risk. Yet, they can save and borrow by interacting with financial intermediaries. Intermediaries take in deposits d from households on which they pay a return r_d, and they issue mortgages m on which they charge interest at rate r_m. Intermediation is costly. We denote by $\frac{\kappa}{2}$ the intermediation cost for one unit of deposits or loans. Financial intermediaries can borrow and lend on the international financial market at the world interest rate r_w. Under the assumption of free market entry and perfect competition, the interest rates on deposits and loans are

$$r_d = r_w - \frac{\kappa}{2} \quad \text{and} \quad r_m = r_w + \frac{\kappa}{2}.$$

The size of the mortgage a household can take out is restricted by the collateral value of the house. Households can borrow up to a share $\lambda_j \in [0, 1]$ of the market value of their entire real estate holdings. We assume that this share depends on the household's age j, which allows us to differentiate loan restrictions between younger and older workers as well as retirees.

3.4 Preferences, endowments, and the budget constraints

Preferences A household lives for exactly J years and we denote the generic age of a household by $j = 1, 2, \dots, J$. Each year, a new cohort of agents is born. Each cohort consists of a continuum of households with measure 1. Households have preferences over stochastic streams of goods consumption $c_j \geq 0$ and shelter $s_j \geq 0$. They maximize a discounted, expected utility function

$$U_0 = \mathbb{E}_0 \left[\sum_{j=1}^{J} \beta^{j-1} u(c_j, s_j) \right],$$

where β is a time discount factor.

Endowments Households are ex ante homogeneous, but differ ex post in their labor productivity. All individuals share a common deterministic, age-specific labor earnings profile e_j. On top, they are exposed to idiosyncratic shocks η. Gross labor earnings of a household consequently read

$$y = w \times e_j \times \exp(\eta), \tag{4}$$

where w is the wage rate per labor efficiency unit. Labor earnings risk η follows an AR(1) process, such that

$$\eta^+ = \rho\eta + \varepsilon^+ \quad \text{with} \quad \varepsilon^+ \sim N(0, \sigma_\varepsilon^2).$$

ρ is the persistence of shocks to labor earnings.

Households pay taxes including social security contributions according to a (progressive) tax schedule $T(\cdot)$. When reaching the mandatory retirement age J_r, they stop working and receive pension payments p. A households net labor income consequently reads

$$y_{net} = y - T(y) + p.$$

Budget constraints The budget constraint of a renter household reads

$$c + \underbrace{p_s s}_{\text{rent}} + d^+ + \underbrace{p_h h^+ - m^+ + \gamma(0, h^+)}_{\text{net real estate investment}} = (1 + r_d)d + y_{net}. \tag{5}$$

Renter households spend on goods consumption c and rent for their shelter $p_s s$. They can save in deposits d^+. In addition, they may decide to purchase real estate at value $p_h h^+$ to be held in the next period, part of which they can finance with mortgages m^+. Investment in real estate causes adjustment costs $\gamma(0, h^+)$. On the income side, renter households receive interest income on their existing deposits d as well as net income from labor or pensions.

The budget constraint of an owner household is

$$c + \underbrace{\delta_h p_h h}_{\substack{\text{maintenance}\\ \text{costs}}} + d^+ + \underbrace{r_m m + (m - m^+)}_{\substack{\text{mortgage interest}\\ \text{+ redemption}}} + \underbrace{p_h(h^+ - h) + \gamma(h, h^+)}_{\text{real estate investment}}$$
$$= (1 + r_d)d + y_{net} + \underbrace{p_s(h - s)(1 - \tau)}_{\text{rental income}}. \quad (6)$$

Owner households spend on goods consumption and pay maintenance costs to their real estate. Whenever they have a mortgage, they have to pay interest and potential redemption payments. In addition, they can choose to change their real estate holdings, which causes both investment costs (or benefits) and adjustment costs. In addition to income from deposits and labor, landlord households also receive rental income for all real estate that they do not consume for themselves. Note that rental income is multiplied by the efficiency wedge $1 - \tau$, which governs rental market efficiency.

3.5 The dynamic optimization problem

The current and next-period states of a household are described by the state vectors

$$\mathcal{X} = (j, \eta, d, m, h) \quad \text{and} \quad \mathcal{X}^+ = (j + 1, \eta^+, d^+, m^+, h^+).$$

In every period, the household's dynamic optimization problem reads

$$v(\mathcal{X}) = \max_{c,s,d^+,h^+,m^+} u(c, s) + \beta \mathbb{E}\left[v(\mathcal{X}^+)\right] \quad (7)$$

subject to the budget constraints (5) or (6) as well as the

$$\begin{aligned} \text{collateral constraint:} \quad & m^+ \leq \lambda_j p_h h^+ \\ \text{minimum house size constraint:} \quad & h^+ \in \{0, [h_{min}, \infty]\} \\ \text{owner-renter constraint:} \quad & s \leq h \text{ if } h > 0 \\ \text{non-negativity constraints:} \quad & c, s, d^+, h^+, m^+ \geq 0. \end{aligned}$$

The solution to the household's problem is a value function $v(\mathcal{X})$ as well as policy functions $c(\mathcal{X}), s(\mathcal{X}), d^+(\mathcal{X}), h^+(\mathcal{X}), m^+(\mathcal{X})$ that all depend on the household's current state $\mathcal{X}$.

3.6 Government

The government raises contributions and taxes on labor earnings and uses them to finance pension payments as well as (wasteful) government expenditure G. Let us denote by Φ the equilibrium cross-sectional measure of households over the state space. Then total government revenue and aggregate pension payments are

$$T = \int T(y)\, d\Phi \quad \text{and} \quad P = \int p\, d\Phi.$$

The budget constraint of the government then is

$$T = P + G, \tag{8}$$

where we assume that G balances the fiscal budget.

3.7 Market clearing

We assume a small open economy setting with a world interest rate r_w. Let us denote by

$$A_{\text{fin}} = \int d - m\, d\Phi$$

aggregate financial assets of all households. The net foreign asset position of the economy is $Q = A_{\text{fin}} - K$. Whenever the net foreign asset position is negative, foreign investors own a part of the domestic capital stock. As a compensation for this investment, the foreign sector consumes $TB = -r_w Q$ in steady state.

With respect to real estate, there are two markets that need to clear. The house price p_h will make sure that all real estate is actually owned by households. The rental price p_s is chosen such that all shelter that is not consumed directly by owners is rented out to other households. The market clearing conditions for the housing and the rental market consequently are

$$H = \int h\, d\Phi \quad \text{and} \quad \underbrace{\int \mathbb{1}_{h=0} \cdot s\, d\Phi}_{\text{shelter demand}} = \underbrace{\int \mathbb{1}_{h>0} \cdot (h - s)(1 - \tau)\, d\Phi}_{\text{shelter supply}}. \tag{9}$$

We assume that the total amount of shelter available to the economy is inelastic. This means that households get to consume the same aggregate amount of shelter regardless of the size of the rental market wedge τ. Hence, we require $\int s\, d\Phi = \bar{S}$.

On the good market, all output goods produced by firms are used as private consumption or investment, public consumption or foreign consumption, such that

$$Y = C + I + G + TB.$$

Note that private consumption and investment read

$$C = C_{\text{goods}} + \Psi_\gamma + \Psi_\kappa \quad \text{and} \quad I = I_k + I_h.$$

Next to the direct consumption of goods, households consumption spending includes aggregate adjustment costs for real estate Ψ_γ, and aggregate intermediation costs on financial markets Ψ_κ. Private investment includes both investment into the capital stock as well as replacement investment of real estate. We provide a formal equilibrium definition in Appendix B.

4 Calibration

Our goal is to simulate 18 different economies, where each economy represents one of the countries in our sample. To parameterize our model, we need to pick values for two sets of parameters:

1. We first define a set of parameters that we consider *invariant across countries*. These include preference parameters, production parameters, the world interest rate, the shelter stock, the minimum house size, and adjustment costs. We choose these parameters in accordance with the data. Those parameters that we cannot immediately read off from some data sources need to be calibrated. We use Germany as a baseline country for calibration.

2. The remainder of parameters is assumed to be *country specific*, in particular the labor earnings process, tax and pension policies, the characteristics of the mortgage market (LTV ratios and interest rate spreads), and the efficiency of the rental market. Except for the last parameter, we take all country specific parameters directly from the data. We finally calibrate the rental market efficiency for each country so as to match the aggregate homeownership rate.

We now explain our calibration process in detail. A superscript c denotes country-specific parameters.

4.1 Country invariant parameters

Preferences We let the instantaneous utility function of households be of constant relative risk aversion type, where the bundle between goods consumption and shelter is aggregated with a Cobb-Douglas function:

$$u(c, s) = \frac{\left(c^{1-\alpha} s^{\alpha}\right)^{1-\sigma}}{1-\sigma}$$

We assign a value of 2 to risk aversion σ, a choice quite typical for the heterogeneous agent macroeconomics literature.[11] We then set $\alpha = 0.16$, which corresponds to the median share of rental and imputed rental expenditure in total consumption expenditure across our sample countries as reported by Eurostat (2017a). We calibrate the time discount factor to target the share of households with net wealth less than 25% of average earnings, see Figure 3. In Germany, this share is equal to 30 percent, which results in a discount factor of $\beta = 0.992$.

[11] In this model, σ fulfills two roles as it defines both the coefficient of relative risk aversion and, through its inverse, the intertemporal elasticity of substitution. Estimates for the latter typically range between values of 1 and 3, whereas risk aversion can be quite high and well beyond values of 10 when estimated from individual financial choices, see for example Vissing-Jørgensen and Attanasio (2003).

Production, trade, and international capital market We deliberately normalize the technology parameter Ω such that the marginal product of labor is equal to $w = 1$. The elasticity of output with respect to capital is set to $\epsilon = 0.3$. Note that our choice of parameters for the production function has no real impact on the results, as we are assuming a small open economy framework where factor prices are fixed. We choose a world interest rate of $r_w = 0.025$, which constitutes as mix between the (in 2017) very low interest rates on deposits and some longer-run investment opportunities that offer higher returns. The trade balance of the German economy is 6.26% of GDP. This is the average value in the years 2010-2017 as reported in Eurostat (2017b). Our choice of trade balance immediately implies a corresponding net foreign asset to GDP ratio. Together with household aggregate financial savings this defines the economy' capital intensity and therefore a marginal product of capital. We calibrate the depreciation rate $\delta_k = 0.059$ such that the implied interest rate equals the world interest rate r_w.

Housing market On the housing market, we normalize the price of real estate in Germany to $p_h^{DE} = 1$. Through the market clearing condition (9), this normalization implies an aggregate shelter to GDP ratio of $\bar{S}/Y = 1.828$, which we consider invariant across countries. We use an annual depreciation rate for housing of $\delta_h = 0.025$, which implies a useful property life of 40 years. To estimate the minimum house size, we normalize the market values of owners' main residence by average labor earnings for each country. We then pool our entire sample and calculate the 5th percentile of the normalized housing wealth distribution. This gives us a minimum house size of $h_{min} = 1.26$. Finally, we let the adjustment cost function $\gamma(h, h^+)$ take the form

$$\gamma(h, h^+) = \begin{cases} 0 & \text{if } h = h^+ \text{ and} \\ \gamma_0 + \gamma_1 p_h |h^+ - h| & \text{if } h \neq h^+. \end{cases}$$

We set the lump-sum adjustment costs as fraction of average labor earnings to $\gamma_0 = 0.15$ (i.e. around 5000 €) and choose a proportional transaction cost of $\gamma_1 = 0.05$. These numbers are broadly in line with the literature, see Andrews et al. (2011). Table C.1 in Appendix C.1 summarizes all parameters that we consider invariant across countries.

4.2 Country-specific parameters

Labor earnings process In our model, gross labor earnings are specified (in logs) as

$$\log(y) = \log(w) + \log(e_j) + \eta \quad \text{with} \quad \eta^+ = \rho\eta + \varepsilon^+$$

and $\varepsilon^+ \sim N(0, \sigma_\varepsilon^2)$, see equation (4). Recall that we normalized $w = 1$. We use information on labor earnings in the HFCS to pin down the earnings dynamics for each country c separately. To do this, we proceed as follows: We use data from households with heads aged between 20 and 62. Labor earnings are defined as total household earnings from employment and self-employment. We drop observations with earnings less than 5% of the median in each country. A simple linear regression with age fixed effects a_j^c allows us to take out the age specific component of labor earnings. We then specify a flexible functional form

$$\log(e_j) = \theta_0^c + \theta_1^c \times j + \theta_2^c \times \mathbb{1}_{j \le J_l^c} \times \frac{(j - J_l^c)^3}{10000} + \theta_3^c \times \mathbb{1}_{j \ge J_u} \times \frac{(j - J_u)^3}{10000}$$

that adequately captures the properties of life-cycle earnings in all countries. We exogenously set $J_u = 50$ and estimate the remaining parameters so as to minimize a residual sum of squares between the age fixed effects a_j^c and the parameterized version of the age profile of labor earnings $\log(e_j)$. Finally, we normalize the values of $\log(e_j)$ such that each country's economy wide average earnings $\bar{y}^c$ is equal to 1, which implies an aggregated labor supply of $L^c = 43$. Table C.2 in the Appendix reports the estimation results and Figure C.1 shows the estimated life-cycle earnings profiles. As for the risk process η, we choose a country-invariant value of $\rho = 0.95$.[12] The variances of the residuals from our linear regression then immediately identify the country-specific innovation variances $(\sigma_\varepsilon^c)^2$. Table C.3 summarizes the parameters of the stochastic labor earnings process.

Taxes We follow Guvenen et al. (2013b) in parameterizing both the progressive income tax as well as the pension formula. Each country's tax schedule is defined as

$$T^c(y) = t^c(y) \times y \quad \text{with} \quad t^c(y) = t_0^c + t_1^c y + t_2^c y^{\phi^c}. \tag{10}$$

$t^c(y) \in [0, 1]$ is the average tax rate a household with labor earnings y has to pay. Recall that we normalized our estimate of earnings in each country such that average earnings are equal to 1. To estimate the parameters of the tax function for each country, we use data on average tax rates (both personal income tax and social security contributions) along the earnings distribution in 2017 from the OECD Tax and Benefits calculator (OECD, 2023a) as well as the OECD Tax Database (OECD, 2023b). Our parameter estimates minimize the residual sum of squares between the statutory average tax rates and our parameterized average tax rate function $t^c(y)$. For more details see Appendix C.3.

Pension Systems All households retire at the age of 63, i.e. model age $J_r = 44$. Once the household enters retirement, she receives a pension that depends on an index of her past net labor earnings. We calculate this index based only on

[12]We can not identify ρ directly in the data. Therefore we chose a value that is within the range of values typically found in studies of the labor earnings process, see for example Heathcote et al. (2010).

information on the household's last realization of the labor earnings process η_{J_r-1} just before retirement:[13]

$$y_{index}\left(\eta_{J_r-1}\right) = \mathbb{E}\left[\frac{\sum_{j=1}^{J_r-1} y_j - T(y_j)}{J_r - 1}\middle|\eta_{J_r-1}\right].$$

The household's pension is calculated from

$$p(\eta_{J_r-1}) = b_0^c \times \bar{y}_{net} + b_1^c \times \min\left[y_{index}\left(\eta_{J_r-1}\right), y_{max}^c\right],$$

where $\bar{y}_{net}$ stands for economy-wide net average labor earnings. The household's pension consists of a lump-sum component b_0^c that is tied to the economy's average net earnings. In addition, a fraction b_1^c of the household's net earnings is replaced up to a ceiling of y_{max}^c. We use data from OECD (2019) on replacement rates of the pension system to parameterize b_0^c, b_1^c and y_{max}^c. Appendix C.4 provides further details as well as parameter estimates.

