

Rental Markets and Wealth Inequality in the Euro-Area

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PRELIMINARY AND INCOMPLETE

Abstract

In this paper we argue that a country's level of wealth inequality can be viewed as a reflection of the quality of its rental market for housing. Using the ECB's Household Finance and Consumption Survey (HFCS), we document that the aggregate homeownership rate and various measures of wealth inequality are negatively correlated across Euro Area countries. Empirically, this relationship is driven by the fact that in countries with lower homeownership rates a larger fraction of households only hold very low amounts of wealth. We show that a simple wedge in the rental market can explain the qualitative features of the data using a general-equilibrium life-cycle model of household investment and consumption. A larger wedge incentivizes households to save more at a young age in order to make a downpayment and buy a house. This leads not only to a higher homeownership rate but also overall fewer households with low wealth, decreasing cross-sectional wealth inequality. Quantitatively, our model explains around 80% of the variation in wealth inequality seen in the data, where rental market inefficiencies alone can explain around 50%. We show that the welfare losses associated with the rental market wedges identified by our model can be substantial.

JEL Classifications: 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? Should we care that some households are wealthier than others? As a buzzword, "inequality" is in high demand. A 696-page monograph covering data and theory on the history of wealth inequality became a New York Times Bestseller in 2014¹. Aimed at a more academic audience, much recent research has focused not only on how unequally wealth, income and consumption are distributed but also whether such inequality should be cause for concern². Whether or not we care about wealth inequality largely depends on what we think it is driven by and what we think the implications of such inequality are. Gokhale and Kotlikoff (2002) argue that, for the U.S., the main driver of wealth inequality is earnings inequality. Piketty (2014) famously argues that increasing concentration of capital ownership is a general feature of market economies since the rate of return on capital tends to lie above the growth rate of output. This theory, however, is less than a consensus³.

In this paper we argue that a higher degree of wealth inequality can arise as mere reflection of better functioning housing rental markets. 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.

Differences in wealth between households can be staggering. In Germany in 2009, half the population had less than €51,500 in net wealth, while the top ten percent of the population had net wealth exceeding €442,000⁴. Germany, however, can hardly be viewed as the norm in the Euro Area. In Spain, by contrast, the median household net wealth is €182,753, with the top ten percent of households owning more than €609,713. Should we think of the median household in Spain as substantially better off than the median household in Germany, either in absolute terms or even only relative to the 10 percent richest households?

In Germany, only 44% of the population own their main residence. In Spain, 83% do. In both countries, real estate accounts for the majority of household assets⁵. Starting from these observations, we ask whether there is a more general relationship between a country's homeownership rate and its degree of wealth inequality. Our answer will be that - all else equal - countries with lower homeownership rates do exhibit more wealth inequality which can be understood as a reflection of the functioning of the rental mar-

¹ Piketty (2014): "Capital in the Twenty-First Century" climbed to the top of the New York Times Best Seller list in the category of best selling hardcover nonfiction on May 18th, 2014

² We will discuss some of that literature in the next section.

³ For a critical discussion see, among many other, Jones (2015)

⁴ According to HFCS data, Median wealth: €51,500, 90th percentile: €442,000

⁵ In Spain, real estate accounts for 77.6% of total household assets, in Germany that number is 61%. Data from the HFCS

ket. We are not aware of any other systematic cross-country study that provides an explanation for the link between differences in wealth inequality and homeownership rates.

First, we will provide empirical evidence that there is indeed a negative correlation between homeownership rates and wealth inequality across countries. Further, we establish a set of stylized facts about household wealth and homeownership for the countries in our data. Most importantly, we show that, no matter their relative size of the population, the majority of renters has little wealth. In that sense, countries with a lower homeownership rate are also countries with more low-wealth households, which explains the bulk of the empirical relationship between the homeownership rate and wealth inequality.

A simple mechanism can explain these features of the data. If there are small barriers for landlords to rent out housing services to other renters, renting a house is cheap and households can remain renters for much of their early life. If there are substantial barriers on rental markets, renting a house is relatively more expensive, and households save more of their income at a young age in order to buy a house. This increases the overall homeownership rate while decreasing not only the fraction of low-wealth households but the economy's overall wealth inequality.

To convey this intuition and assess the quantitative importance of this mechanism, we construct a general equilibrium life-cycle model with uninsurable idiosyncratic labor income risk and a housing tenure choice. The rental market in this model features a rental market wedge between the shelter supplied by landlords and the shelter received by renters. As a benchmark, we calibrate the model's parameters to match the income distribution, tax and pension policy and homeownership rate of Germany. For each remaining country in our dataset we then employ country specific estimates for the income process as well as fiscal policy and recalibrate the rental market wedge to match the respective homeownership rate.

Our calibrated model can account for the stylized facts of the data we identify. Quantitatively, it accounts for about 80% of the variation in wealth inequality across countries observed in our data, while rental market inefficiencies alone account for around 50% of wealth inequality differences. The main result is that a larger wedge on rental markets induces households to save more at the beginning of their life cycle. This leads not only to a higher homeownership rate but also a lower degree of cross-sectional wealth inequality. In addition, if we interpret the rental market wedges as inefficiencies that can be overcome, these barriers impose substantial welfare costs on households in high-homeownership countries. Forcing German households to adopt Spanish rental market institutions would be equivalent to lowering their consumption streams by more than 8% for every year of their life cycles.

Relation to the Literature

Methodologically, our paper is related to a large body of literature that - building on early models in Bewley (1986) and Aiyagari (1994) - study cross sectional heterogeneity and inequality in models where households face uninsurable idiosyncratic risk. Financial markets are incomplete, households have to self-insure against idiosyncratic risk, and the distributions of household wealth and consumption become equilibrium objects we can study. A standard Aiyagari (1994)-type model cannot explain the distribution of wealth we find in the data across developed countries. This is also true in overlapping-generation versions of this model where households' life-cycle profiles of income are modeled explicitly⁶. One strategy to better account for the data this is to adjust one's calibration approach. Rather than measuring a labor-earnings process in cross-sectional or panel data on labor income, Castaneda et al. (2003) simply calibrate the labor income process to directly match the wealth inequality observed in the U.S. data. In a more recent paper, Diaz and Luengo-Prado (2010) follow the same strategy but include durable goods in the model to explicitly consider cross-sectional aspects of real-estate wealth⁷. The obvious drawback of such an approach is that much of wealth inequality is explained by the calibrated shape of the earnings distribution. With this project, we are less interested in exactly explaining the level of wealth inequality and more interested in degree to which differences in rental markets across countries can explain variations in wealth inequality and homeownership across these same countries. For that reason, we find it more important to work with an earnings distribution that can match the cross-sectional distribution of earnings.

In general, there is an increasing recognition of the special role of consumer durables, especially housing, for understanding the consumption and savings dynamics of young and poor households. Fernandez-Villaverde and Krueger (2011) is typically credited with the insight that the combination of borrowing constraints and consumer durables produce young agents who accumulate durables early in life and then increase non-durable consumption later on. We build on this insight by showing that variations in the incentives to accumulate housing early in life can have substantial effects on the wealth distribution, particularly at the lower end. As in Yang (2009), we include transaction costs to prevent a gradual sale of housing as households get older.

One important difference between housing and many other consumer durables is the possibility to simply rent one's home. Besides Diaz and Luengo-Prado (2010), Gruber and Martin (2003) and Silos (2007) are important early examples of work that explicitly adds rental housing to explain why many young people have very little to no real estate wealth. While these papers consider perfect rental markets, our contribution to that strand of the literature is to explicitly link the shape of the lower tail of the wealth distribution to the potentially imperfect functioning of the rental market.

⁶ For a summary of such failures, see Diaz-Gimenez et al. (1997)

⁷ For example, real estate wealth becomes less important as a share of wealth for wealthier households.

Other papers have tried to link the after-tax return of housing to capital accumulation and inequality. Gervais (2002) shows that, with the preferential tax treatment in the U.S., housing has a higher return than business capital, which leads to distortions and helps homeowners build wealth. Focusing specifically on wealth inequality, Cho and Francis (2011), however, find that the preferential tax treatment does not contribute to wealth inequality in the U.S.