Details of the mortgage market We use country-specific values for the interest rate spread κ^c. To parameterize them, we compare the interest rates earned on 1-year deposits and paid on 5-year mortgages from the ECB Data Portal (ECB, 2023). As for the maximum loan-to-value ratio λ_j we proceed as follows: We assume that there is a country-specific absolute maximum $\bar{\lambda}^c$ for the loan-to-value ratio. All households under the age of 40 (model age $j = 21$) can finance their real estate up to this maximum amount. For households aged 40 and over, the allowed loan-to-value ratio decreases linearly in age until it reaches a value of zero at retirement entry. This means that

$$\lambda_j = \begin{cases} \bar{\lambda}^c & \text{if } j \leq 21 \\ \bar{\lambda}^c \times \frac{J_r - j}{J_r - 21} & \text{if } 21 < j \leq J_r \\ 0 & \text{if } j > J_r. \end{cases}$$

We choose country-specific values for $\bar{\lambda}^c$ based on the 90th percentile of the loan-to-value distribution in each country in the HFCS. Parameter values can be found in Appendix C.5.

Rental market efficiency Last but not least, we need to specify the efficiency of the rental market τ^c in each country c. We calibrate this value such that the model simulated aggregate homeownership rate matches the empirical one in each country. Table 1 compares the aggregate homeownership rate and the rental market efficiency from the data with the values generated from the 18 different versions of the model. By construction, we get an almost perfect match for the homeownership rate. In terms of rental market efficiency, we find that the model implied rental market wedge lines up pretty closely with the data on rent control in Figure 6. Figure 7 shows a scatter plot of the two series.

[13]This approach keeps the computational time of the model feasible, since it allows us to omit an extra continuous state variable that tracks a household's earnings history.

Table 1: Homeownership and rental market efficiency: data vs. model

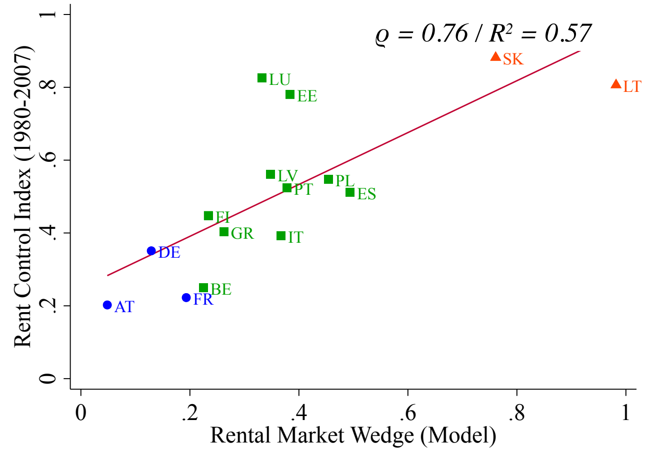
	HO rate		Rental wedge τ^c	
Country	Data	Model	Data	Model
Germany	43.44	43.44	0.3510	0.1291
Austria	45.50	45.50	0.2024	0.0484
Netherlands	57.31	57.32		0.2333
France	57.54	57.53	0.2226	0.1933
Finland	65.97	65.97	0.4479	0.2338
Italy	68.19	68.19	0.3923	0.3672
Luxembourg	68.77	68.77	0.8264	0.3320
Belgium	69.12	69.12	0.2500	0.2248
Greece	71.75	71.75	0.4036	0.2625
Latvia	72.58	72.58	0.5609	0.3480
Portugal	74.27	74.28	0.5240	0.3780
Estonia	75.17	75.17	0.7802	0.3838
Spain	75.65	75.66	0.5119	0.4939
Slovenia	76.05	76.05		0.5739
Poland	79.09	79.10	0.5476	0.4542
Hungary	83.83	83.83		0.9847
Slovakia	88.71	88.71	0.8817	0.7610
Lithuania	93.11	93.17	0.8064	0.9819
Correlation	1.000		0.758	

The correlation coefficient between the two is at a remarkable 0.76, which makes us confident that rental market efficiency is an essential driver of the aggregate homeownership rate. Note that the relationship between the rental wedge and aggregate homeownership is not linear. While the wedge tends to increase with the aggregate homeownership rate, there is still considerable variation across countries that stems from differences in earnings, taxes, pensions and the structure of the mortgage market.

5 Simulation Results

Our calibration process delivers 18 versions of our quantitative model that each stand for one of the sample countries. The only cross-country data we targeted explicitly was the aggregate homeownership rate. All other cross-country variation was estimated directly from the HFCS or external data sources. We now want to investigate how our model performs along the *untargeted dimensions* of the data. As a first step, we therefore compare the stylized facts found in the data with the corresponding results from the model. Second, we show which of the cross-country variation is important in explaining the aggregate homeownership rate. Third, we point to the central mechanisms in the model that shape the cross-

Figure 7: Rental market efficiency: data vs. model



Source: Own calculations based on HFCS and ReMaIn data.

country relationship between homeownership and wealth inequality. Finally, we provide a welfare analysis.

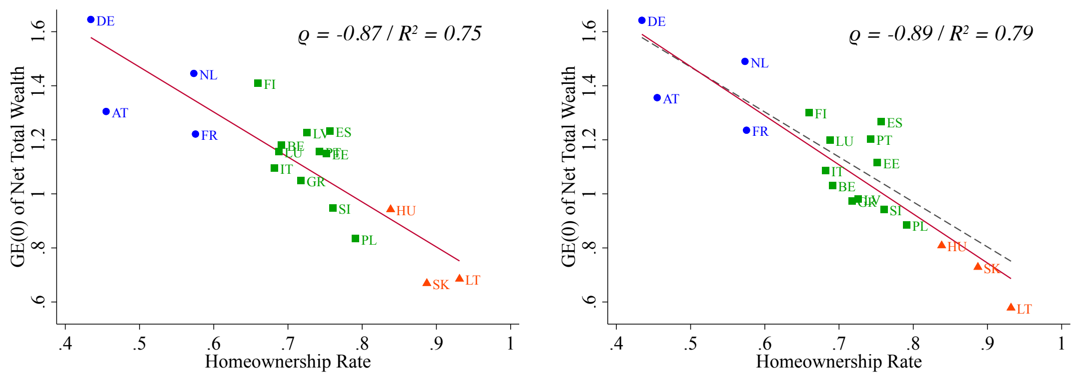
5.1 Cross-check of stylized facts

As a first evaluation of the model's success in replicating real-life patterns, we compare the stylized facts established in Section 2 with the predictions made by the model. To facilitate the visual comparison, we redraw the graphs generated from the HFCS data and directly compare them with graphs produced from the model.

Homeownership and wealth inequality Our main stylized fact concerns the cross-country relationship between homeownership and wealth inequality. In Figure 2 we found a strong and negative relationship between the aggregate homeownership rate and the $GE(0)$-index of wealth inequality across our sample countries. Figure 8 compares the corresponding stylized fact found in the data (left panel) with the predictions made from the model (right panel). In the right panel, we repeat the regression line from the data (gray dashed line). Our model does very well in capturing the variation in wealth inequality across countries. It predicts a strong negative correlation of -0.89 between aggregate homeownership and wealth inequality. In the data the correlation coefficient is -0.87. The share of variation in wealth inequality explained by a simple linear regression is 79 percent, again quite close to the empirical counterpart. Remarkably, our model is able to adequately capture the residual variation (beyond aggregate homeownership) in wealth inequality across countries. Comparing, for example, Germany and Austria, Netherlands and France, or Finland and Italy, the model is able to paint an adequate picture of these countries' wealth inequality, albeit the fact that these

Figure 8: Homeownership rates and wealth inequality: data vs. model

(a) Data (b) Model



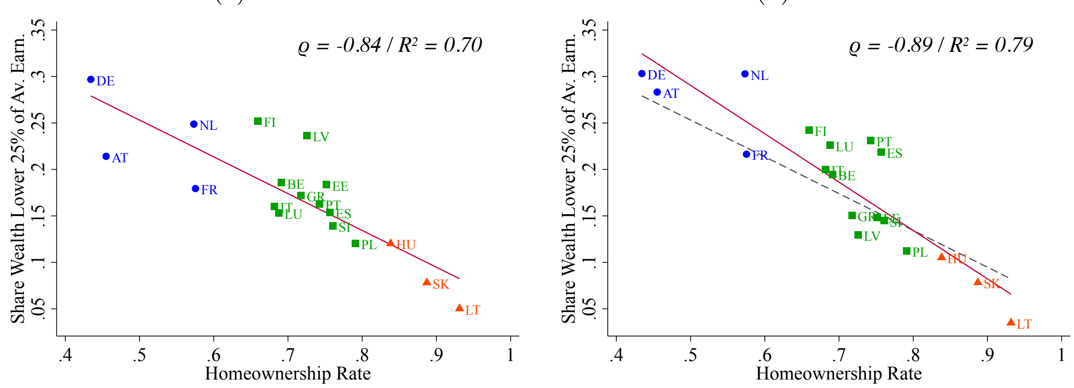
Source: (a) Own calculations based on HFCS data using all five implicates.

countries have quite similar aggregate homeownership rates. The source of this additional variation lies in the cross-country variation of labor earnings processes, tax and pension policies and the structure of the mortgage market that we consider on top of variation in the efficiency of the rental market. In Sections 5.2 and 5.3 we investigate the fit of the model and its relation to certain modeling assumptions in more detail.

Renters often hold very low wealth The HFCS data also shows considerable variation in the fraction of low-wealth households across countries. In Figure 9, we compare the fraction of households with a net wealth of less than a quarter of average annual labor earnings between the data (left) and the model (right). Again data and model show a quite similar picture. There is a strong negative

Figure 9: Homeownership rates and low-wealth households: data vs. model

(a) Data (b) Model



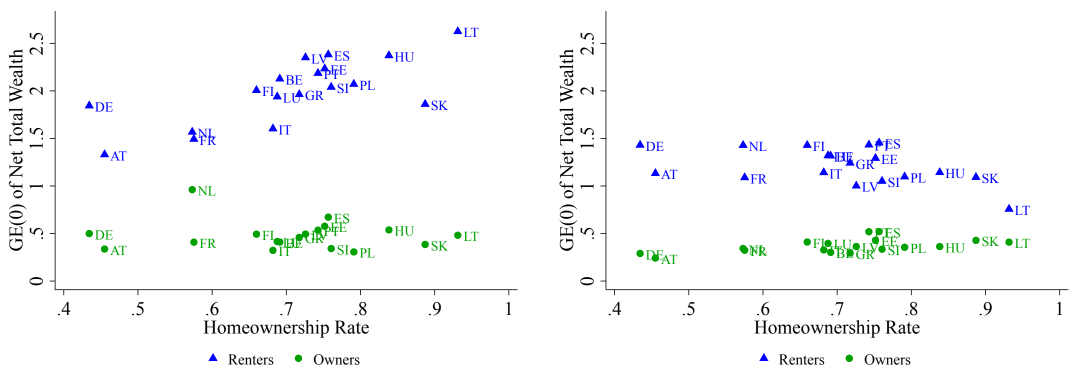
Source: (a) Own calculations based on HFCS data using all five implicates.

correlation between the aggregate homeownership rate and the share of households holding very low wealth. The correlation coefficient is -0.84 in the data and -0.89 in the model. In fact, the model predicts an even steeper relationship than the data, as it somewhat overpredicts the share of low-wealth people in Austria, in the Netherlands and in France.

A central insight from the empirical work was that renters tend to often hold very low amounts of wealth and that wealth inequality in the group of renters is typically much larger than wealth inequality in the group of owners. Figure 10 compares group-specific measures of wealth inequality both in the data and in the model. Our model is generally able to replicate the patterns found in the

Figure 10: Wealth inequality by tenure: data vs. model

(a) Data (b) Model



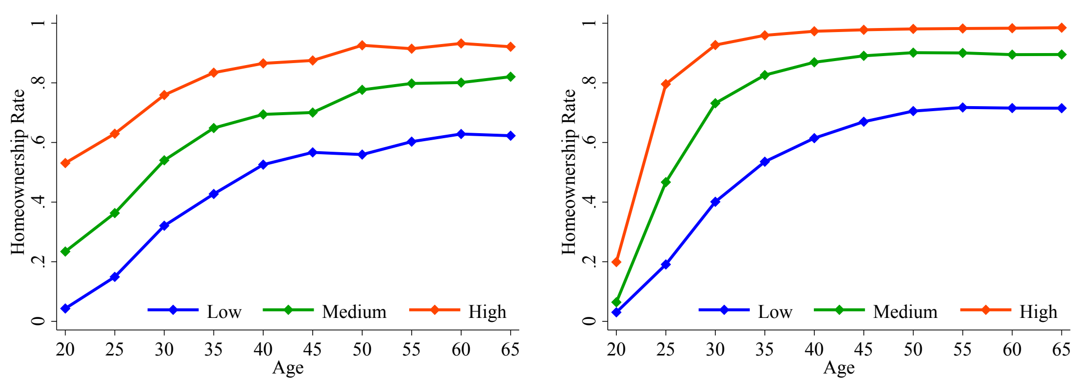
Source: (a) Own calculations based on HFCS data using all five implicates.

data. It shows a significantly higher wealth inequality within the group of renters than in the group of owners. The $GE(0)$-index of wealth inequality takes values of around 0.5 for owners and ranges between 1.0 and 1.5 for renters. Note that, as the aggregate homeownership rate increases, our model predicts the wealth inequality measure in the group of renters to stay about constant. In the data, wealth inequality in the group of renters increases. There may be two explanations for this. On the one hand, with an aggregate homeownership rate close to 1, the remaining fraction of the population who actually rent might become an ever more select group. On the other hand, owning to the small sample size of renters in high homeownership rate countries, the measure of wealth inequality may also become more noisy.

Renting and age Last but not least, we pointed to the fact that in countries with vivid rental markets, renting is a viable option for individuals of all ages. Figure 11 therefore compares the life cycle of homeownership between data and model. To facilitate comparison, we again formed three country groups according to levels of the aggregate homeownership rate. Just like in the data, we find that our model predicts homeownership rates to be consistently lower for households of all ages in countries with large rental markets. In the low homeownership group,

Figure 11: Homeownership over the life cycle: data vs. model

(a) Data (b) Model



Explanations: blue: HR $<$ 60%, green: 60% $\leq$ HR $<$ 80%, red: HR $\geq$ 80%
Source: (a) Own calculations based on HFCS data using all five implicates.

around 30 percent of the 55 to 65 year-olds are still renters. In contrast, when the aggregate homeownership rate is high, then households of all ages tend to be homeowners more often. Of course, since the life cycle of model households starts at the age of 20, there are some differences between model and data especially at young ages. Parts of this may be explained by the choice of household size, see Mitman et al. (2024).

5.2 What explains differences in homeownership?

We now want to focus on the elements in the model that are important in explaining cross-country variation in the homeownership rate. There are three domains in which the model countries differ:

1. *Wedge:* rental market efficiency as defined by the rental market wedge
2. *Income/Policy:* life-cycle earnings profiles, the variance of earnings shocks, income tax, and pension policy
3. *Mortgage:* interest rate spreads and LTV requirements on mortgages

To elaborate on the importance of these three domains for defining homeownership, we simulate different variants of the model. In each variant, we let the model parameters associated with some domains vary across countries. The model parameters of the other domains are set to their cross-country average. For each of these variants, we measure the goodness of fit with respect to the homeownership rate as

$$R_h^2 = 1 - \frac{\sum_c \left(HR^c_{model} - HR^c_{data}\right)^2}{\sum_c \left(HR^c_{data} - \overline{HR}^c_{data}\right)^2}.$$

HR_{data} denotes a country's empirical aggregate homeownership rate and HR^c_{model}

is the model generated counterpart. $\overline{HR}^c_{data}$ is the (unweighted) average homeownership rate across countries. Note that our model is highly non-linear and not necessarily mean preserving. This means that R^2_h values are not additive and that negative values of the R^2_h measure are possible.

We report the decomposition results in Table 2. A checked box for each domain means that the model parameters associated with this domain vary across countries. An unchecked box means that they are set to their cross-country averages. In addition to the goodness-of-fit measure, we also report the minimum and maximum aggregate homeownership rate. The simulation results show that

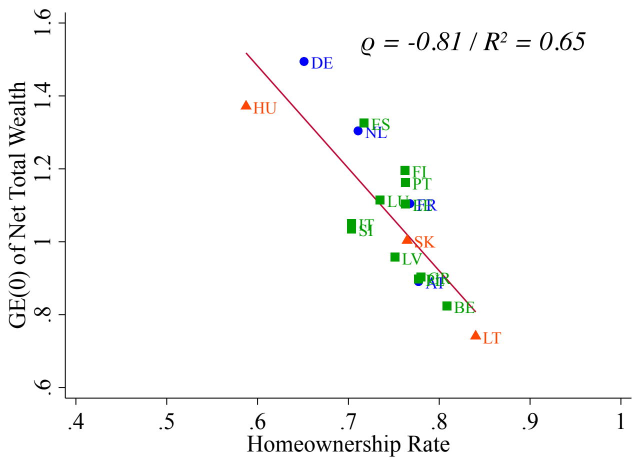
Table 2: Homeownership rates with different assumptions

Cross-Country Variation			HR		
Wedge	Income/ Policy	Mortgage	R^2_h	min	max
☑	☑	☑	1.000	0.434	0.932
☑	☑	☐	0.924	0.446	0.942
☑	☐	☑	0.852	0.409	0.895
☑	☐	☐	0.860	0.411	0.915
☐	☑	☑	−0.129	0.587	0.840
☐	☑	☐	0.050	0.665	0.849
☐	☐	☑	−0.277	0.621	0.802

cross-country differences in rental market efficiency are the single most important source of variation in explaining homeownership. A model in which only the rental market wedge τ^c varies across countries still captures 86 percent of the variation in homeownership. In turn, a model in which parameters vary along all other domains but rental market efficiency hardly explains any of the variation in the aggregate homeownership rate. This is not only true in terms of the R^2_h measure of goodness of fit, but also for the range of homeownership rates the model is able to generate. When rental market efficiency is fixed at the cross-country average, the model is not able to generate homeownership rates below 0.59 or above 0.85, while in the data the rate varies between 0.43 and 0.91.

The results in Figure 12 enforce this view. In this figure, we show the relation between aggregate homeownership and wealth inequality in a variant of the model in which all parameters vary across countries but rental market efficiency is fixed at the cross-country average. The most noticeable aspect of this figure is the discrepancy between the predicted aggregate homeownership rates and their empirical counterparts. The sample countries are lined up in a totally different order than they would empirically. In addition, the range of homeownership rates is much smaller compared to what we see in the data. To sum up, our model simulations indicate that rental market efficiency, as measured by our wedge, is the primary factor in explaining cross-country variation in homeownership rates.

Figure 12: Model performance without rental market wedge



5.3 Mechanisms that shape wealth inequality

The results in Figure 12 lead to a second important insight: Even without variation in rental market efficiency, the model predicts a strong negative correlation between aggregate homeownership and wealth inequality. While this model variant does not get aggregate homeownership rates right, the correlation coefficient between homeownership and wealth inequality is still at -0.81. This strongly suggests that the mechanisms responsible for the negative correlation between homeownership and wealth inequality across countries are to be discovered in other aspects of the model.

To get to the bottom of the causes of variation in wealth inequality, it is worth thinking about the differences between rental and housing markets in our model. Rental markets are inefficient, but at varying degrees across countries. As rental market inefficiency increases, more households are pushed into buying homes. But housing markets are frictional and therefore inefficient, too. Houses can only be bought at a minimum size of h_{min}. Together with an LTV requirement on mortgages this means that households have to provide a (potentially substantial) downpayment before being able to buy at all. This causes prospective first-time buyers to save up quickly before buying their home. The situation is enforced by non-convex adjustment costs $\gamma(h, h^+)$, which lead households to only infrequently adjust the size of their house. This means that buyers should be somewhat certain about the ideal size of their home, as errors are costly to correct. In addition, transaction costs may limit downsizing behavior when old. And since only few households are able to afford a home out of their liquid savings, young homebuyers have to take out mortgages that cause another layer of inefficiency. The interest rate spread between mortgages and deposits creates incentives for mortgagors to accumulate wealth faster than renters, who only invest in deposits. On top, LTV requirements lead owners to pay down their mortgages over the life cycle, which enforces their wealth accumulation.

To sum up, there are three major domains of the model that can influence the homeownership-wealth-inequality relationship: (i) housing market frictions, (ii) mortgage market frictions, and (iii) other country-specific parameters like income or policy. To provide a decomposition of the importance of each of these domains, we run several model variants in which we separately shut down single elements of the model. We then measure the importance of each model domain for the homeownership-wealth-inequality relationship in terms of the slope coefficient β of a linear regression of wealth inequality on the aggregate homeownership rate. Table 3 provides the results of our decomposition and Figure 13 visualizes them.

Our full model predicts a regression slope of -1.817 and therefore provides a good fit to the data. The gray dots in Figure 13 show the empirical GE(0) index of wealth inequality in our 18 sample countries. The red line is obtained from running a linear regression of wealth inequality on aggregate homeownership in our full model.

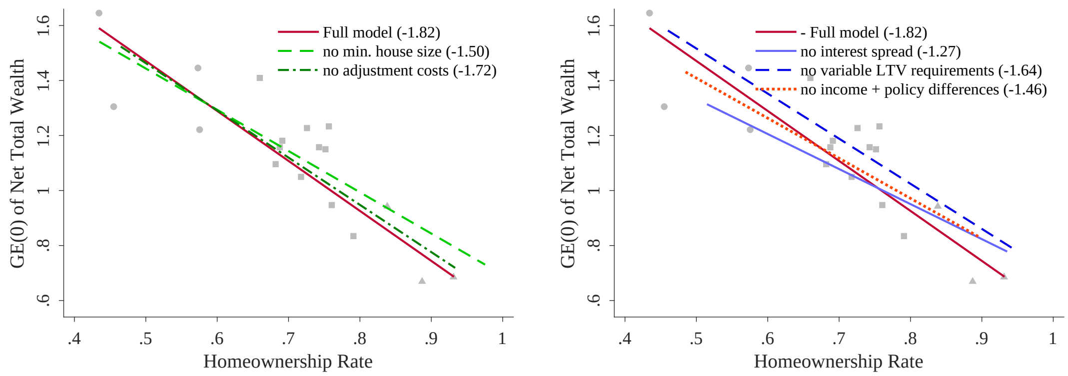
Table 3: Wealth-inequality-homeownership relationship

	$GE(0)$	
	β	Δ in %
Full model	-1.817	
Housing market frictions		
no minimum house size h_{min}	-1.500	-17.46
no adjustment costs $\gamma(h, h^+)$	-1.718	-5.49
Mortgage market frictions		
no interest rate spread κ^c	-1.274	-29.89
no variable LTV requirements λ_j	-1.640	-9.77
Other country differences		
no income & policy differences	-1.458	-19.78

Housing market frictions To understand how important housing market frictions are for shaping cross-country patterns in wealth inequality, we first run a model variant in which we eliminate the minimum house size requirement (i.e. we set $h_{min} = 0$). Second, we study a variant in which we eliminate proportional and fixed adjustment costs. Eliminating minimum housing size requirements leads to a sizable reduction of the regression coefficient of 17.5 percent, whereas the elimination of housing adjustment costs reduces the regression slope by only 5.5 percent. The left panel of Figure 13 shows that the slope changes mainly originate in high homeownership countries. The dashed green line is the regression line in the model variant without minimum house size requirement, the dash-dotted line is the one in the model variant without adjustment costs.

Figure 13: Sources of wealth inequality across countries

(a) Housing market frictions (b) Mortgage market + other frictions



A minimum house size requirement together with LTV restrictions creates a need for cash when buying a house. This need is especially severe in high homeownership rate countries, where households buy a home early in life. In these countries, minimum house size requirements force young prospective home-buyers to save up quickly to make a sizable downpayment, which leads to lower wealth inequality. Once the requirement is eliminated, inequality increases and the slope of the regression line flattens. Non-convex transaction costs have a similar effect. As adjusting real estate holdings is costly, households will try to buy a large enough house already with their first transaction. This again fuels savings of the young. On top, transaction costs make downsizing complicated, which leads old owners to decumulate less of their wealth. Both effects lead to lower wealth inequality in countries with high homeownership rates. Consequently, when transaction costs are eliminated, wealth inequality in these countries rises.

Mortgage market frictions In a second set of experiments, we examine the importance of mortgage market frictions for the homeownership-wealth-inequality relationship. First, we consider a simulation, where we set the interest rate spread κ^c to zero. Then we run a model variant, where we eliminate country- and age-specific LTV requirements. This means that we set a common threshold of $\bar{\lambda} = 0.788$ for all individuals of all ages in all countries.[14]

Mortgage market frictions have a strong impact on the relationship between wealth inequality and homeownership. Eliminating the interest rate spread between mortgages and deposits results in a substantial decline in the regression slope of almost 30 percent compared to the full model. The solid blue line in the right panel of Figure 13 illustrates this. When we eliminate the interest rate spread, we see a decrease in wealth inequality in countries with a mixed renter-homeownership balance and an increase in wealth inequality in countries with a large share of

[14]The value is the cross-country average of maximum LTV allowances $\bar{\lambda}^c$.

homeowners. We can attribute this to two opposing effects. On the one hand, the interest spread between mortgages and deposits increases the between-group inequality of renters and homeowners. It incentivizes young indebted owners to accumulate wealth quickly in order to reduce their mortgage balance. Renters, however, save less owing to the low interest rates on their deposits. On the other hand, the interest rate spread decreases wealth inequality within the group of homeowners, as it forces young homeowners to rapidly increase their wealth when paying back their mortgages, but at the same time incentivizes them to slow down their wealth accumulation afterwards. Naturally, the increase in between-group inequality is more pronounced in low homeownership countries, whereas the decrease in within-group inequality for homeowners dominates in countries with a large aggregate homeownership rate. Eventually, this leads to a significant decline in the regression slope when we eliminate the interest rate spread from our model.

When we shut down country- and age-specific LTV requirements, the slope of the regression line reduces by almost 10 percent. The dashed blue line in Figure 13 illustrates this model variant. LTV restrictions, similar to minimum house size requirements, decrease wealth inequality within the group of current and future homeowners, as they force young prospective home-buyers to save up quickly in order to make a sizable downpayment, and keep indebted owners saving as they have to gradually pay down their mortgage balance up to their date of retirement. Consequently, the elimination of LTV requirements leads to an overall higher level of wealth inequality. The effect is particularly pronounced in high homeownership countries, which flattens the regression line.

Income and policy In the final model variant, we eliminate differences in income profiles, labor market risk, and tax and pension policy across countries. The results are displayed in the last row of Table 3. Consistent with the view that wealth inequality is partly a mirror of inequality in net earnings, eliminating cross-country differences in income and policy parameters decreases the regression slope by about 20 percent. This situation is also shown as dotted red line in the right panel of Figure 13.

Summary Summing up, in economies with inefficient rental markets, households are pushed into homeownership and must contend with both housing and mortgage market frictions. The results in this section confirm that both types of frictions are important in shaping the cross-country relationship between homeownership and wealth inequality. Mortgage market frictions alone can account for almost 40 percent of this relationship, with the most important explanatory factor being the interest rate spread between mortgages and deposits. Housing market frictions contribute around 23 percent, most importantly through the minimum house size requirement.[15]

[15] Note that the effects in Table 3 do not sum up to 100 percent, as there can be interaction effects between the different model elements.

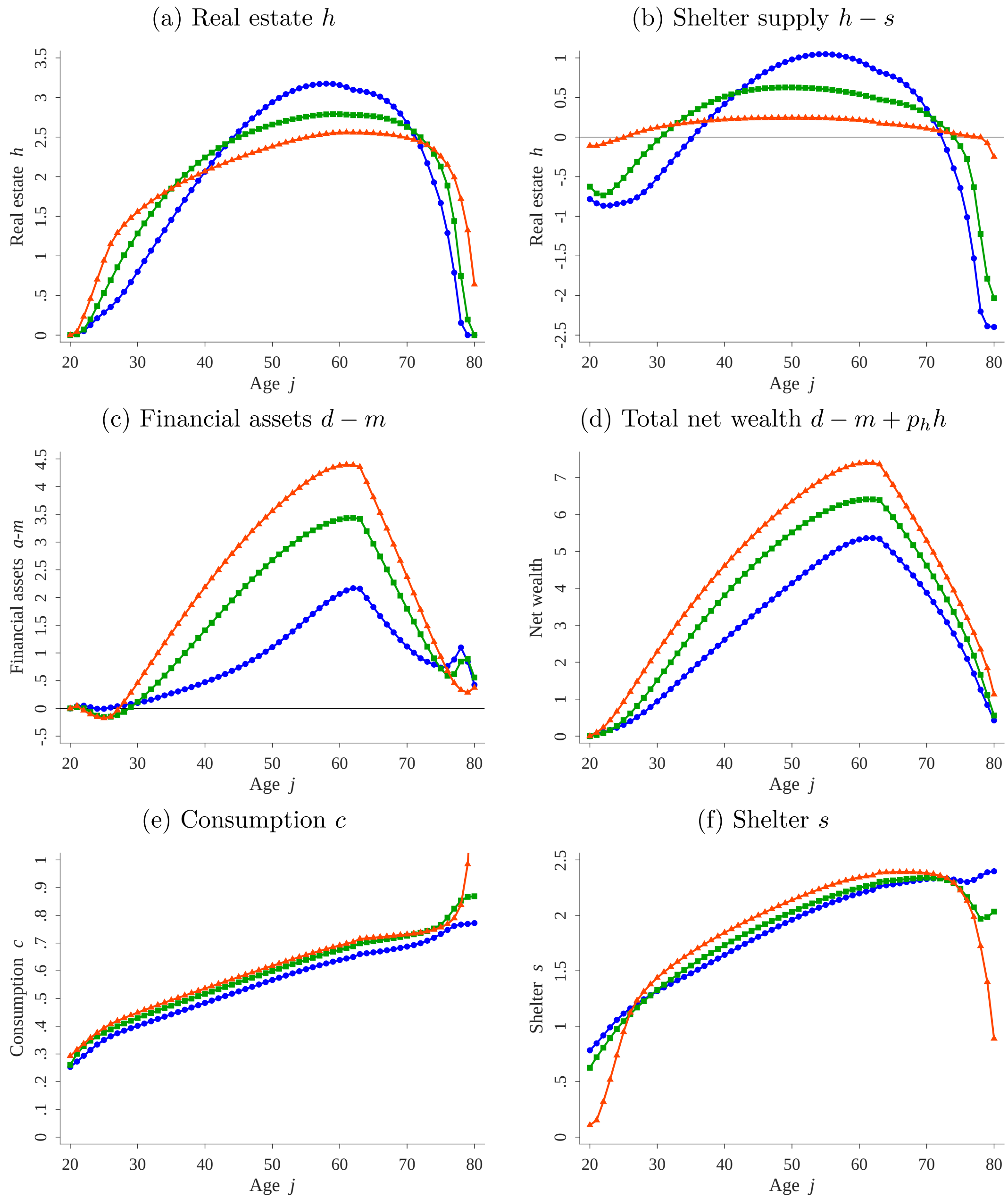
5.4 Understanding life-cycle behavior

We briefly want to study the life-cycle behavior of households in countries with different aggregate homeownership rates. To isolate the effect of rental market efficiency on household behavior, we conduct the following simulation exercise: We set country-specific rental market efficiencies τ^c to their calibrated values in the baseline simulation model. However, we average income profiles, labor market risk parameters, policy parameters, and mortgage parameters across countries. We then form three country groups according to their aggregate homeownership rates, and calculate (unweighted) average life-cycle profiles over each group. Blue dots stand for countries with aggregate homeownership rates less than 60%, green squares for medium-range homeownership rates between 60% and 80%, and red triangles for high homeownership rates above 80%.