Beyond those already mentioned, there is a large body of work that shares the same general modeling technique, but differs in the questions it addresses. Davis and Van Nieuwerburgh (2015) provide an excellent review of the literature of housing in macroeconomics. A few examples worth pointing out are Cocco (2005), the sequence of papers by Flavin and Yamashita (2002,2011), and Flavin and Nakagawa (2008), which all study the portfolio composition of households in the presence of housing.

Why do households become homeowners at all? While implicit in the work cited above, it is worth considering this question explicitly. Imagine a simple model where households can save both by accumulating financial assets and purchasing houses that supply shelter services. If these shelter services can be traded on perfect rental markets, households would be indifferent between owning and renting in equilibrium; such a model would have nothing to say about the aggregate homeownership rate. To get around this, many, if not most papers, simply assume that households have a preference for owner-occupied housing vis-a-vis renting. DiPasquale and Glaeser (1999) and Rossi and Weber (1996)⁸ link homeownership to non-consumption related benefits. Alternatively, one could view the utility benefit as a reduced-form way of modeling certain types of inefficiencies. Henderson and Ioannides (1983) argue that if we think of a house as a durable good that is costly to use, the fact that rental contracts are always incomplete implies an "over-utilization" of rental properties which makes renting inherently more costly than owning. Hard-wiring a preference for owner-occupied housing is a way of incorporating such agency costs in a reduced-form way. The more direct way to include such agency costs is to simply treat them as a rental cost to be paid by either the landlord or the tenant. The work by Campbell and Cocco (2007) is an example for such an approach.

In terms of modeling, our approach is closest to that in Campbell and Cocco (2007). We will allow rented and owner-occupied housing services to enter a household's utility functions in the same way but make renting costly. Ultimately, we want to understand how the same forces that push households toward homeownership also drive wealth accumulation. For that reason, we will work with a wedge that operates on the rental market: Only a fraction of any unit of shelter supplied to the rental market may arrive at the potential tenant. We view this wedge as a stand-in for the institutional framework that shapes rental markets.

⁸ A note of caution should be applied to these studies, however, as they are primarily investigating correlation rather than causation.

There is research that has investigated this institutional framework. Tax benefits like mortgage-interest deduction, regulation on rental prices or the availability of social housing are just a few examples of how policy can shape a household's decision to become a homeowner. 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. 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). Considering the developments in Germany after the second world war, they explore how the rental market's institutional framework in Germany was shaped by the historic sequence of policy choices and how it may affect aggregate homeownership rates. For a good survey on the microeconomics of housing, see also Han and Strange (2015).

Since we are primarily concerned with aggregate wealth accumulation, we will ignore many aspects of the literature on the microeconomics of housing. Instead we will remain agnostic what exactly it is that shapes rental markets and indirectly identify differences in rental markets through our wedges.

Beyond our focus on wealth inequality and homeownership, a large literature of life-cycle models with uninsurable idiosyncratic labor income has emerged that seeks to reconcile cross-sectional facts of income, consumption, and wealth with models that describe the behavior of macroeconomic aggregates. As an overview, see the special issue of the Review of Economic Dynamics on "Cross-Sectional Facts for Macroeconomists" and in particular the introduction Krueger et al. (2010).

By linking rental markets to wealth inequality, our paper also contributes to the broader literature on wealth inequality. After it became commonly accepted that income inequality had been rising across developed countries since around the 1980s⁹, economists have also tried to understand the evolution of wealth inequality. Using a combination of tax returns and household balance sheets, Saez and Zucman (2016) show that wealth inequality as measured by the wealth share of the top 0.1% has been u-shaped since 1913, starting out at 25%, dropping to around 8% in the 1970s and exceeding 20% post 2009. Piketty (2014) introduced the historical development of wealth inequality not just to economists but to the public at large. However, as Jones (2015) points out in a recent JEP article, describing a general trend in wealth inequality is difficult. While wealth inequality as measured by the wealth share of the top 1% seems to have risen over the past 50 years, it is still substantially lower than it was as recently as the beginning of the 20th century. In The U.K., the top 1% owned almost 70% of the total wealth around 1910. In the U.S., that figure was around 45%, while it is at around 35 percent in the U.S. and around 25 percent in the U.K. today.

We see our contribution to this greater debate about wealth inequality as pointing to

⁹ see, for example, Piketty and Saez (2006)

the benefits of not only considering the evolution of wealth holdings at the top of the distribution. We show that a significant amount of cross-country variation in wealth inequality is driven by the behavior of households at the bottom and middle of the wealth distribution.

Two papers are worth mentioning for using the same data we do. Pham-Dao (2016) also observes that there is substantial variation in wealth inequality in Europe. She further notes that wealth inequality tends to be larger in countries with a more equal labor earnings distribution. She finds that a substantial part of the variation in inequality can be explained by differences in social safety net policies like unemployment insurance. We view her findings as a complement to the findings in our paper. Kaas et al. (2015) have a brief note in which they observe the same relationship between wealth inequality and the homeownership rate we do. They neither provide a more detailed description of this relationship, nor do they propose an explanation. In this paper, we provide such an explanation.

Finally, in our normative analysis we will argue that there is no reason to care about wealth inequality or even income inequality intrinsically. Rather, we are concerned with consumption inequality that directly affects households' welfare. For example, Aguiar and Bils (2015) argue that, if measured correctly, consumption inequality has indeed tracked income inequality quite closely over past years.

Our results will suggest a different relationship between the inequality of wealth and the inequality of consumption. In our model, better access to rental markets tends to increase wealth inequality by giving households the option to avoid accumulating real estate wealth early in their life cycle. This allows them to consume more when they are young, reducing the variation of consumption over the life cycle as well as the cross-sectional inequality of consumption. The broader point here is that an unequal distribution of wealth may well be the sign of an efficient functioning of markets in the spirit of Lucas (1992). Depending on policy constraints, attempts to reduce wealth inequality may then make everyone worse off.

2 Data and Stylized Facts

Our main data source is the *Household Finance and Consumption Survey* (HFCS) provided by the European Central Bank. The HFCS collects household level data on wealth and consumption in 15 Euro area countries. Although the data collection is administered by the national central banks, the data are harmonized so that they are comparable across countries. While the HFCS collects data on Cyprus, Malta, and the Slovak Republic, for the sake of a cleaner cross-country comparison, we exclude these three countries from our sample. The economies of the former two are obviously substantially smaller than any of the countries. The Slovak Republic was established in 1993 only and was under communist ruling until 1989. At the country level, the sample se-

lection is similar to the US Survey of Consumer Finances, meaning that wealthy households are oversampled. Up to now, only two waves of this survey are available and we restrict our attention to the first wave. However, in the appendix, we cross-check that our stylized facts also hold in the second wave of the data. The HFCS was collected between the years 2008 and 2011 and made available in 2013.¹⁰ For each survey respondent, we observe the total amount of *real assets* as the value of her main residence, other real estate property, vehicles, valuables and self-employment businesses,¹¹ *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 *liabilities* (outstanding mortgage and non-mortgage debt). We measure household's total *net wealth* as the sum of real and financial assets minus liabilities. In addition, we declare a household to be a *homeowner*, if the respondent reports to own her main residence at least partly. The majority (86%) of the group of non-homeowners has rented their main residence, the remainder lives in a "free use" arrangement. We therefore refer to this group as *renters*. Finally, the survey gathers information on households' *total gross income*, which comprises income from employment, self-employment, pensions, social transfers, private transfers, and income from renting and investing. Note that we standardize all monetary measures of the household by the standard OECD equivalence scale to account for differences in the demographic composition across different entities.

Table 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, however only has about 3,500 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". In the last column of Table 1 we report median net wealth to income (WTI) ratios. There is substantial heterogeneity in wealth holdings across the surveyed countries. While Germany, Austria, Finland, and the Netherlands exhibit median WTI ratios of around 2 or even less, these ratios lie above a value of 5 in Italy, Spain, and others.¹²

¹⁰ A detailed description of the survey methodology of the HFCS can be found in Eurosystem Household Finance and Consumption Network (EHFCN) (2013).

¹¹ Real assets are valued at current market prices as estimated by the respondent.