Figure 14 illustrates the life-cycle profiles of various economic factors: real estate holdings h, shelter supply $h - s$ (real estate holdings minus self-consumed shelter), financial assets $d - m$, total net wealth $d - m + p_h h$, regular consumption c, and shelter consumption s. A distinct pattern emerges in household investment behavior. In countries with efficient rental markets, households tend to purchase real estate later in life. Consequently, real estate holdings are more concentrated among middle-aged to older households, who often become outright owners and landlords. This creates a clear pattern of shelter supply over the life cycle, where younger and very old households rent from those in their middle years. Conversely, in countries with inefficient rental markets, shelter supply is nearly zero. Households in these regions strive to buy homes as early as possible, financing these purchases with substantial mortgages. Due to high mortgage rates, they accumulate more financial assets over their life cycle but have fewer real estate holdings around retirement age compared to their peers in low homeownership rate countries. The early purchase of real estate, coupled with high mortgage amounts and interest rates, drives net wealth accumulation in high homeownership rate countries. This results in higher net wealth levels throughout the life cycle in these countries.

Regular consumption c in panel (e) of Figure 14 follows a typical life-cycle pattern, with consumption levels increasing over time. Recall that the calibrated time discount factor is $\beta = 0.992$, which means that the time preference rate is higher than the interest rate. In high homeownership countries, consumption levels are relatively low for the very young and high for the very old. Young households in these countries, who do not own real estate, must purchase shelter at high rental market prices, reducing their regular consumption expenditure. Conversely, older households retain their real estate until late in life, maintaining significant wealth which they eventually convert into consumption. Shelter consumption, shown in panel (f), is primarily influenced by shelter prices and real estate holdings. In countries with high homeownership rates and inefficient rental markets, young households face high rental prices, limiting their ability to purchase shelter. Shelter consumption also declines towards the end of the life cycle

Figure 14: Life-cycle profiles (varying only τ)



Explanations: blue: HR $< 60\%$, green: $60\% \leq$ HR $< 80\%$, red: HR $\geq 80\%$

as individuals liquidate their real estate holdings. However, the cash from selling homes allows older households to consume more shelter than younger ones.

5.5 Some Normative Implications

If we consider the rental market wedge τ^c as indicative of costs or inefficiencies that could eventually be overcome, it is reasonable to question the burden these inefficiencies place on affected households. As mentioned earlier, inefficiencies in the rental market push households into purchasing real estate quickly. However, the real estate market also has significant frictions and inefficiencies. Conversely, a well-functioning rental market can limit households' exposure to severe housing and mortgage market frictions. When young, households have the time to wait until (i) their labor market uncertainty has largely resolved and (ii) they have built enough liquid wealth to purchase a house of their ideal size and quality. Meanwhile, they can rent property at fair prices or even choose to remain renters for their entire lives. These effects allow for better smoothing of consumption and shelter expenditure over the life cycle, as shown in Figure 14.

In order to assess the welfare effects of rental market efficiency, we use the simulation experiment of the previous section, i.e. only the rental market wedge varies across countries and all other parameters are set to cross-country average values. In this scenario, we calculate ex-ante expected utility

$$U_0^c = \mathbb{E}_0 \left[\sum_{j=1}^{J} \beta^{j-1} \frac{\left[(c_j)^{1-\alpha}(s_j)^{\alpha}\right]^{1-\sigma}}{1-\sigma} \right]$$

for each country c. Our measure of welfare is the consumption equivalent variation

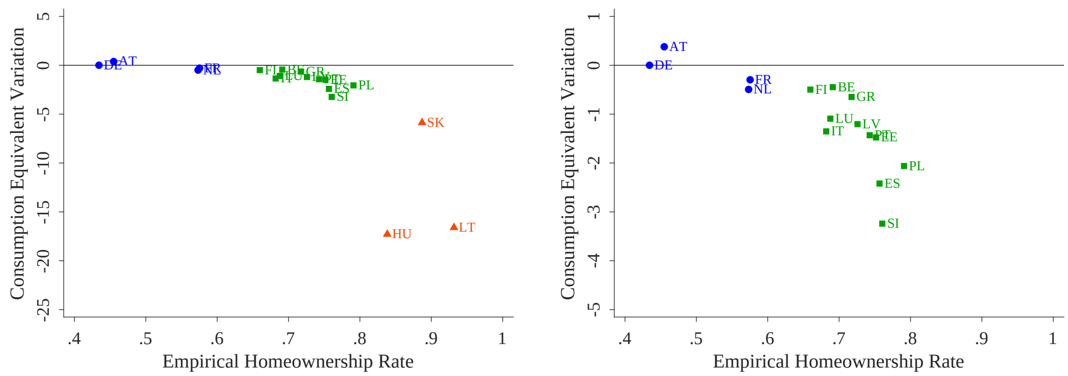
$$\phi^c = \left\{ \left[\frac{U_0^c}{U_0^{\mathrm{DE}}} \right]^{\frac{1}{(1-\sigma)(1-\alpha)}} - 1 \right\} \times 100.$$

ϕ^c measures the percentage share of regular consumption c that we would have to give to or take away from households at all ages and all potential states in Germany in order to make them as well of as households living in a country with rental market regulation τ^c.

The welfare results are summarized in Figure 15. The horizontal axis shows a country's empirical homeownership rate, while the vertical axis displays the consumption equivalent variation between living in the German rental market regime and other degrees of rental market efficiency. The right panel zooms in by excluding high homeownership countries. There is a clear negative correlation between aggregate homeownership and aggregate welfare. This is not surprising, as high homeownership rates result from significant inefficiencies in the rental market and frictions in the housing market. Note that this relationship is not monotonic, as rental market efficiency varies non-monotonically across countries, as shown in Table 1. In countries with very high homeownership rates, households are up to 20 to 25 percent worse off in consumption terms. Even in countries with medium homeownership rates, welfare is about 1 to 4 percent lower than under the German rental market regulation.

Figure 15: Welfare effects (varying only τ^c)

(a) All countries (b) Excluding very high HR



6 Conclusion

In this paper, we have demonstrated a robust negative relationship between the aggregate homeownership rate and wealth inequality across Euro-Area countries and beyond. We argue that variations in the aggregate homeownership rate reflect differences in the efficiency of rental markets across countries. When rental markets are inefficient, households are compelled to purchase real estate early in life and to hold onto it for their lifetime. This exposes them to significant frictions in the housing and mortgage markets, which in turn decreases wealth inequality. Our welfare analysis shows that households would prefer to live in a country with efficient rental markets and higher wealth inequality.

One implication of these results is that, to the extent they can be attributed to more inefficient rental markets, variations in wealth inequality across countries should be viewed contrary to the normative intuition the reader might have: a higher degree of wealth inequality is actually beneficial. This is not because wealth inequality is intrinsically valuable, but because it reflects better consumption smoothing over the life cycle and less severe exposure to housing market frictions. This can be summarized by two general observations: First, more equality can be a symptom of underlying inefficiency, counteracting the typical equity-efficiency trade-off that researchers often consider when discussing inequality. Second, without a clear theory of the emergence of wealth inequality, merely looking at wealth data may be misleading regarding whether households are overall better or worse off. This applies both to a cross-section of countries and to the dynamics of wealth inequality within any given country. For example, one could imagine a high homeownership country implementing policies that liberalize rental markets and subsequently seeing its wealth inequality rise. Our model suggests that this increase in inequality should be welcomed as a sign that the reforms are working and overall welfare is increasing.

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Rental Markets and Wealth Inequality in the Euro-Area

Appendix for Online Publication

Johannes Huber, Fabian Kindermann and Sebastian Kohls

A Additional Data Work

A.1 Detailed data description

The household finance and consumption survey is a household survey with a focus on wealth and consumption conducted in the entire Euro Area as well as Poland and Hungary. At the country level, the sample selection is similar to the US Survey of Consumer Finances, meaning that wealthy households are oversampled. We restrict our attention to the third wave of the survey, the data of which was collected in 2017. For each survey respondent, we observe the total amount of

1. *real assets* as the value of her main residence, other real estate property, vehicles, valuables and self-employment businesses,[16]

2. *financial assets* (deposits, mutual funds, bonds, non-self-employment private business, shares, managed accounts, outstanding claims towards third parties, voluntary pensions, whole life insurance plans and other financial assets), and

3. *liabilities* (outstanding mortgage and non-mortgage debt).

We measure household's total *net wealth* as the sum of real and financial assets minus liabilities.

We standardize all wealth and other monetary measures of the household by the standard OECD equivalence scale in order to account for differences in the demographic composition across different entities. We define the household's age as the age of the household head according to the UN/Canberra definition. Finally, we drop the top 1% wealth rich households from the sample in order to create a better match between the data and the simulation model we use.

[16]Real assets are valued at current market prices as estimated by the respondent or imputed if necessary. In the latter case, the survey provides 5 different imputations.

Table A.1 summarizes the dataset. The number of respondent households is quite unevenly distributed across countries. While small countries like Luxembourg and Slovenia naturally have a smaller number of respondents, countries like Finland and France have gathered more than 10,000 household observations. Germany, being the largest economy of the Euro area in terms of population size has about 4,800 observations. The sampling weights provided in the HFCS correct for these different subsample sizes, so that a weighted aggregate statistic in the pooled country sample is calculated with realistic country sizes, see the column "Weighted HH". Finally, we find that the aggregate homeownership rate differs substantially across countries. While in Germany and Austria only about 45 percent of households own their primary residence, around 90 percent of households in Slovakia and Lithuania are outright owners.

Table A.1: Sample Description

Country		No. of HH	Weighed HH (in million)	Homeownership Rate (in %)
Austria	(AT)	3,044	3,896,013	45.50
Belgium	(BE)	2,296	4,836,905	69.12
Germany	(DE)	4,820	39,952,874	43.44
Estonia	(EE)	2,641	584,947	75.17
Spain	(ES)	5,647	18,356,719	75.65
Finland	(FI)	10,026	2,650,339	65.97
France	(FR)	12,279	29,034,306	57.54
Greece	(GR)	2,984	4,120,957	71.75
Croatia	(HR)	1,338	1,480,368	85.19
Hungary	(HU)	5,843	3,964,358	83.83
Italy	(IT)	7,346	25,269,544	68.19
Lithuania	(LT)	1,639	1,274,193	93.11
Luxembourg	(LU)	1,587	224,216	68.77
Latvia	(LV)	1,226	828,505	72.58
Netherlands	(NL)	2,525	7,717,644	57.31
Poland	(PL)	5,806	13,241,568	79.09
Portugal	(PT)	5,792	4,076,922	74.27
Slovenia	(SI)	1,995	816,496	76.05
Slovakia	(SK)	2,160	1,833,800	88.71
Total		80,994	164,160,674	

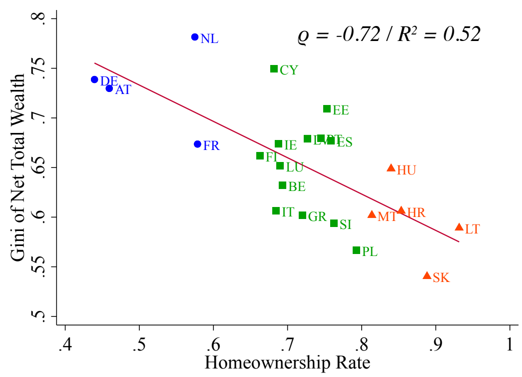
A.2 Measures of Wealth Inequality

In this appendix, we investigate whether our choice of measure and our choice of sample selection is important for our main stylized fact: a strong and negative correlation between wealth inequality and homeownership. To this end, Figure

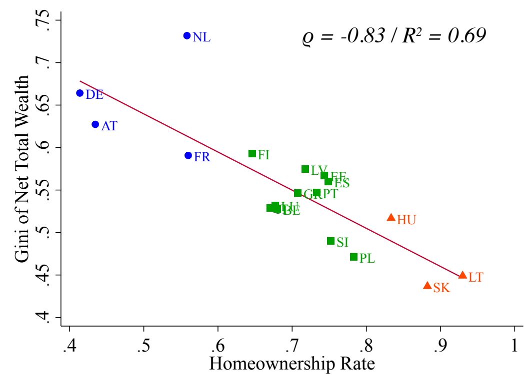
A.1 plots cross-country correlations between the Gini index of wealth inequality and the aggregate homeownership rate for different selections of the sample. In panel (a) we use the full sample including all households in all countries, in panel (b) we only look at the bottom 95% of the wealth distribution. Recall that in our main sample in the paper, we only drop the top 1% wealth holders. In panel (c) we only look at people with a positive net wealth and in panel (d) we only consider the working age population, meaning all households in which the household head is age 60 or younger. In all graphs, we can see the same strong and negative correlation between wealth inequality and aggregate homeownership, which confirms our view that sample selection is not a driver of our results.

Figure A.1: Gini index for different selected samples

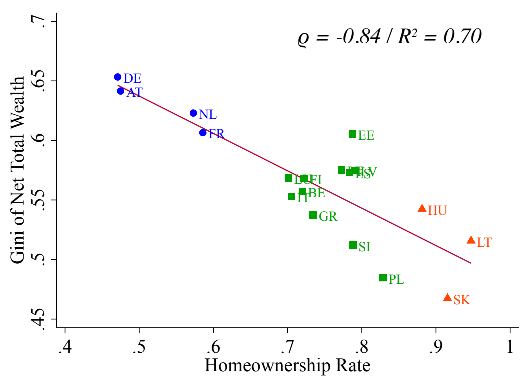
(a) Full sample



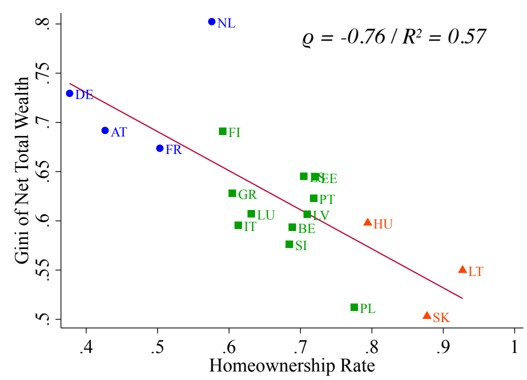
(b) Bottom 95% of wealth distribution



(c) Only positive net wealth



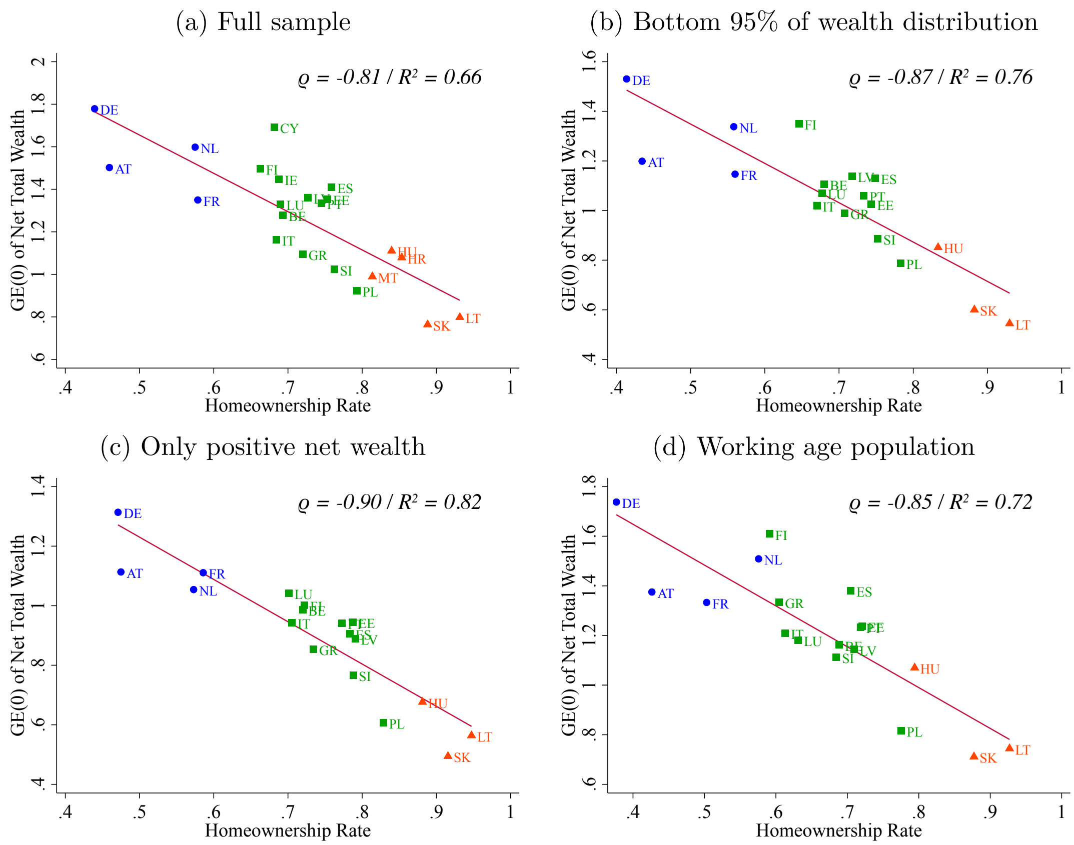
(d) Working age population



Source: own calculations based on HFCS using all five implicates

In Figure A.2 we repeat the same exercise, but with our preferred measure of wealth inequality, the $GE(0)$ index. We see the very same pattern as in Figure A.1, meaning a strong and negative correlation between wealth inequality and homeownership in all sample selections. This leads us to the conclusion that our main stylized fact is also not very sensitive to our measure of wealth inequality.