¹² Note that our data does not include claims individuals have towards public pensions schemes, which are of quite significant size in many countries. This should be kept in mind when comparing WTI ratios across countries. In our quantitative model, however, we will use pension data from the OECD to account for such differences.

Table 1: Number of Respondent Households by Country in the HFCS

Country		No. of HH	Weighted HH (in million)	Median WTI ratio
Austria	(AT)	2,380	3.77	2.07
Belgium	(BE)	2,327	4.69	4.83
Germany	(DE)	3,565	39.67	1.39
Spain	(ES)	6,197	17.02	7.44
Finland	(FI)	10,989	2.53	2.23
France	(FR)	15,006	27.86	3.47
Greece	(GR)	2,971	4.11	4.35
Italy	(IT)	7,951	23.82	5.78
Luxembourg	(LU)	950	0.19	5.14
Netherlands	(NL)	1,301	7.39	2.21
Portugal	(PT)	4,404	3.93	4.64
Slovenia	(SI)	343	0.78	5.36
Total		58,384	135.76	3.53

2.1 Stylized Fact 1: Homeownership and Wealth Inequality

The main focus of this paper, however, is not on average wealth holdings but on wealth inequality within countries, how this inequality varies across countries of the Euro area, and how wealth inequality connects to one of the households major asset components, the household's main residence.

Throughout this paper, we measure wealth inequality in terms of the generalized entropy index GE of order 0, which will allow us to provide a linear decomposition of wealth inequality later on.¹³ The class of GE indices with parameter α is defined as

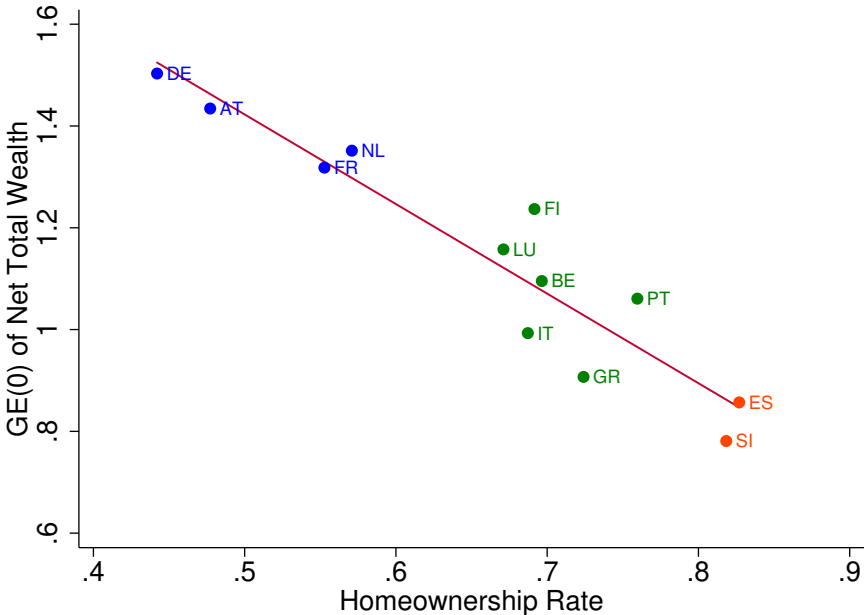
$$GE(\alpha) = \begin{cases} -\frac{1}{N} \cdot \sum_{i=1}^N \log\left(\frac{w_i}{\bar{w}}\right) & \text{for } \alpha = 0, \\ \frac{1}{N} \cdot \sum_{i=1}^N \frac{w_i}{\bar{w}} \cdot \log\left(\frac{w_i}{\bar{w}}\right) & \text{for } \alpha = 1, \text{ and} \\ \frac{1}{N \cdot \alpha(\alpha-1)} \cdot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

¹³ Generally speaking, the literature on inequality uses the Gini Index, the Atkinson Index (Atkinson, 1970), or the Generalized Entropy (GE) Index to measure inequality. Although widely used in the applied economics literature, the Gini Index is a disputed measure of inequality (see, for example, De Maio, 2006). Besides having problems which apply to any method of data reduction, a particular feature of the Gini index is that it is quite sensitive to changes in the middle part of the distribution. More importantly, it is not straightforward to decompose the Gini index into components stemming from different subgroups of the population. In fact, out of the mentioned three classes of inequality measures, the class of GE Indices is the only one allowing for additive decomposition (see Shorrocks, 1980).

where N denotes the total number of sample observations, w_i is the wealth level of individual i and \bar{w} the average wealth of the population. For a value of α equal to zero, the GE index is the negative of the log-deviation from the mean. By compressing large wealth realizations, this index is most sensitive to changes in the bottom and middle parts of the wealth distribution. With an increasing α , more and more weight is given to very large wealth realizations so that the index becomes more sensitive to inequality stemming from the top tail. As we will see later on, a lot of the differences in wealth inequality across Euro area countries stem from the bottom end of the wealth distribution. Hence, the $GE(0)$ is a suitable measure here. In addition to selecting this particular inequality measure, we also take out the top one percent wealth holders (country by country) from our sample and recode every household with a net-wealth of less than 1% of average labor income to hold exactly 1% of average labor income in wealth. This allows us to not lose any data when calculating inequality indices and facilitates comparison between the data and our quantitative model. In Appendix B, we provide robustness checks with respect to using different inequality measures and varying sample selection.

Figure 1 shows the relationship between wealth inequality and the homeownership rate in the 12 countries of our sample. It first of all reveals that there is substantial

Figure 1: Homeownership Rates and Wealth Inequality Across Countries



$$\beta = -1.7603^{***} \quad / \quad R^2 = 0.88$$

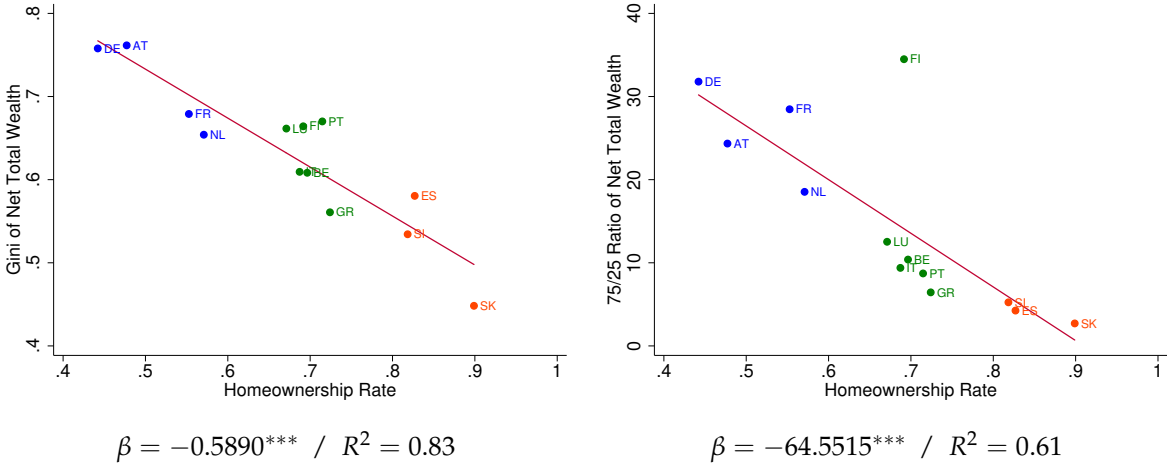
Source: Own calculations based on HFCS.¹⁴

variation in both the homeownership rate (on the x-axis) as well as wealth inequality (on the y-axis) across different countries. To facilitate comparison between data and our quantitative model, we classified countries according to those with low homeownership rate (blue), those with a medium range homeownership rate (green) and those with a high homeownership rate (red).

Most importantly, however, the figure reveals a negative correlation between the homeownership rate and wealth inequality, meaning that countries with low homeownership rate – and therefore with many renters – tend to exhibit a large inequality in household net wealth holding. A simple regression indicates that this correlation is statistically significant at the 1 percent level with a regression coefficient of -1.7603. Therefore, on average, a 10 percent reduction in the homeownership rate is associated with a decline in the GE(0) index of wealth inequality of 0.18 points.

To ensure that this relationship is not merely driven by our choice of inequality measure, we run the same regression using other measures of inequality. The left panel

Figure 2: Using Other Measures of Inequality



Source: Own calculations based on HFCS.

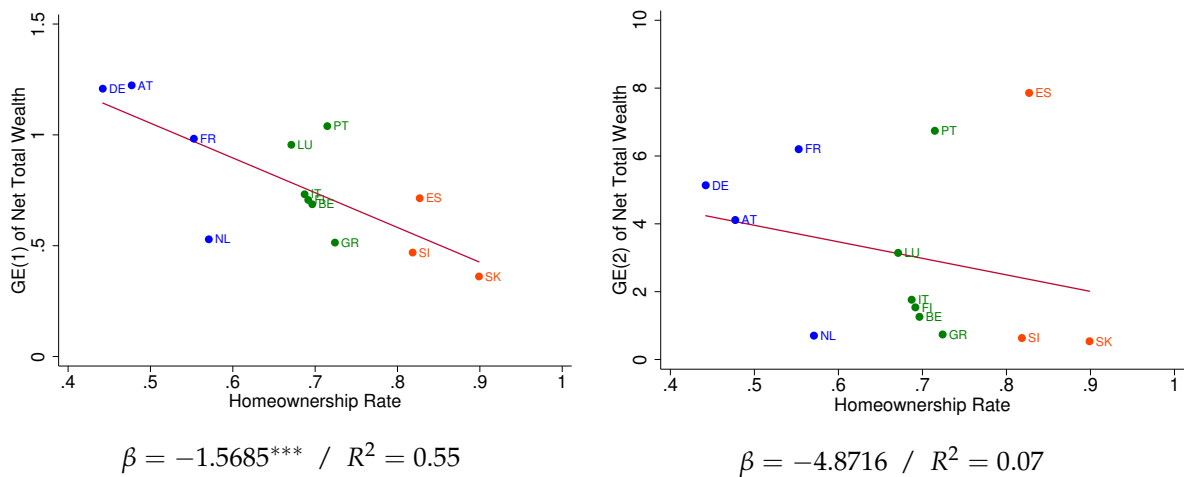
of Figure 2 shows the correlation between the Gini Index of wealth inequality and the homeownership rate across countries. The scale of the index is obviously different from that of the GE(0) index. Nevertheless, the strength of the correlation and the share of the variance in wealth inequality explained remains untouched. The right panel of Figure 2 reports the correlation between the homeownership rate and the ratio of the third and first quartile of the wealth distribution. With Finland being an outlier,

¹⁴ All regression results are obtained from bootstrapping with 1000 replicate weights and using 5 imputations. Standard errors for the regression coefficient and the R^2 value are reported in parentheses. A regression result is given two stars, when the zero is outside of both a parametric and non-parametric 95 percent confidence band around the regression coefficient. The coefficient gets three stars in case the same is true for 99 percent confidence bands.

we again find the same strong correlation as observed in the previous graph. Note that the difference in wealth holdings across countries are quite remarkable. While in countries with medium or high homeownership rates the third quartile owns about 5 to 10 times the amount of wealth as the first quartile, the factor lies in between 20 and more than 30 in our sample countries with a small number of homeowners.

Figure 3 shows the cross country evolution of wealth inequality measured with GE indices of higher order. A higher α means that the index is more sensitive towards inequality arising from the top of the wealth distribution. As the inequality measure becomes more sensitive to top wealth inequality, the correlation between wealth inequality and homeownership slowly vanishes. We therefore conclude that the relevant

Figure 3: Stronger Weights on Tails of the Distribution



Source: Own calculations based on HFCS.

variation in inequality that causes the negative correlation between wealth inequality and homeownership that we observe in the HFCS data is rather stemming from the bottom than the top of the wealth distribution. Hence, we can summarize our first set of stylized facts as follows:

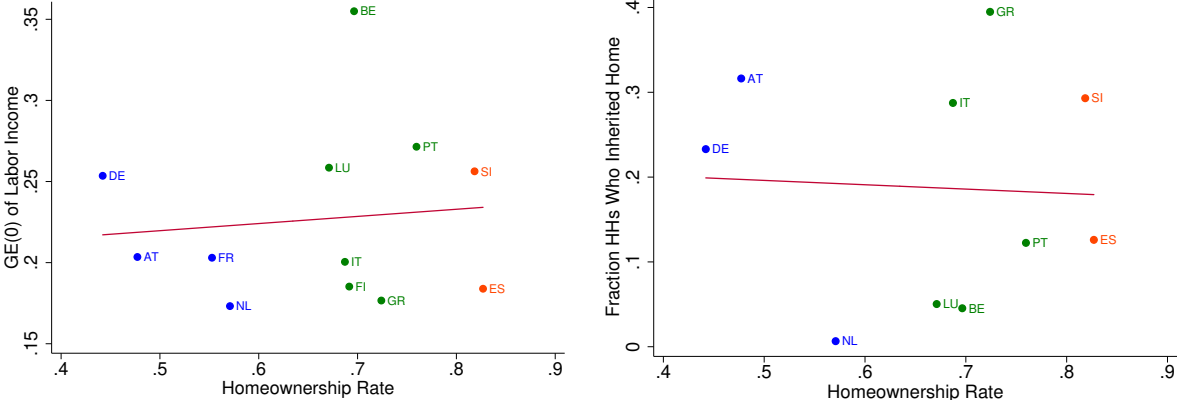
Stylized Fact 1. (Wealth Inequality and Homeownership)

- (i) *There is a strong, significant and robust negative correlation between homeownership rates and wealth inequality across countries.*
- (ii) *The cause of the correlation seems to stem from the low and middle parts of the wealth distribution, not from the top tail.*

Before we continue stressing the point that the presence (or absence) of low wealth households is important for understanding the above correlation, we want to shed some light on what the data suggests is not behind the correlation of wealth inequality and homeownership. To this end, Figure 4 shows in the left panel the relationship

between the GE(0) index of labor income and homeownership in our 12 sample countries. The figure shows that there is no significant correlation between homeownership and income over our sample countries, suggesting that differences in wealth inequality are not a simple reflection of differences in the labor earnings process. The right panel

Figure 4: Labor income inequality and inheritance



Source: Own calculations based on HFCS.

of Figure 4 shows the fraction of households that received their primary residence either as inheritance or as gift from someone else. Again, there is no systematic pattern across our sample of countries. Hence, in countries with high homeownership rates, households actually buy more houses than in countries with a lot of renters.

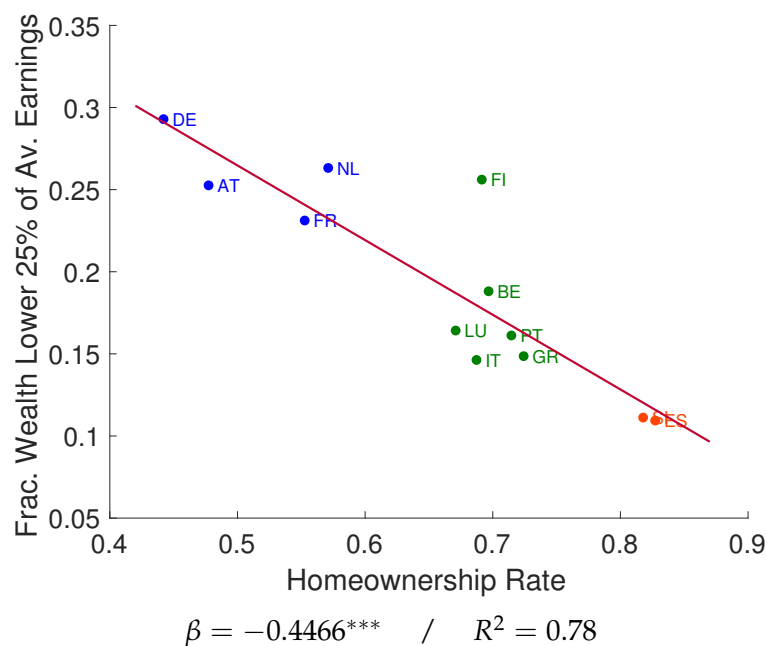
2.2 Stylized Fact 2: The Fraction of Low Wealth Households

To strengthen the point that the lower end of the wealth distribution is the key to understanding differences in wealth inequality across countries, Figure 5 shows the fraction of the population in each country that holds an amount of net wealth equal to 25% of the country’s average labor income (including transfers) or less. Again we see a strong negative correlation, meaning that in countries with a lot of homeowners, there are few households with a very small amount of wealth, while in countries with a lot of renters, holding little to no wealth is a quite common phenomenon.