Figure A.2: $GE(0)$ index for different selected samples



Source: own calculations based on HFCS using all five implicates

A.3 Cross-check with other survey waves

The Household Finance and Consumption survey was first conducted around the year of 2008/09. Since then, there have been three survey waves. Wave 1 was made available in 2010 and Wave 2 was made available in 2014. In this paper, we are using wave 3, which was made available in 2017. In Figure A.3 we show that our main stylized fact, a strong and negative cross-country correlation between wealth inequality and homeownership, also holds in the other survey waves.

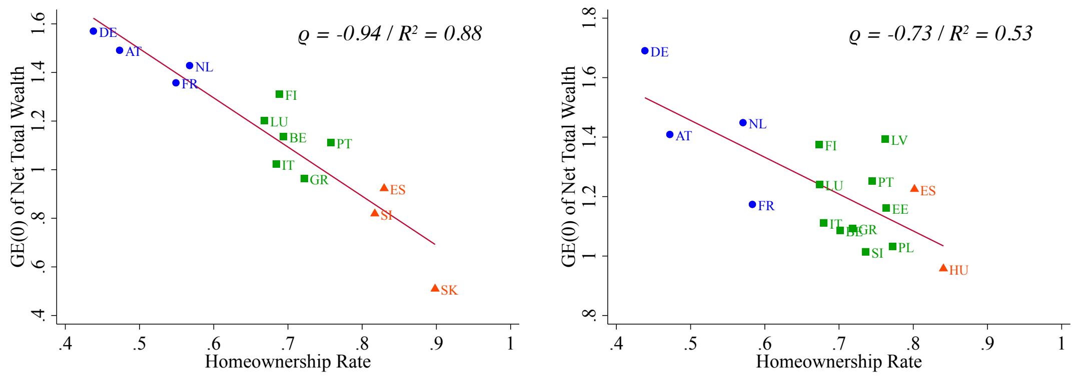
A.4 A Formal Decomposition of the $GE(0)$ index

The $GE(0)$ is a member of a more general class of generalized entropy indices with parameter α:

$$GE(\alpha) = \begin{cases} -\frac{1}{N} \cdot \sum_{i \in \mathcal{N}} \log\left(\frac{w_i}{\bar{w}}\right) & \text{for } \alpha = 0, \\ \frac{1}{N} \cdot \sum_{i \in \mathcal{N}} \frac{w_i}{\bar{w}} \cdot \log\left(\frac{w_i}{\bar{w}}\right) & \text{for } \alpha = 1, \text{ and} \\ \frac{1}{N \cdot \alpha(\alpha - 1)} \cdot \sum_{i \in \mathcal{N}} \left[\left(\frac{w_i}{\bar{w}}\right)^{\alpha} - 1\right] & \text{otherwise.} \end{cases} \quad (11)$$

Figure A.3: Wealth inequality and homeownership in other waves

(a) Wave 1 (2010) (b) Wave 2 (2014)



Source: own calculations based on HFCS using all five implicates

The class of generalized entropy indices measures equality of some variable w_i in a population $\mathcal{N}$ of size N. The variable $\bar{w}$ denotes the population average of w_i. Different orders of the generalized entropy index place different weights on particular parts of the distribution. As a rule of thumb, the $GE(0)$-index places a lot of weight on the bottom end of the distribution. Just like the Gini-index, the $GE(1)$ is sensitive to changes in the middle parts of the distribution, while the $GE(2)$ index places more weight on the upper end extremes. Using $\alpha = 0$, we measure the log-deviation of net wealth from its mean. Note that, because we are using the logarithm, we have to make an assumption regarding households who have zero or negative net wealth. Throughout this paper, whenever we calculate the $GE(0)$ index, we therefore "recode" all households to have a net wealth level that amounts to at least 1% of average labor earnings. Since the fraction of households with zero or negative wealth is generally small in our sample and in our model, this does not play a huge role in shaping our results. We ran robustness checks by simply excluding these households and it did not make any difference, see panel (c) in Figure A.2.

The $GE(0)$-index is additively decomposable. Let us define two subgroups $\mathcal{N}_a$ and $\mathcal{N}_b$ of the total population, such that $\mathcal{N} = \mathcal{N}_a \cup \mathcal{N}_b$. Let us further denote $N_a = |\mathcal{N}_a|$ and $N_b = |\mathcal{N}_b|$. Then we can write

$$\begin{aligned} GE(0) &= -\frac{1}{N} \cdot \sum_{i \in \mathcal{N}} \log\left(\frac{w_i}{\bar{w}}\right) \\ &= -\frac{N_a}{N} \cdot \frac{1}{N_a} \sum_{i \in \mathcal{N}_a} \log\left(\frac{w_i}{\bar{w}_a} \cdot \frac{\bar{w}_a}{\bar{w}}\right) - \frac{N_b}{N} \cdot \frac{1}{N_b} \sum_{i \in \mathcal{N}_b} \log\left(\frac{w_i}{\bar{w}_b} \cdot \frac{\bar{w}_b}{\bar{w}}\right) \\ &= \left(1 - \frac{N_b}{N}\right) \cdot \left[-\frac{1}{N_a} \sum_{i \in \mathcal{N}_a} \log\left(\frac{w_i}{\bar{w}_a} \cdot \frac{\bar{w}_a}{\bar{w}}\right)\right] + \frac{N_b}{N} \cdot \left[-\frac{1}{N_b} \sum_{i \in \mathcal{N}_b} \log\left(\frac{w_i}{\bar{w}_b} \cdot \frac{\bar{w}_b}{\bar{w}}\right)\right] \end{aligned}$$

$$
\begin{aligned}
&= \left(1 - \frac{N_b}{N}\right) \cdot \left[-\frac{1}{N_a} \sum_{i \in \mathcal{N}_a} \log\left(\frac{w_i}{\bar{w}_a}\right) - \log\left(\frac{\bar{w}_a}{\bar{w}}\right) \right] \\
&\qquad\qquad\qquad\qquad + \frac{N_b}{N} \cdot \left[-\frac{1}{N_b} \sum_{i \in \mathcal{N}_b} \log\left(\frac{w_i}{\bar{w}_b}\right) - \log\left(\frac{\bar{w}_b}{\bar{w}}\right) \right] \\
&= \left(1 - \frac{N_b}{N}\right) \cdot WR_a + \frac{N_b}{N} \cdot WR_b + \left(1 - \frac{N_b}{N}\right) \cdot GE_a + \frac{N_b}{N} \cdot GE_b
\end{aligned}
$$

with group-specific (negative) log-mean-ratios and GE indices

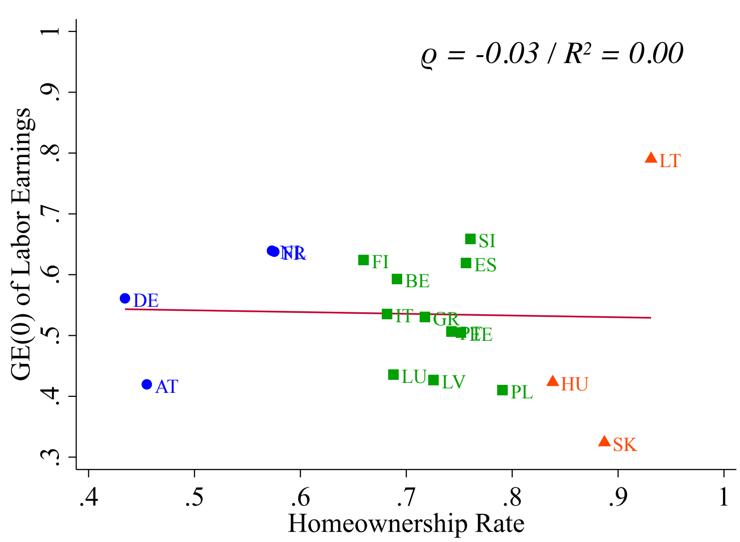
$$
WR_g = -\log\left(\frac{\bar{w}_g}{\bar{w}}\right) \quad \text{and} \quad GE_g = -\frac{1}{N_g} \sum_{i \in \mathcal{N}_g} \log\left(\frac{w_i}{\bar{w}_g}\right)
$$

where $\bar{w}_g$ denotes the group-specific mean of the variable w_i. Now let us define group a as the group of renters and group b as the group of owners. Then HR $= \frac{N_b}{N}$ is the economy's aggregate homeownership rate and the above decomposition immediately implies (1).

A.5 Alternative mechanisms

In Section 2.3, we discussed some mechanisms that are potential candidates in explaining cross-country variation in wealth inequality. Figure A.4 shows the cross-country correlation between labor earnings inequality and the aggregate homeownership rate. We can see that there is clearly no significant correlation between the two.

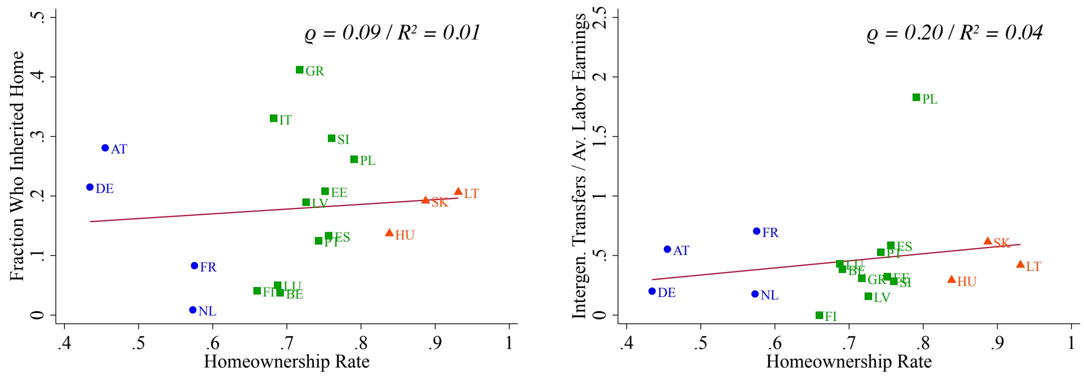
Figure A.4: Homeownership and Earnings Inequality



Source: Own calculations based on HFCS data using all five implicates.

In Figure A.5 we investigate the cross-country relationship between aggregate homeownership and the fraction of owners that inherited their home as well as the size of intergenerational transfers to people under the age of 40. Again, there is no strong relationship with aggregate homeownership. This suggests that inheritances and intergenerational transfers are less promising channels in explaining the cross-country correlation between wealth inequality and aggregate homeownership.

Figure A.5: Inheritances and intergenerational transfers



Source: Own calculations based on HFCS data using all five implicates.

B Equilibrium Definition

We now want to formally define an equilibrium of the economy.

Definition 1 (Stationary Recursive Competitive Equilibrium)**.** *Given a world interest rate r_w and a set of fiscal policies $(T(\cdot), p, G)$, a stationary recursive competitive equilibrium for the economy is a collection of value and policy functions (v, c, s, d^+, h^+, m^+), for the household, optimal input choices (K, L), a trade balance TB, a wage rate w, a shelter price p_s, a house price p_h, and an invariant probability measure Φ with the following properties:*

1. *[Household maximization] Given prices (w, r, p_s, p_h) and fiscal policies, the value function v satisfies the Bellman equation (7), and (c, s, d^+, h^+, m^+) are the associated policy functions.*
2. *[Firm optimization]: Given wages w and a world interest rate r_w the firm's choices satisfy*

$$r_w = \epsilon\Omega \left(\frac{L}{K}\right)^{1-\epsilon} - \delta_k \quad \text{and} \quad w = (1-\epsilon)\Omega\left(\frac{L}{K}\right)^{-\epsilon}.$$

3. *[Government budget constraint] The government's budget (8) is balanced.*
4. *[Market clearance]*
   - *(a) The labor market clears:*

$$L = \int y(j, \eta, d, m, h)\ d\Phi$$

   - *(b) The capital market clears:*

$$K = \int d(j, \eta, d, m, h) - m(j, \eta, d, m, h)\ d\Phi - Q$$

   - *(c) The housing market clears:*

$$H = \int h(j, \eta, d, m, h)\ d\Phi$$

   - *(d) The rental market clears:*

$$\underbrace{\int \mathbb{1}_{h=0} \cdot s\ d\Phi}_{\text{shelter demand}} = \underbrace{\int \mathbb{1}_{h>0} \cdot (h - s)(1-\tau)\ d\Phi}_{\text{shelter supply}}$$

   - *(e) The balance of payments identity is satisfied:*

$$TB = -r_w Q$$

(f) *The goods market clears:*

$$Y = C + \Psi_\gamma + \Psi_\kappa + p_h \delta_h H + \delta_K K + G + TB$$

with

$$\begin{aligned}
C &= \int \ c(j,\eta,d,m,h)\ d\Phi, \\
\Psi_\gamma &= \int \ \gamma\Big(h, h^+(j,\eta,d,m,h)\Big)\ d\Phi, \ \ \textit{and} \\
\Psi_\kappa &= \frac{\kappa}{2} \times \int \ d(j,\eta,d,m,h) + m(j,\eta,d,m,h)\ d\Phi.
\end{aligned}$$

5. *[Consistency of Probability Measure] The invariant probability measure Φ is consistent with the population structure of the economy, with the risk process for labor earnings, and the household policy functions (d^+, h^+, m^+).*

C Calibration

C.1 Summary of calibrated country-invariant parameters

Table C.1 summarizes the model parameters that are common across all countries.

Table C.1: Summary of parameters invariant across countries

Parameter	Description	Value
α	Shelter-share of expenditure	0.160
σ	Relative risk aversion	2.000
β	Discount factor	0.992
ϵ	Capital intensity of production	0.300
r_w	World interest rate	0.025
δ_k	Depreciation of capital	0.059
$\bar{S}/Y$	Shelter stock (as multiple of German GDP)	1.828
δ_h	Depreciation of real estate	0.025
γ_0	fixed adjustment costs for house buying	0.150
γ_1	proportional transaction costs houses	0.050

C.2 Estimating income profiles and processes

We define the labor earnings dynamics in logs as

$$\log(y) = \log(w) + \log(e_j) + \eta \quad \text{with} \quad \eta^+ = \rho\eta + \varepsilon^+$$

and $\varepsilon^+ \sim N(0, \sigma_\varepsilon^2)$. Recall that we normalized $w = 1$. We use cross-sectional information on household labor earnings from the HFCS to pin down the parameters of the above equation. We assume that both the labor earnings profile e_j as well as the innovation variance σ_ε^2 are country specific.

In a first step, we run regressions of the form

$$\log(\hat{y}_i^c) = a_j^c + \nu_i^c,$$

where $\hat{y}_i^c$ is the labor earnings observation of a household i in country c in the HFCS. a_j^c is an age fixed-effect and ν_i^c is the regression residual. The resulting age fixed effects as well as their standard errors are shown in Figure C.1.

Next we want to put some structure on the age-earnings profile, as the age-fixed effects exhibit quite some noise in some countries that have a relatively small sample size. To this end, we specify a flexible functional form

$$\log(e_j) = \theta_0^c + \theta_1^c \times j + \theta_2^c \times \mathbb{1}_{j \le J_l^c} \times \frac{(j - J_l^c)^3}{10000} + \theta_3^c \times \mathbb{1}_{j \ge J_u} \times \frac{(j - J_u)^3}{10000}$$

for the labor earnings profile in each country that allows us to capture the particularities of the profile. We set $J_u = 50$ for all countries. The specified profiles then have 5 free parameters per country $(\theta_0^c, \theta_1^c, \theta_2^c, \theta_3^c, J_l^c)$. We estimate these parameters by minimizing a residual sum of squares

$$(\theta_0^c, \theta_1^c, \theta_2^c, \theta_3^c, J_l^c) = \arg\min \sum_{j=20}^{62} (a_j^c - e_j)^2.$$

The parameter estimates are shown in Table C.2. The resulting life-cycle earnings profiles are shown as blue lines in Figure C.1.

Table C.2: Results of estimation process for life-cycle earning profiles

Country	θ_0^c	θ_1^c	θ_2^c	θ_3^c	J_l^c
Germany	−0.6918	0.0096	5.0896	−1.3233	34
Austria	−0.7294	0.0136	−0.2321	−3.8942	32
Netherlands	−0.1602	−0.0002	8.5784	0.6087	34
France	−0.4611	0.0056	2.0132	−1.4354	33
Finland	−0.6066	0.0102	5.7090	−2.3745	33
Italy	−0.3274	0.0023	2.5905	−1.4520	34
Luxembourg	−0.1596	−0.0015	6.3870	−1.3625	32
Belgium	−0.1327	−0.0011	11.2751	0.1053	31
Greece	−0.1920	0.0001	13.6808	−0.4368	29
Latvia	0.0981	−0.0086	12.2064	1.3222	28
Portugal	−0.2463	−0.0006	1.4394	−0.4438	39
Estonia	−0.0585	−0.0043	129.5081	−0.5768	25
Spain	−0.2120	−0.0022	3.6622	0.9382	36
Slovenia	−0.4623	0.0053	4.0686	−2.8289	31
Poland	0.2694	−0.0108	1.2557	−0.0622	38
Hungary	−0.0595	−0.0046	25.8913	−0.1157	27
Slovakia	−0.5245	0.0080	13.4387	−1.3746	27
Lithuania	−0.2195	−0.0005	12.5292	−1.4755	27

Figure C.1: Estimated life-cycle labor earnings profiles

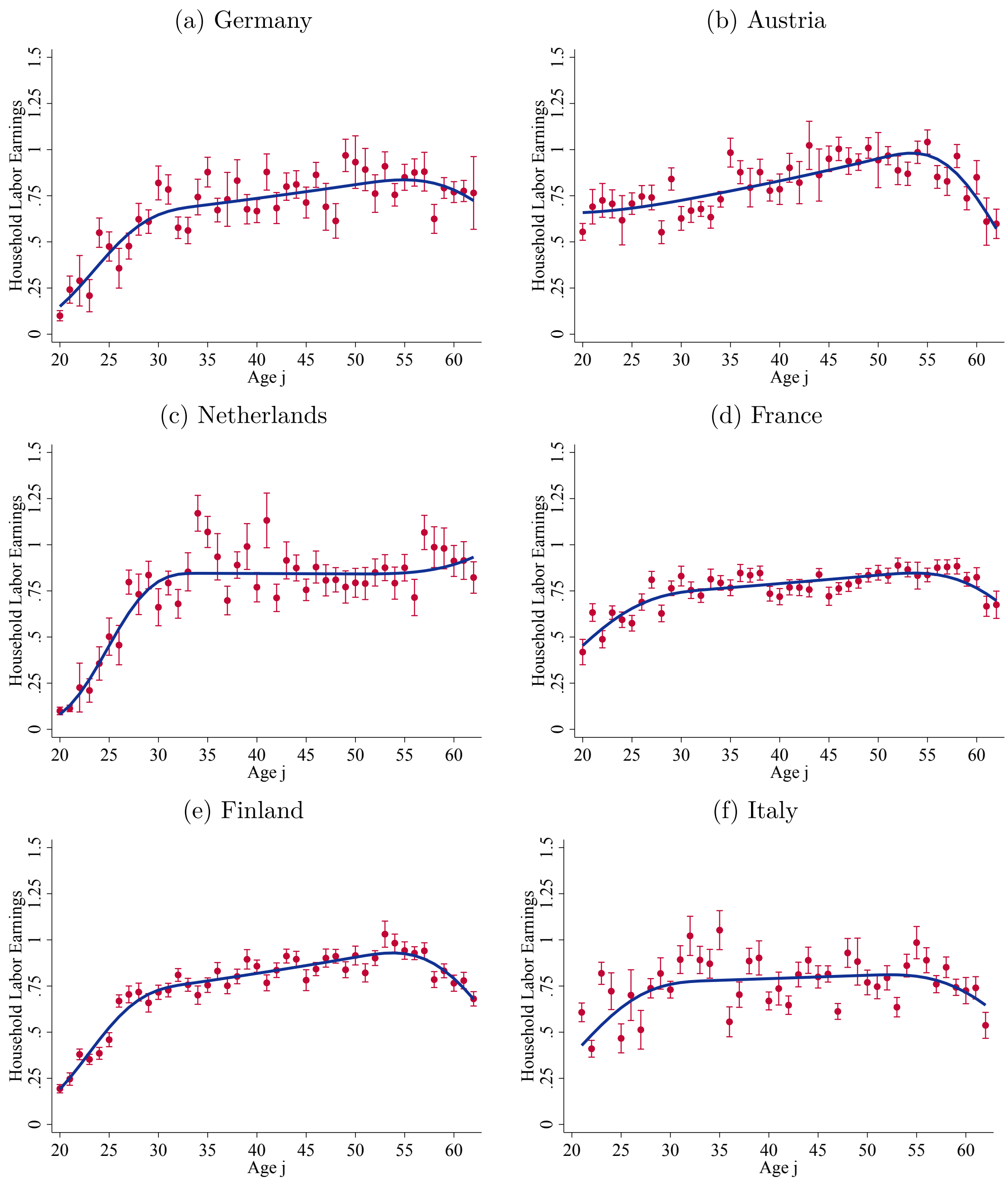


Figure C.1: Estimated life-cycle labor earnings profiles (cont.)

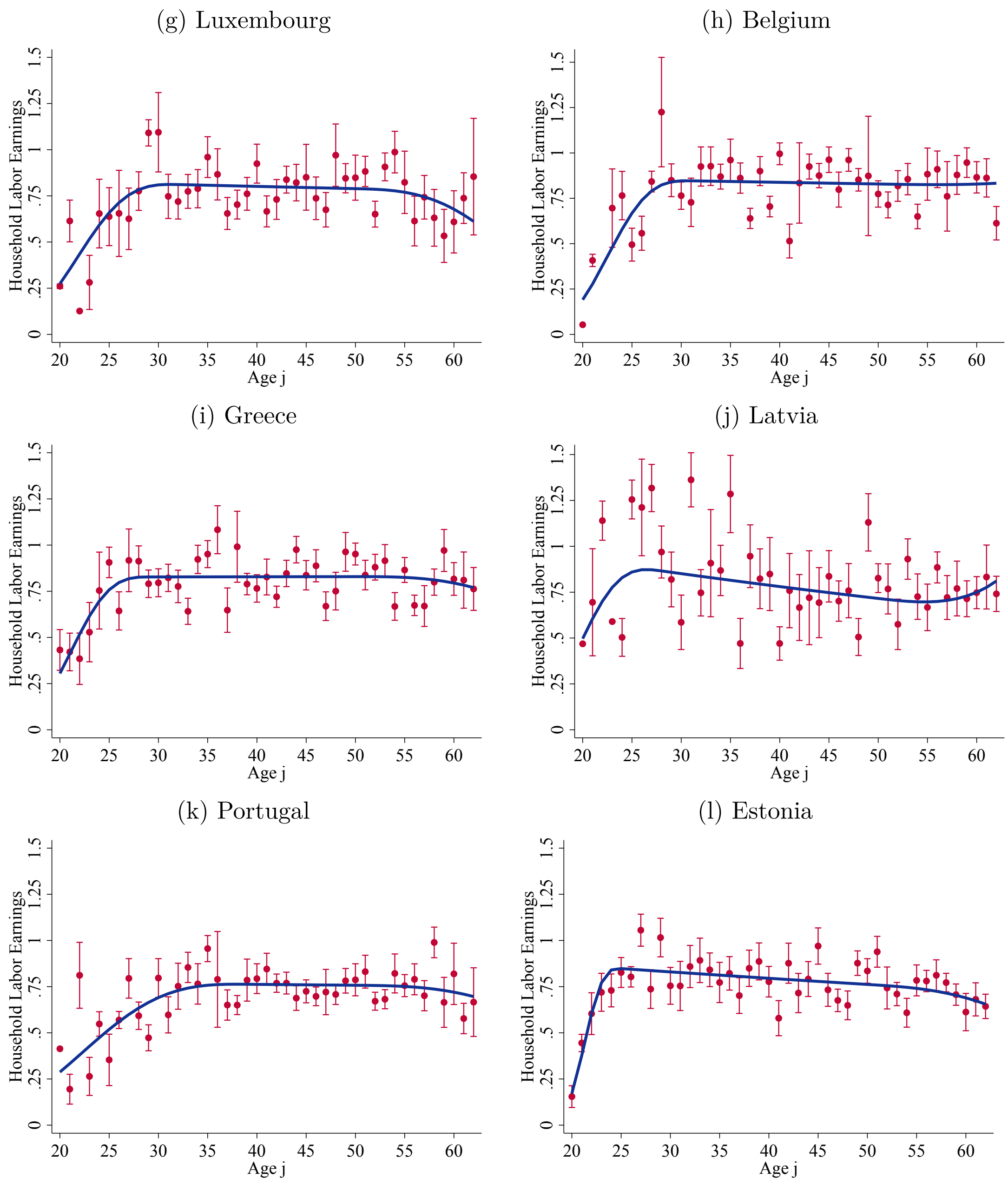
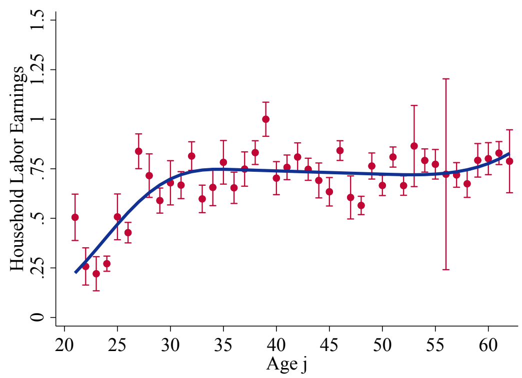
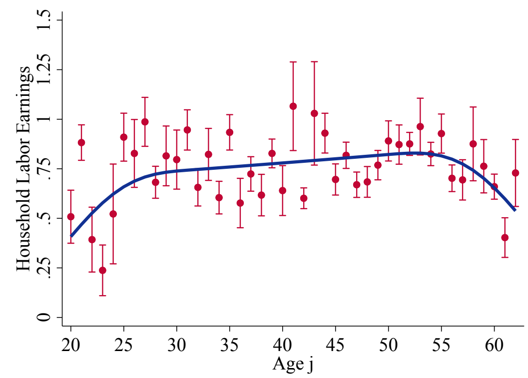


Figure C.1: Estimated life-cycle labor earnings profiles (cont.)

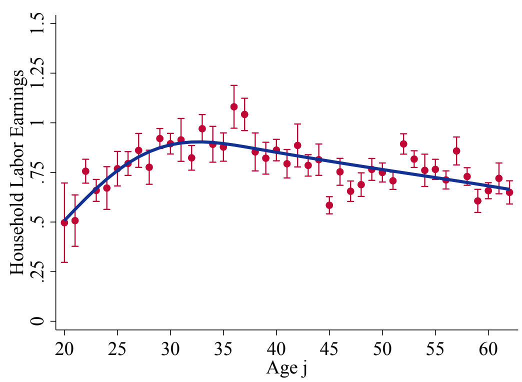
(m) Spain



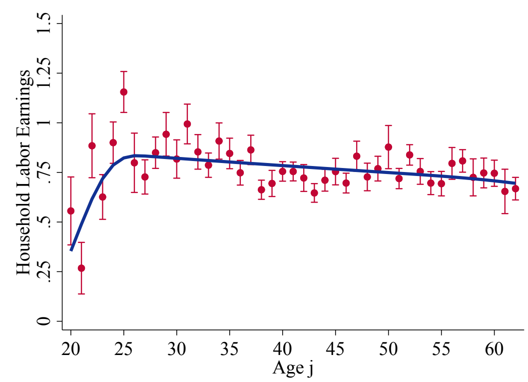
(n) Slovenia



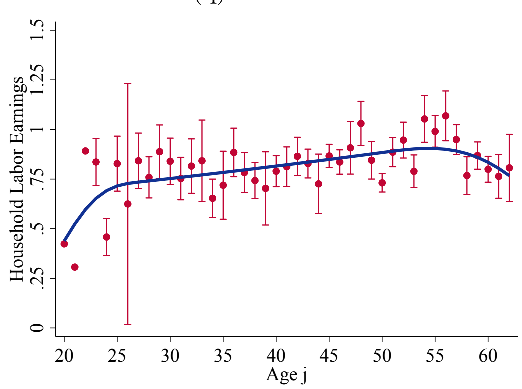
(o) Poland



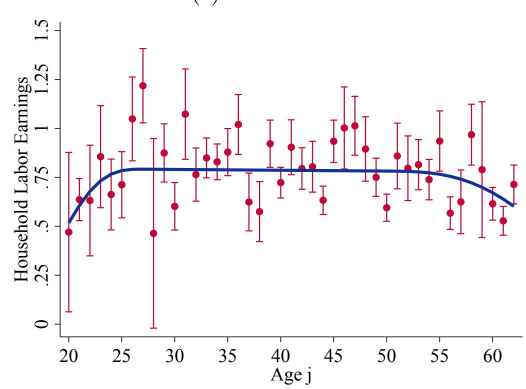
(p) Hungary



(q) Slovakia



(r) Lithuania



Having parameterized the age-earnings profiles, we still need to set the parameters of the earnings risk process η. We choose a country-invariant value of $\rho = 0.95$ for the autocorrelation of the process.[17] After that, we use the variance of the regression residuals $\text{Var}(\nu_i^c)$ to determine the innovation variance $(\sigma_\varepsilon^c)^2$. Specifically, we set

$$(\sigma_\varepsilon^c)^2 = (1 - \rho^2)\text{Var}(\nu_i^c).$$

Table C.3 shows the resulting parameter values for $(\sigma_\varepsilon^c)^2$.