Stylized Fact 2. (The Fraction of Low Wealth Households)

In countries with low homeownership rates, there are many households holding little to no wealth, while in countries with a lot of homeowners, low wealth households hardly exists.

Figure 5: Homeownership Rates and the Fraction of Households with Low Wealth



Source: Own calculations based on HFCS.¹⁵

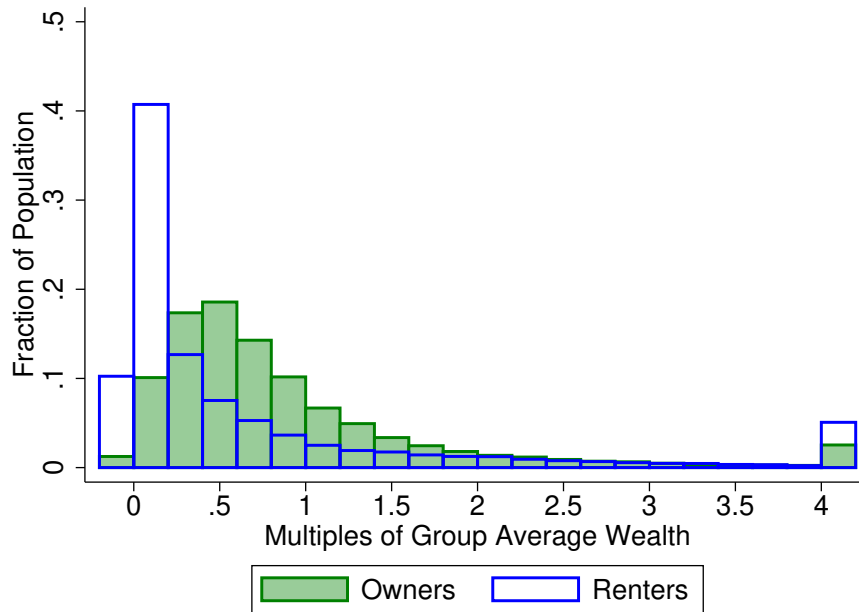
2.3 Stylized Fact 3: Who is a Low Wealth Household

In a next step, we want to elaborate on who are the households holding a very small amount of wealth in the data. To do so, we take a more detailed look at the wealth distributions within the groups of renters and owners. We therefore use a pooled cross-country sample.¹⁶ However, before combining the data for different countries, we divide them by the country and group specific means of household net wealth $\bar{w}_{g^c}^c$, accounting for the fact that we saw major differences in average wealth holdings across countries in Table 1. The wealth data we presented in the following should therefore be interpreted as multiples of average wealth holdings, which makes the comparison between the groups of renters and owners particularly simple.

Figure 6 shows histograms of the net wealth distribution of renters and owners in the pooled country sample. For simplicity, we grouped all households with net wealth smaller than zero as well as those with net wealth greater than four times the group average together. Recall that mean wealth in the groups of renters and owners is equal to one, respectively. This figure immediately reveals that a large fraction of renters in our sample actually holds a very small amount or even negative wealth. More than 50 percent of renters are reporting a net wealth level that is smaller than 20 percent of the average wealth level of their group. In comparison, for homeowners there are only

¹⁶ We study the distribution by ownership status and country in the next section.

Figure 6: Wealth Distributions Within Groups of Renters and Owners



Source: Own calculations based on HFCS. Figure displays averages calculated with standard cross-sectional weights using 5 imputations.

11 percent of households with so few wealth. Overall, while the wealth distribution in the group of homeowners seems to follow a distribution that roughly looks log-normal, the wealth distribution of renters is way more skewed to the right with a substantial amount of net wealth realizations close to zero.

Stylized Fact 3. (Renters are Low Wealth Households)

The wealth distribution of renters is much more skewed to the right than that of owners. Specifically, among renters, a larger fraction of households have negative or very small amounts of wealth compared to the group’s average than among homeowners.

2.4 Stylized Fact 4: Wealth Inequality by Ownership Status

In the following, we want to put a little more structure on the investigation of differences between the wealth distributions of renters and owners. Specifically, we would like to decompose our wealth inequality measure into effects coming from the unequal distribution of wealth within the groups of homeowners and renters as well as from across group inequality.

We can write the GE(0) index of wealth inequality¹⁷ we show that w in a country c as

$$GE^c = \underbrace{HR^c \cdot WR_o^c + (1 - HR^c) \cdot WR_r^c}_{\text{between group inequality}} + \underbrace{HR^c \cdot GE_o^c + (1 - HR^c) \cdot GE_r^c}_{\text{within group inequality}} \quad (2)$$

with

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

Note that WR_g^c is the log deviation of the average wealth of a subgroup $g \in \{owner, renter\}$ from the economy wide average wealth. GE_g^c on the other hand denotes the generalized entropy index of wealth inequality within subgroup g . The first part of the decomposition consequently is a measure of *between group inequality* weighted by the respective group sizes. The second term is a measure of *within group inequality*. If the average wealth of homeowners and renters were identical, the between group term would obviously disappear.

The above decomposition shows that wealth inequality can change across countries owing to two reasons:

1. Changing the homeownership rate changes the weights we put on each subgroup's (owners and renters) contribution to the total GE. Hence, if average wealth ratios (WR_g) or the GE indices (GE_g) systematically differ across the two subgroups in all countries, changing the homeownership rate has a direct effect on the measured wealth inequality.
2. If the wealth ratios or GE indices of owners and/or renters vary systematically across countries then, even without a changing homeownership rate, we should observe differences in wealth inequality across countries.

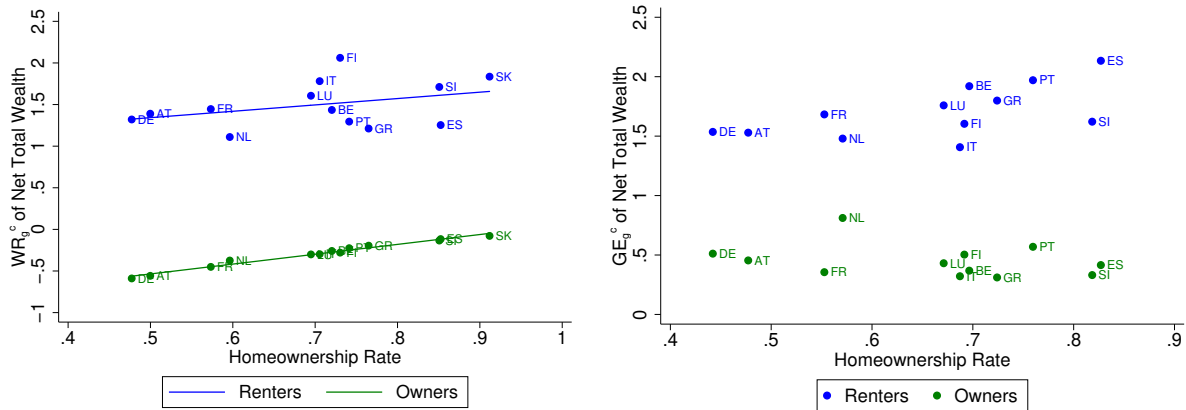
To shed light on the importance of these two channels, Figure shows the evolution of wealth ratios and GE indices of renters and owners across our sample countries.

The left panel of Figure 7 shows how the log wealth ratios WR_g^c evolve with the aggregate homeownership rate in each subgroup. Two things stand out. First, a higher homeownership rate leads to higher wealth ratios in both groups. In Appendix C we show that this is a purely mechanical effect that appears whenever owners have a higher average wealth than renters. However, albeit his upward movement, the difference in wealth ratios between the groups of renters and owners is quite stable across countries.

In the right panel of Figure 7 we can see the GE indices for the group of homeowners and the group of renters in each country. In fact, the GE indices are even more stable

¹⁷ See Appendix C for details.

Figure 7: WR_g^c and GE_g^c Across Countries



Source: Own calculations based on HFCS.

across countries. However, it is striking that wealth inequality within the group of homeowners is substantially lower than inequality within the group of renters. In fact, the GE index of net wealth inequality of renters is about 3 times as high as that of owners. Naturally, an increasing homeownership rate then leads to a reduction in wealth inequality, since the share of the population for which wealth is much more equally distributed becomes larger. In Appendix C we provide a more formal decomposition of this relationship and show that the fact that the wealth of renters is more unequally distributed than the wealth of owners is the most important driver of cross country wealth differences.

Stylized Fact 4. (Wealth Inequality by Ownership Status)

Cross-country differences in wealth inequality are largely driven by the fact that wealth is more unequally distributed within the group of renters than within the group of owners.

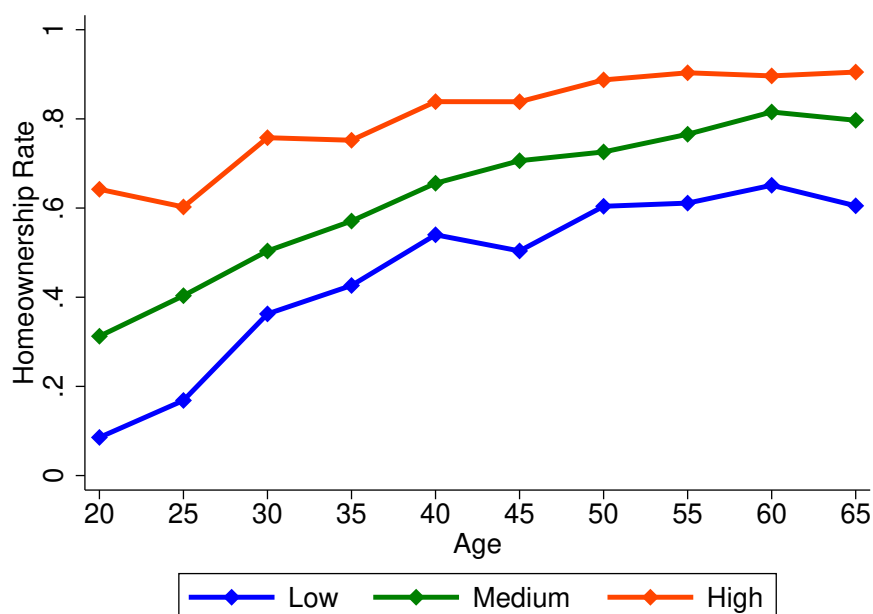
2.5 Stylized Fact 5: The Life Cycle of Homeownership

We saw that there is substantial variation across countries with respect to the aggregate homeownership rate. Figure 8 shows the homeownership rate for all countries in our sample over the life cycle¹⁸.

A clear pattern emerges: households in countries with high homeownership rates become homeowners early on in their life cycle. In Spain, for example, most of the increase in the homeownership rate happens before age 35 while households in Germany households only really start buying homes around age 30. There is also a ranking in

¹⁸ We construct the data by looking at the homeownership rate for 5-year age bins from 20 to 65 and then everyone above 70 for the last data point

Figure 8: Homeownership Over the Life Cycle



terms of maximal homeownership rates. While in Spain around 90 percent of the 55-year cohort owns their main residence, in Germany no age group has a homeownership rate exceeding around 60 percent.

Stylized Fact 5. (Homeownership Over the Life Cycle)

- (i) *In countries with an overall higher homeownership rate, young households hold more houses.*

2.6 Stylized Fact 6: The Portfolio of Renters and Owners

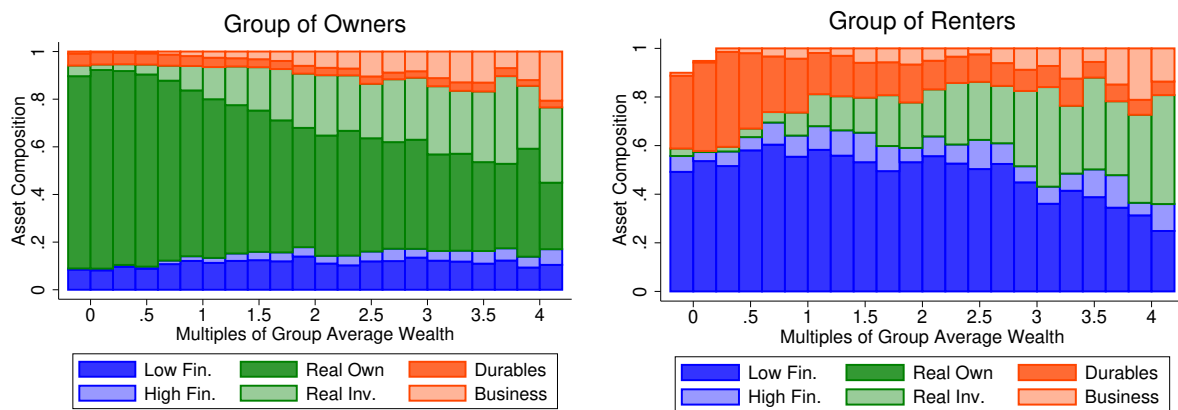
Last but not least, in order to shed more light on the savings behavior of different households, we want to take a more detailed look at the portfolio composition of different households in different groups. We therefore classify assets according to the following six categories:

1. *Low-yield financial assets:* deposits, government bonds, corporate bonds, voluntary pension plans and whole life insurance
2. *High-yield financial assets:* mutual funds, non-self-employment private business investment, shares, managed accounts, etc.
3. *Self-used real estate:* value of the primary and potentially a secondary residence
4. *Real estate investment:* all owned property that is rented out to others

5. *Durables*: mostly vehicles but also some valuables
6. *Business*: the value of a self-employment business

The shares of these six asset categories for households at different places in the wealth distribution are depicted in Figure 9 for both homeowners (left panel) and renters (right panel). A plot for the distribution of liabilities can be found in Appendix B.

Figure 9: Composition of Assets Within Groups of Homeowners and Renters



Source: Own calculations based on HFCS.

What stands out immediately is that owner-occupied real estate makes up for about 70 to 80 percent of the asset side of the household balance sheet for homeowners. Other than owning their home, at the bottom of the wealth distribution homeowners hold about 10 percent of their wealth in deposits and roughly another 10 percent are invested in durables, typically a car. Wealthier households also invest in real estate that they rent out to others. High yield financial assets like stocks or investment funds seem to play only a minor role in the household portfolio. Self-employment business wealth does play a role, but only at the top-tail of the wealth distribution, i.e. for households holding more than twice the average wealth.

When looking at renters in the right panel of Figure 9, the picture looks quite similar in the sense that they are invested in about equal shares in deposits and durables.¹⁹ Nevertheless, the overall share deposits (and durables) take in the households asset side of the balance sheet are naturally much higher, since renters don't own a house. Similarly to homeowners, high yield financial assets do not play an important role for renters. Note, again, that richer households buy real estate for investment purposes. Given the distribution of net wealth in Figure 6, however, the share of such households in the total population is extremely small.

¹⁹ Note that at the very bottom end of the wealth distribution shares don't add up to one, since some households report to not have any wealth at all.

Overall we can conclude that the major difference between homeowners and renters in terms of the portfolio composition is that a large part of assets for homeowners is made up of their own residence. Other than that, both homeowners and renters at least in the dense parts of the wealth distribution mostly invest in low yield financial assets like deposits and buy durables.