Table C.3: Stochastic process for labor earnings

Country	ρ	$\text{Var}(\nu_i^c)$	$(\sigma_\varepsilon^c)^2$
Germany	0.95	0.6837	0.0667
Austria	0.95	0.3649	0.0356
Netherlands	0.95	0.4917	0.0479
France	0.95	0.5517	0.0538
Finland	0.95	0.5137	0.0501
Italy	0.95	0.4965	0.0484
Luxembourg	0.95	0.5222	0.0509
Belgium	0.95	0.3606	0.0352
Greece	0.95	0.4095	0.0399
Latvia	0.95	0.4954	0.0483
Portugal	0.95	0.5599	0.0546
Estonia	0.95	0.5491	0.0535
Spain	0.95	0.6518	0.0636
Slovenia	0.95	0.5254	0.0512
Poland	0.95	0.4653	0.0454
Hungary	0.95	0.6275	0.0612
Slovakia	0.95	0.3656	0.0356
Lithuania	0.95	0.4487	0.0437

[17] We can not identify ρ directly in the data. Therefore we chose a value that is within the range of values typically found in studies of the labor earnings process, see for example Heathcote et al. (2010).

C.3 Parameterization of Tax Schedules

We follow Guvenen et al. (2013b) in parameterizing country-specific labor earnings tax schedules. Specifically, we set

$$T^c(y) = t^c(y) \times y \quad \text{with} \quad t^c(y) = t_0^c + t_1^c y + t_2^c y^{\phi^c}. \tag{12}$$

$t^c(y)$ is the country-specific average tax rate function that we need to parameterize. Recall that we normalized labor earnings y in our model such that average labor earnings are equal to $\bar{y} = 1$.

To parameterize the average tax rate functions for each country, we use two sources of data. The OECD Tax and Benefits calculator (OECD, 2023a) provides us with gross earnings $\hat{y}$ and corresponding tax loads $\hat{T}^c(\hat{y})$ (labor earnings taxes and social security contributions) for different values of labor earnings. We use these data to calculate empirical average tax rates $\hat{t}^c(y) = \frac{\hat{T}^c(\hat{y})}{\hat{y}}$ at earnings levels $y = \{0.50, 0.60, 0.70, \ldots, 2.00\}$ (measured as fractions of average earnings). In addition, we calculate the marginal tax rate at two times the average earnings as

$$\hat{\tau}_m^c(2.00) = \frac{\hat{t}^c(2.00) \cdot 2.00 - \hat{t}^c(1.99) \cdot 1.99}{0.01}.$$

Next we turn to the OECD Tax Database (OECD, 2023b) and extract data on the empirical top marginal tax rate $\hat{\tau}_{\text{top}}^c$ (again labor earnings taxes plus social security contributions) and the earnings threshold $\hat{y}_{top}^c$ at which the top marginal tax rate applies (again measured as fraction of average earnings). Using the two marginal tax rates $\hat{\tau}_m^c(2.0)$ and $\hat{\tau}_{\text{top}}^c$, we interpolate the marginal tax rate at any earnings level $y \in [2, \hat{\tau}_{\text{top}}^c]$ as

$$\hat{\tau}_m^c(y) = \hat{\tau}_m^c(2.00) + \left(\hat{\tau}_{\text{top}}^c - \hat{\tau}_m^c(2.00)\right) \times \frac{y - 2.00}{\hat{\tau}_{\text{top}}^c - 2.00}$$

and use the top marginal tax rate for any value beyond $\hat{\tau}_{\text{top}}^c$. Using these interpolated marginal tax rates, we calculate the average tax rate at a value $y \geq 2$ as

$$\hat{t}^c(y) = \frac{\hat{t}^c(2.00) \cdot 2.00 + \int_{2.00}^{y} \ \hat{\tau}_m^c(y) \ dy}{y}.$$

From this extrapolation procedure, we obtain average tax rates for the earnings values $y = \{2.50, 3.00, 3.50, \ldots, 8.00\}$. Overall, our data collection and extrapolation procedure delivers empirical values of average tax rates for labor earnings levels

$$\mathcal{Y} = \{0.5, 0.6, 0.7, \ldots, 1.9, 2.0, 2.5, 3.0, 3.5, \ldots, 7.5, 8.0\}.$$

The values of empirical average tax rates for this earnings range are shown in Figure C.2.

We finally estimate the parameters $\{t_0^c, t_1^c, t_2^c, \phi^c\}$ by minimizing a residual sum of squares

$$(t_0^c, t_1^c, t_2^c, \phi^c) = \arg\min \sum_{y \in \mathcal{Y}} \left[\hat{t}^c(y) - \left(t_0^c + t_1^c y + t_2^c y^{\phi^c} \right) \right]^2.$$

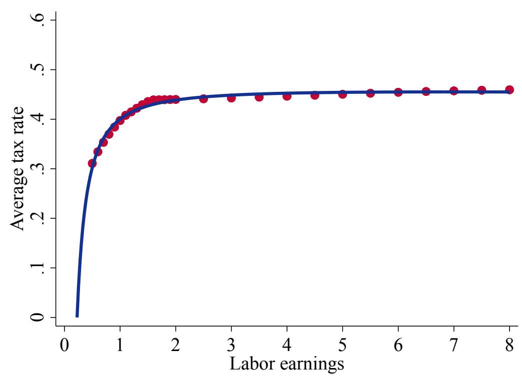
The parameter estimates are shown in Table C.4. The resulting life-cycle earnings profiles are shown as blue lines in Figure C.2.

Table C.4: Results of estimation process for tax schedules

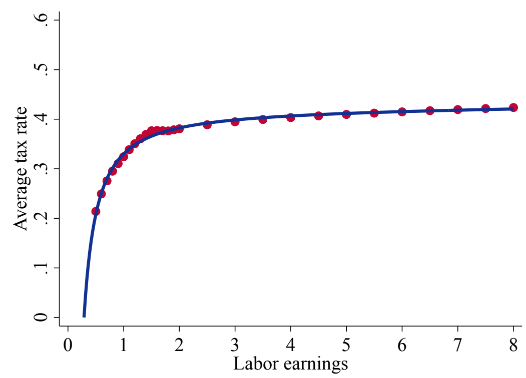
Country	t_0^c	t_1^c	t_2^c	ϕ^c
Germany	0.46687	−0.00096	−0.06568	−1.32111
Austria	0.41732	0.00125	−0.08859	−1.24551
Netherlands	0.60711	−0.00655	−0.22583	−0.71478
France	0.53561	−0.00079	−0.23722	−0.41438
Finland	4.13332	−0.00332	−3.78708	−0.03000
Italy	1.40460	−0.01606	−1.06478	−0.14872
Luxembourg	0.65835	−0.01175	−0.35181	−0.53290
Belgium	0.56301	0.00373	−0.15783	−1.23192
Greece	5.48228	−0.01169	−5.21400	−0.03000
Latvia	1.45792	−0.03092	−1.13834	−0.03000
Portugal	0.49956	0.00483	−0.23084	−0.66993
Estonia	0.22293	−0.00389	−0.01731	−1.59570
Spain	0.99679	−0.00582	−0.78223	−0.16682
Slovenia	3.52715	0.00144	−3.19874	−0.03000
Poland	0.92323	0.00843	−0.64570	−0.03000
Hungary	0.33500	0.00000	0.00000	−0.10232
Slovakia	0.32077	0.00404	−0.09050	−0.72739
Lithuania	0.24971	−0.00152	−0.02355	−2.28686

Figure C.2: Empirical and estimated average tax rates

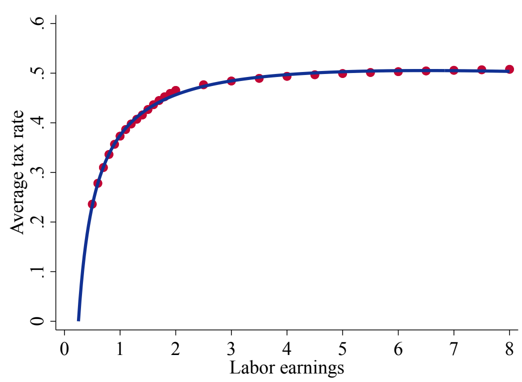
(a) Germany



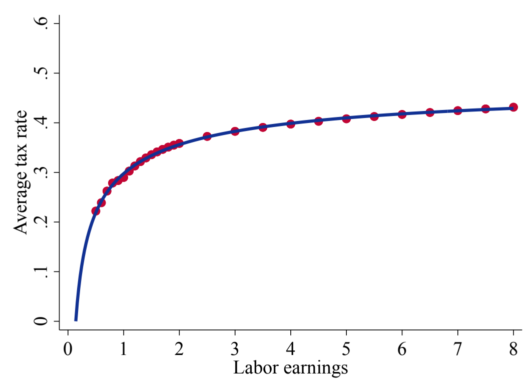
(b) Austria



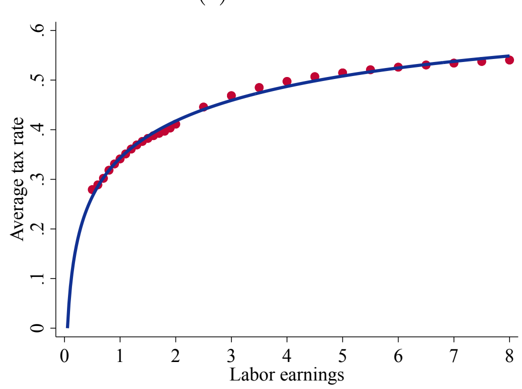
(c) Netherlands



(d) France



(e) Finland



(f) Italy

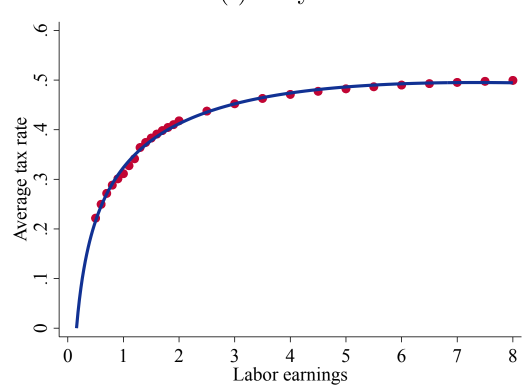


Figure C.2: Empirical and estimated average tax rates (cont.)

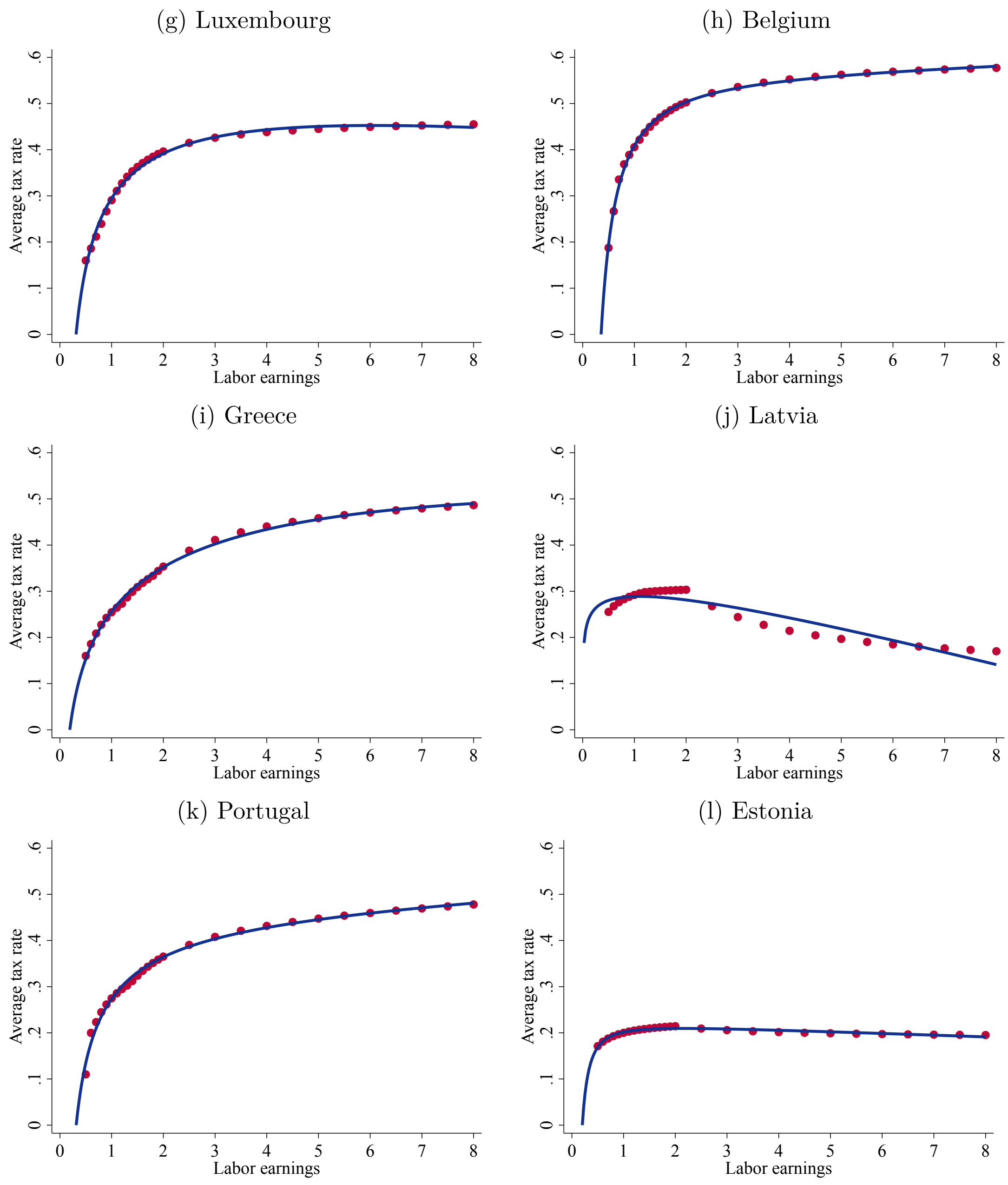
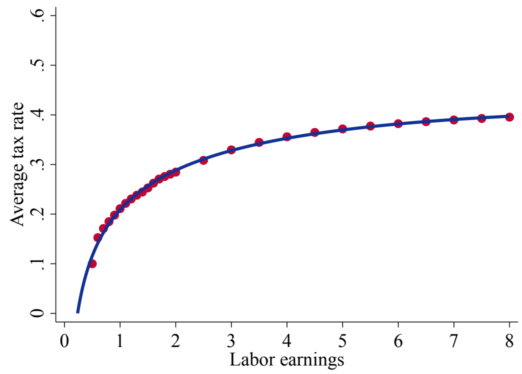
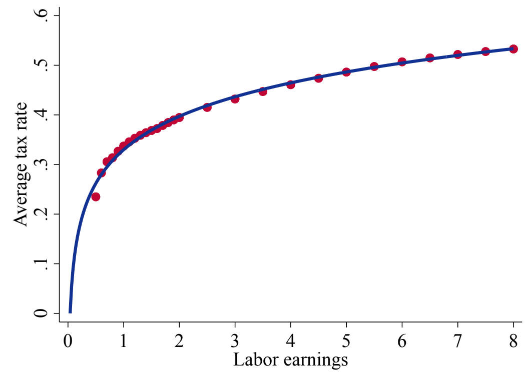


Figure C.2: Empirical and estimated average tax rates (cont.)