Stylized Fact 6. (Wealth Distribution and Portfolio Composition)

- (i) Renters and owners in the lower and mid parts of the wealth distribution invest primarily in low-yield financial assets like deposits or bonds and durables. For homeowners, owner-occupied housing is the single-most important component of their assets.*
- (ii) Wealthy households, regardless of whether owners or renters, tend to buy real estate for investment purposes and hold some self-employment business equity. High-yield financial assets like stocks and investment funds hardly play a role in household portfolios.*

2.7 Summary of Stylized Facts

To sum up, our data suggests that

1. In countries with many renters and few homeowners, there is a lot of wealth inequality.
2. In countries with many renters and few homeowners, there are a lot of households with very small amounts of net wealth.
3. Renters are the ones who hold relatively little wealth.
4. Wealth is also much more unequally distributed among renters compared to homeowners.
5. In countries with high homeownership rates, young households hold more houses.
6. All households in the Euro area predominantly invest in low yield financial assets, their own primary residence and real estate that they rent out to others. For the majority of the populations, other financial wealth plays hardly any role in the household portfolio.

Having established these stylized facts, a general picture emerges from the data: across the countries in our sample, a lot of the variation in wealth inequality seems inextricably linked to homeownership. On the aggregate, real estate is the most significant component of household wealth, as it is for households that own real estate. The main other assets class that households hold are low-yield financial assets that should essentially be viewed as forms of deposits. Even in countries where renters make up more than half of the population we do not see them holding other asset positions that make

up for the lack of real estate. It turns out that knowing the share of renters in a country is almost equivalent to knowing the share of household with low net wealth holdings.

In the subsequent sections we lay out a quantitative model to explain these features of the data. The next section develops this general equilibrium life-cycle model, in which households can choose to invest in low-yield financial assets, their own residence as well as in real estate that they might rent out to others on a rental market for shelter. There will be a wedge on the rental market, governing its efficiency. If a real estate investor rents out on real unit of shelter to a tenant, the tenant will only be able to consume a fraction $1 - \tau_s$ of this real estate property. We calibrate this rental market wedge to match the homeownership for each country in our sample and strive to understand, whether and by how much inefficiencies in the rental market can quantitatively explain the stylized facts identified in this section.

3 A Quantitative Model

We build a general equilibrium life-cycle model with uninsurable idiosyncratic labor income risk and a housing tenure choice. We assume that the economy has a financial sector engaged in intermediating household savings, household borrowing and firm capital usage. We'll introduce a spread between the interest households earn on financial assets they own and mortgages they take out to finance their real estate investment. This spread is supposed to capture the costs of intermediation. Finally, we'll model the economy as a small open economy subject to a fixed world interest rate. Since we are ultimately trying to model differences in homeownership and inequality within the Euro area, we are not after explanations that involve differences in interest rates.

3.1 Households

Every household lives for J periods and we denote the generic age of a household by $j = \{0, \dots, J - 1\}$. In every period, a new cohort of agents is born. Each cohort consists of a continuum of households with measure 1.

In every period of their life j , households care about consumption of fruit c_j and shelter s_j , and have time-separable preferences. The household's per-period preferences over fruit and shelter consumption can be represented by the per-period utility

$$u(c_i, s_i) \tag{3}$$

Households discount future utility with a discount factor $\beta \in (0, 1)$. Their preference can further be represented by an utility function of the expected utility form, so that when faced with uncertainty about their future income their savings and consumption

decisions maximize the discounted sum of future expected per-period utility as in (3).

Households differ with respect to their education $e \in 0, 1$ and we don't model the process by which they acquire this education. We will interpret the high level of education ($e = 1$) as tertiary education and a low level of education ($e = 0$) as anything below that. When they are born, households draw an idiosyncratic permanent shock α_i from an education-specific distribution which is fixed over their life span. Additionally, in every period households draw an idiosyncratic shock η_{ij} to their labor productivity from another education-specific distribution.

In each period j for the first $J_L < J$ periods, household i will earn some gross income from working $y_W(j, e_i, \alpha_i, \eta_{ij}) = w \cdot \tilde{y}(j, e_i, \alpha_i, \eta_{ij})$ which is the product of the wage rate for effective labor w and the effective hours $\tilde{y}(j, e, \alpha, \eta)$ supplied to the market. While we assume that labor supply is completely inelastic, individual labor productivity depends on the household's age j , education level e , a permanent idiosyncratic shock α_i and an idiosyncratic shock η_{ij} . As a function of its labor income y , a household has to pay an average tax rate $t(y) \in (0, 1)$ on its labor income. The resulting after-tax income as a function of labor productivity state variables $x = (j, e, \alpha, \eta)$ is then given by

$$y_N^c(j, e, \alpha, \eta) = [1 - t(y(j, e, \alpha, \eta))]y(j, e, \alpha, \eta) \quad (4)$$

For the remaining $J - J_L$ periods, the household is retired and receives a pension y^P . We will assume that the pension is a function of the household's average life-time income. We follow Kindermann and Krueger (2014) in modeling what we call "life-time income" $\bar{y}(e, \alpha, \eta)$ as only dependent on the household's education shock e , permanent shock α , and the last productivity shock η it received. We denote the pension by

$$y^P(e, \alpha, \eta) = \Omega(\bar{y}(e, \alpha, \eta)) \quad (5)$$

Where Ω is the pensions function. We can then summarize the households income function at age j generally as

$$y((j, e, \alpha, \eta)) = \begin{cases} y_N^c(j, e, \alpha, \eta) & \text{if } j < J_L \\ y^P(e, \alpha, \eta) & \text{if } j \geq J_L \end{cases}$$

We will discuss the evolution process for η , the distributions for α as well as the tax and pension functions t and Ω in the calibration section.

3.2 Government

The government raises taxes and uses them to pay out pensions and finance its operations G . Aggregate taxes are given by

$$T = \int_{x(:,j < J_L)} t(y_W(x))y_W(x)d\mu_x(x)$$

where $\mu_x(x)$ is the measure over all shocks x . The notation $x(:,j < J_L)$ means that the integral is taken with respect to all states e, η but only for $j < J_L$.

The aggregate pension cost is simply given by

$$Y^p = \int_{x(:,j \geq J_L)} y^p(e, \alpha, \eta)d\mu_x(x)$$

The budget constraint for the government is

$$T = Y^p + G \tag{6}$$

3.3 Real Estate and the Rental Market

A unit of real estate produces one unit of shelter in every period. Every unit of real estate is owned by a household. The real estate's owner can decide whether she wants to consume or sell the shelter produced by the real estate. We interpret such a sale as "renting out" the real estate to a tenant. Whenever real estate gets rented out, only a fraction $(1 - \tau_s)$ of every unit of shelter sold actually arrives at the household renting the real estate. Other than τ_s , rental markets are perfectly competitive.

The market to buy and sell houses is perfectly competitive as well and in every period the household can buy and sell real estate at a unit price of $p_h > 0$. Every period, a unit of real estate depreciates and a fraction $\delta_h < 1$ of the unit becomes worthless and has to be replaced.

Finally, changing one's housing stock is costly and the household has to incur a non-convex adjustment cost

$$\gamma(h, h') \begin{cases} = 0 & \text{if } h = h' \\ > 0 & \text{if } h \neq h' \end{cases} \tag{7}$$

Note that this implies that a household with positive real estate holdings $h > 0$ has to pay $\delta_h p_h h$ and replenish the depreciated part of its holdings if it wants to maintain h and avoid paying the adjustment cost.

3.4 Financial Markets

As in Aiyagari (1994) and Bewley (1986), households are incomplete in the sense that households cannot insure against idiosyncratic shocks. Households can borrow and

lend by interacting with financial intermediaries. These intermediaries take in deposits from households on which they pay r_d and issue mortgages on which they charge r_m . Intermediation is costly. For each unit of good the intermediary takes in or lends out it has to pay a per-period intermediation fee of $\frac{\kappa}{2} < 1$ units of the good.

The financial intermediaries can borrow and lend on international financial markets at the interest rate $r_w > 0$.

There is free entry into the financial intermediation market, individual firms make zero profits and we have

$$\begin{aligned} r_d &= r_w - \frac{\kappa}{2} \\ r_m &= r_w + \frac{\kappa}{2} \end{aligned}$$

A mortgage is restricted by the collateral value the household can post. The household is only able to borrow up to $\lambda_j \in (0,1)$ of the house value when financing a house with a new mortgage. Let p_h be the price of real estate. λ_j varies with age - specifically, it starts at $\bar{\lambda}$ at $j = 1$ and starts declining at some point T_λ all the way to $\underline{\lambda}$ at $j = T - 1$. This captures the fact that old people are not able to finance real estate with high leverage as their remaining life-span does not allow them to commit to repaying large amounts of debt²⁰.