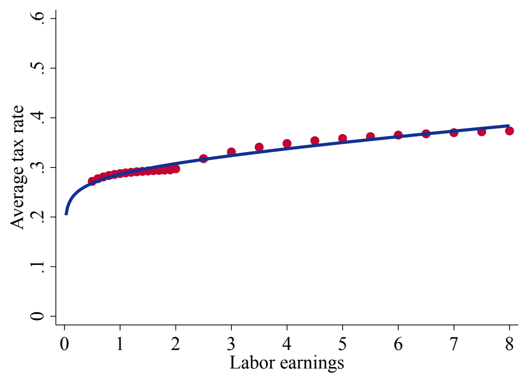
(m) Spain



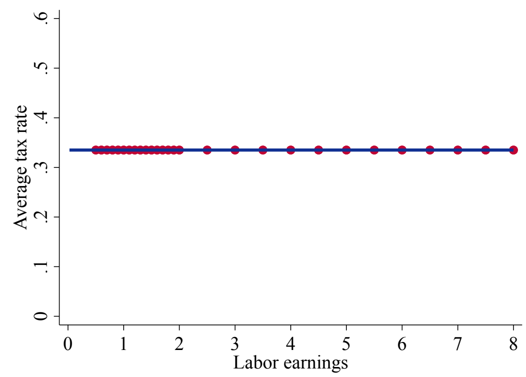
(n) Slovenia



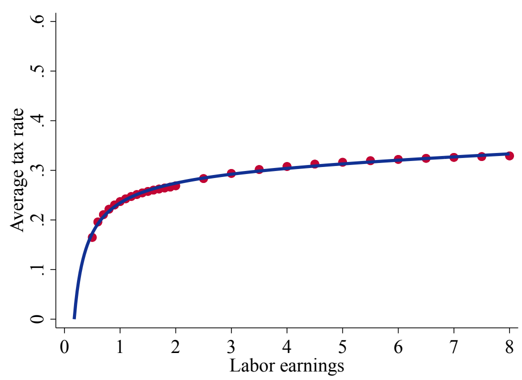
(o) Poland



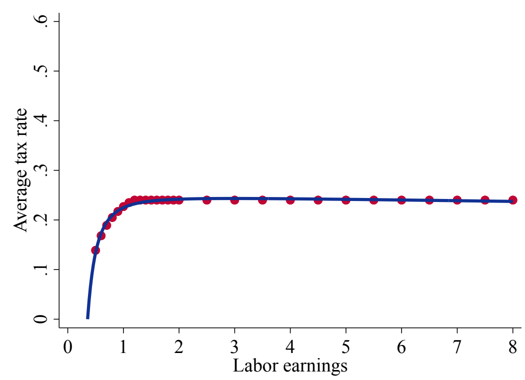
(p) Hungary



(q) Slovakia



(r) Lithuania



C.4 Parameterization of Pension Payments

Once they enter retirement, households receive an after-tax pension payment based on an index of their past earnings

$$p(\eta_{J_r-1}) = b_0^c \times \bar{y}_{net} + b_1^c \times \min\left[y_{index}\left(\eta_{J_r-1}\right), y_{max}^c\right].$$

To parameterize the country-specific parameters b_0^c, b_1^c and y_{max}^c, we extract data on net pension levels from the OECD's publication "Pensions at a Glance" (OECD, 2019). Specifically, the OECD provides data on net pension levels $\hat{p}^c(y_{index})$ as a function of an individual's life-cycle average net labor earnings on the range $y_{index} \in [0.5, 4.5]$. We estimate the parameters $\{b_0^c, b_1^c, y_{max}^c\}$ by minimizing a residual sum of squares

$$(b_0^c, b_1^c, y_{max}^c) = \arg\min \sum_{y_{index}} \left[\hat{p}^c(y_{index}) - \left(b_0^c \bar{y}_{net} + b_1^c \min\left[y_{index}, y_{max}^c\right]\right)\right]^2.$$

The parameter estimates are shown in Table C.5. The empirical pension profiles are shown as red lines in Figure C.3, the estimates pension schedules are shown in blue.

Table C.5: Results of estimation process for pension payments

Country	b_0^c	b_1^c	y_{max}^c
Germany	0.09582	0.42084	1.53148
Austria	0.17252	0.71928	1.50874
Netherlands	0.29923	0.51530	4.52655
France	0.31843	0.41291	4.68035
Finland	0.20227	0.45119	4.24621
Italy	0.21095	0.69857	3.21894
Luxembourg	0.36095	0.52943	2.56409
Belgium	0.24194	0.41718	0.95760
Greece	0.16093	0.35492	3.35763
Latvia	0.06473	0.47802	4.58313
Portugal	0.31182	0.60459	4.16463
Estonia	0.22093	0.30832	4.49749
Spain	0.12263	0.70589	1.67637
Slovenia	0.18830	0.37988	1.71274
Poland	0.01961	0.33112	2.63765
Hungary	0.00000	0.84314	4.58122
Slovakia	0.21467	0.45716	4.42644
Lithuania	0.17332	0.13716	5.60379

Figure C.3: Empirical and estimated pension payments

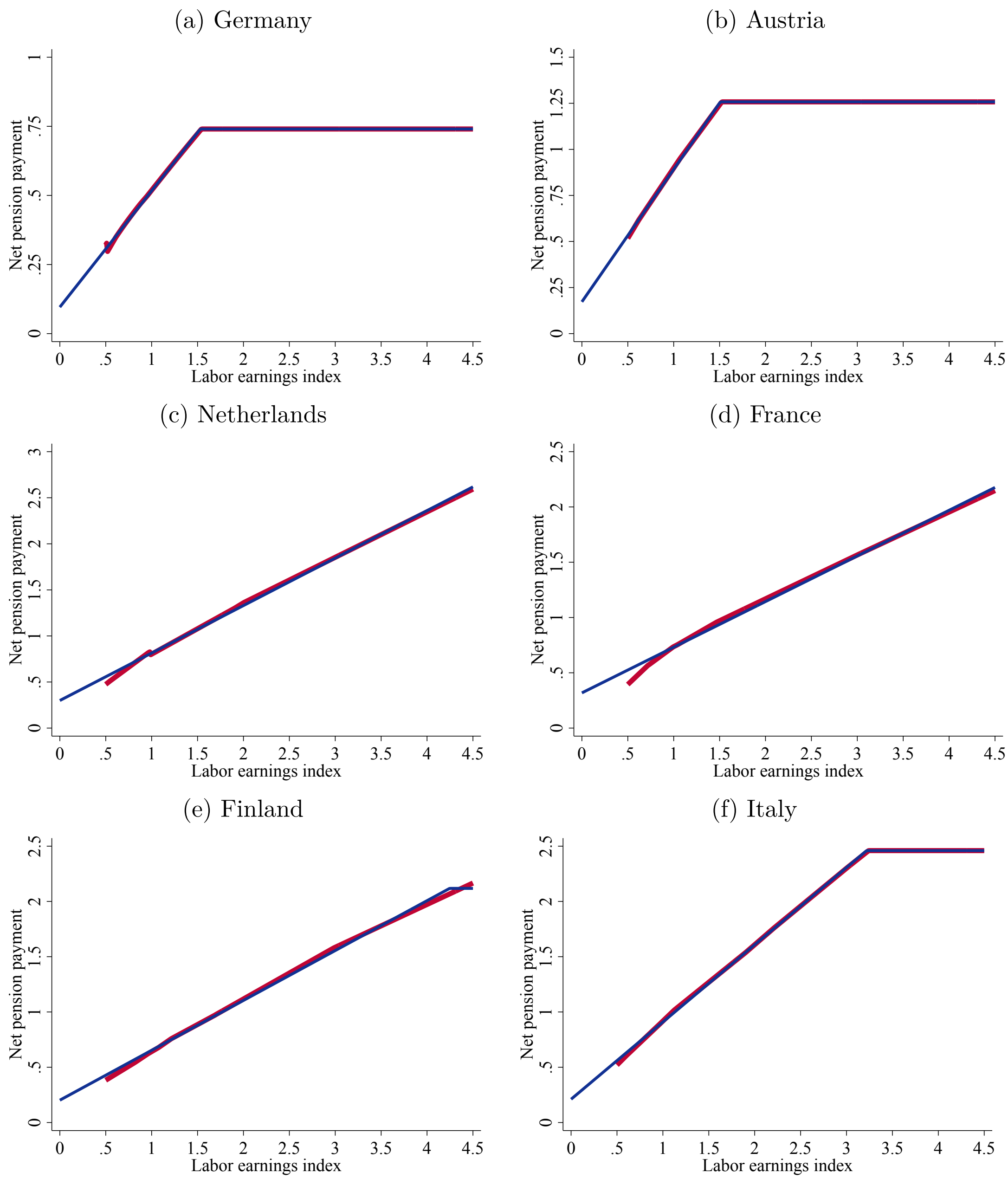
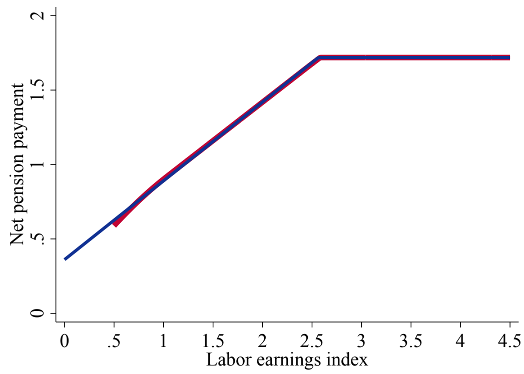
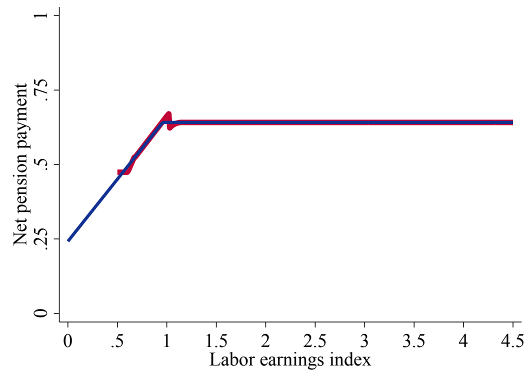


Figure C.3: Empirical and estimated pension payments (cont.)

(g) Luxembourg

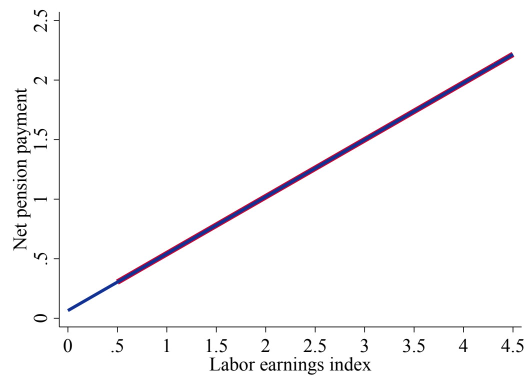


(h) Belgium

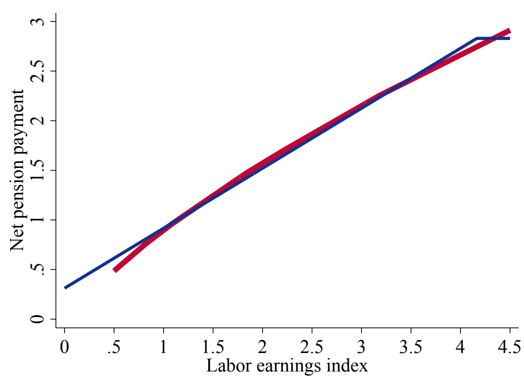


(i) Greece

(j) Latvia



(k) Portugal



(l) Estonia

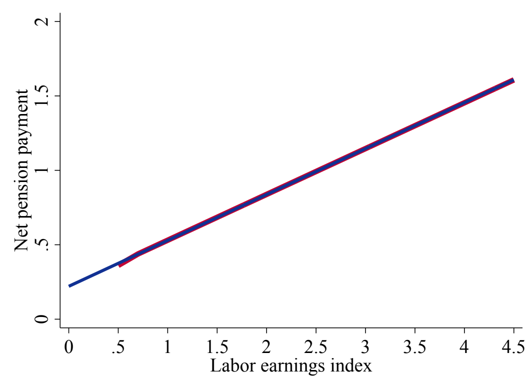
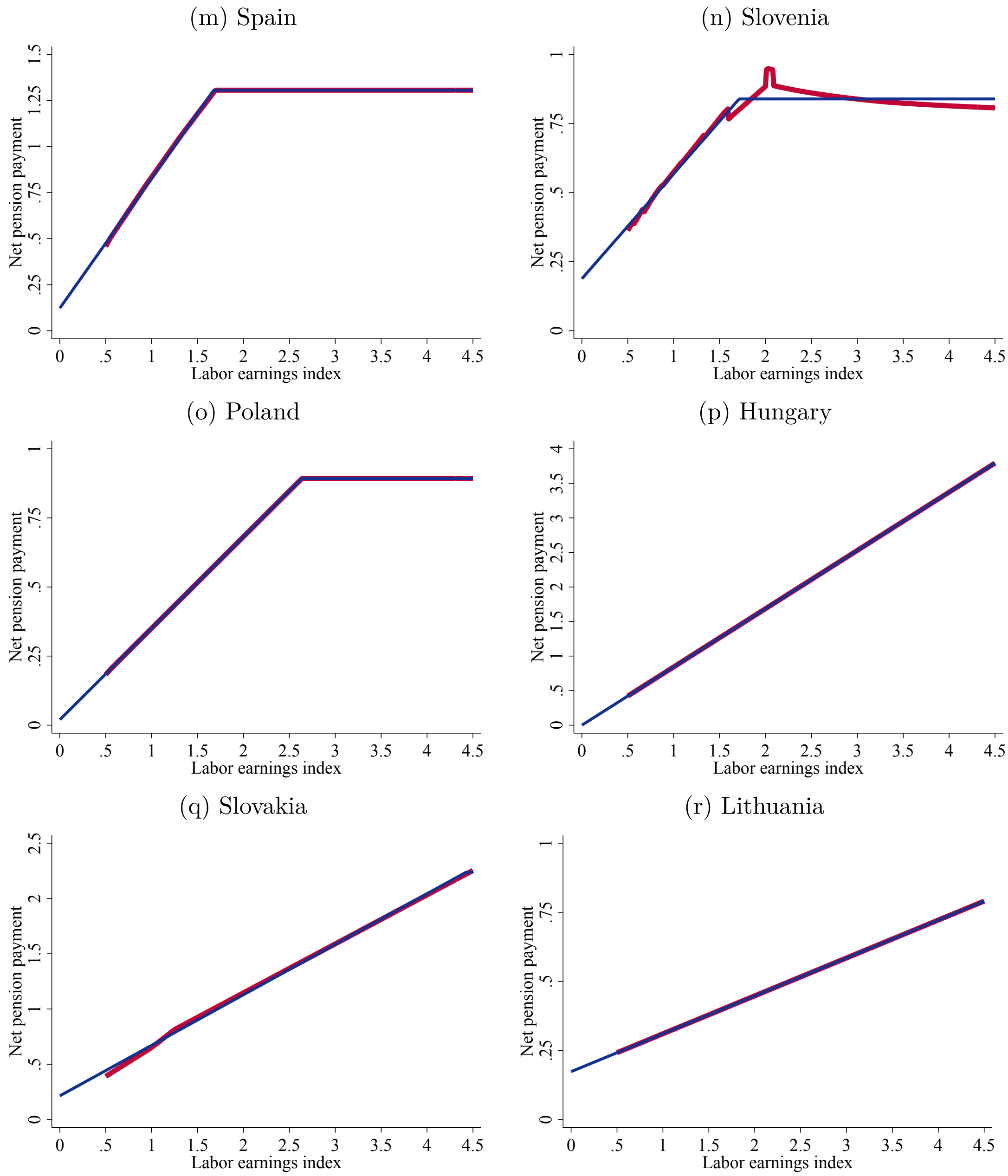


Figure C.3: Empirical and estimated pension payments (cont.)



C.5 Details on the Mortgage Market

Table C.6: Mortgage market parameters

	Interest spread (in %)	Maximum LTV	
Country	κ^c	Data	$\bar{\lambda}^c$
Germany	2.618	0.881	0.881
Austria	1.656	0.757	0.757
Netherlands	2.048	1.308	0.945*
France	1.235	0.955	0.945*
Finland	0.653	0.965	0.945*
Italy	1.312	0.600	0.600
Luxembourg	1.713	0.853	0.853
Belgium	2.175	0.852	0.852
Greece	1.733	0.729	0.729
Latvia	1.742	0.615	0.615
Portugal	0.873	0.947	0.945*
Estonia	1.389	0.807	0.807
Spain	1.144	1.133	0.945*
Slovenia	2.167	0.518	0.518
Poland	2.218	0.710	0.710
Hungary	4.324	0.530	0.530
Slovakia	1.740	0.820	0.820
Lithuania	1.439	0.653	0.653

*Parameter was adjusted to be consistent with the model.