3.5 Household's Problem

In every period, the household's value function is given by:

$$v(j, e, \alpha, \eta, h, b_-, b_+) = \max_{c, s, h', b'_-, b'_+} u(c, s) + \beta \mathbb{E} [v(j+1, e, \alpha, \eta', h', b'_-, b'_+)] \quad (8)$$

subject to the constraints:

$$\begin{aligned} c + p^s(s - h)(1 - \tau_s \mathbb{1}_{[h>0]}) + \gamma(h, h') + b_- - b_+' &\leq w^c y^c(j, e, \alpha, \eta) \\ &+ p^h(h - h') - \delta_h h + (1 + r_d)b_+ - (1 + r_m)b_- \end{aligned} \quad (9)$$

$$b_- \leq \lambda p_j^h h_j \quad (10)$$

$$c, s, b_-, b_+' \geq 0 \quad (11)$$

$$h' \in \{0, [h_{min}, \infty)\} \quad (12)$$

$$s \leq h \text{ if } h > 0 \quad (13)$$

(9) is the household's budget constraint. (10) is the household's borrowing constraint, (11) ensures that all choice variables remain positive. states that if the household went

²⁰ If $\lambda_T > 0$, the household would be able to die with outstanding debt it would never have to repay.

to become an owner, she must afford a minimum house size h_{min} and (13) is a constraint that prevents households from renting additional shelter for their consumption if they are homeowners.

The solution to the household's problem is given by a value function $v(\chi)$ as well as policy functions $c(\chi), s(\chi), h'(\chi), b'_-(\chi), b'_+(\chi)$ where $\chi = (j, e, \alpha, \eta, h, b_-, b_+)$ are the household's states.

3.6 Production Sector

There is a representative firm that produces all the output in the economy using aggregate capital and labor:

$$Y = AK^{\xi}L^{1-\xi} - \delta_k K$$

where δ_k is capital depreciation. The firm pays out the interest rate r_w and wage w^c which are given by the usual marginal pricing conditions:

$$r_w + \delta_k = \alpha A \left(\frac{L}{K} \right)^{1-\alpha} \quad (14)$$

$$w^c = (1 - \alpha) A \left(\frac{L}{K} \right)^{-\alpha} \quad (15)$$

3.7 Housing and Capital Depreciation

Since we consider an equilibrium with a fixed capital stock, a country's capital investment is simply equal to its capital depreciation:

$$I_K = \delta_k \bar{K}$$

Similarly, since we also assume that housing is in fixed supply at a stock \bar{H} , the country's housing investment is also simply given by

$$I_H = \delta_h \bar{H}$$

3.8 Foreign Sector

Since we model each economy as a small open economy subject to the world interest rate r_w , we include a simple foreign sector in the model.

Let the net financial asset holdings of households be given by

$$F = \int_{\chi} b'_-(\chi) - b'_+(\chi) d\mu(\chi)$$

where $\mu(\chi)$ is the equilibrium measure over the household's states. Whenever the domestic capital stock K is smaller than the net financial assets F owned by the households, the country will be a net owner of foreign assets. Conversely, whenever a country's capital stock K exceeds the net financial assets F the households, the foreign sector will own part of the country's capital stock. The payment for this ownership is reflected in the country's net exports to the foreign sector. Given the world interest rate r_w , the foreign sector consumes

$$Ex = r_w(K - F)$$

of the country's production.

3.9 Aggregate Adjustment Costs

Finally, the adjustment costs paid by the households for changes in their real estate ownership as well as the financial sector's intermediation cost also have to be included in the aggregate resource constraint.

The aggregate cost of real estate adjustment is given by

$$\Psi_\gamma = \int_\chi \gamma(h, h'(\chi)) d\mu(\chi)$$

The cost of financial intermediation is given by

$$\Psi_\kappa = \frac{\kappa}{2} \int_\chi b'_-(\chi) + b'_+(\chi) d\mu(\chi)$$

3.10 Equilibrium

We can now define a stationary recursive competitive equilibrium for a country's economy.

Definition 1 (Stationary Recursive Competitive Equilibrium). *A stationary recursive competitive equilibrium for the economy is a set of equilibrium decision rules $c(\chi), s(\chi), h'(\chi), b_-(\chi), b_+(\chi)$ and value functions $v(\chi)$ where $\chi = (h, b_-, b_+, j, e, \alpha, \nu)$, a shelter price p_s , a wage w , housing price p_h , a capital depreciation rate δ_k , Government expenditure G , optimal input choices K and L for firms, net exports Ex and a stationary measure $\mu(\chi)$ such that for a fixed capital stock $K = \bar{K}$, a fixed housing stock \bar{H} , the world interest rate r_w , the tax function $t(y)$, and the pension function $\Omega(\bar{y})$*

1. *Given wages w and prices (p_s, p_h) , the household's decision rules and value functions solve (8) subject to (9) - (13)*

2. Given δ_k and wage w the firm's choices are optimal and satisfy

$$r_w + \delta_k = \xi A \left(\frac{L}{\bar{K}} \right)^{1-\xi}$$

$$w = (1 - \xi) A \left(\frac{L}{\bar{K}} \right)^{-\xi}$$

3. The governments budget is balanced: $G = T - Y^P$

4. The housing market clears: $\bar{H} = \int_{\chi} h'(\chi) d\mu(\chi)$

5. The goods market clears: $Y = C + I_H + I_K + G + Ex + \Psi_k + \Psi_\gamma$

6. The capital stock is fully utilized: $K = \bar{K}$

7. The labor market clears: $L = \int_{\chi} y(j, e, \alpha, \eta) d\mu(\chi)$

8. $\mu(\chi)$ is generated by individuals' optimal choices and consistent with the distribution of α and the process governing the evolution of η .

4 Calibration

In this section, we describe how we choose the parameters of the model. Once we have selected them, we calibrate our model by going through the following steps:

- (1) Select the parameters controlling preferences, production, financial markets, labor income shocks, taxes, pensions, adjustment costs and the world interest rate to match the situation in Germany.
- (2) Jointly calibrate the rental market wedge τ_s^{DE} , the housing stock \bar{H} , and the time discount factor β , to match Germany's homeownership rate, normalize the price level $p_h^{\text{DE}} = 1$, and obtain a fraction of households with wealth below 25% of average income of around 30%. Furthermore, set the capital stock \bar{K} so that net exports are zero.
- (3) For every other country c , adjust the income process as well as tax and pension profiles, but keep the capital stock \bar{K} and the housing stock \bar{H} the same as for Germany. Calibrate τ_s^c to match the country's homeownership rate.

The idea here is that by running (2), we have a benchmark economy with normalized house prices. Using (3), we identify the rental market wedge τ_s necessary to account for the homeownership rate once we have accounted for differences in the income process as well as tax and pension policies.

4.1 Preferences

We model household preferences using a Cobb-Douglas utility function over consumption and shelter. Such a utility function is homothetic, implying that the expenditure share of shelter is independent of a household's income. This approach is standard in the literature and consistent with the data in the sense that long-run expenditure shares of housing expenditures are roughly constant. Davis and Ortalo-Magné (2011) use evidence from the Census of Housing to show that expenditure shares are constant over time and across metropolitan areas for the U.S.. Data from

$$u(c, s) = \frac{(c^{1-\alpha} s^\alpha)^{1-\sigma}}{1-\sigma} \quad (16)$$

As is well known, α corresponds to the expenditure share of shelter a household with preferences as in (16) would choose. So long as most households are unconstrained and rents are imputed correctly²¹ then, α is identified as the expenditure share in the data. σ , which controls the preference for inter-temporal substitution as well as risk-aversion, is set to $\sigma = 2$.

4.2 Production

We assume that production happens using the aggregate production function:

$$Y = AK^{1-\zeta}L^\zeta$$

We will set A to match the average wage in the economy. With this normalization of wages and a fix interest rate, the production parameters will have no real impact on the results and we just set $\zeta = 0.3$.

4.3 Labor Market, Taxes and Pensions

4.3.1 Gross Labor Income

So long as the household is active in the labor market, household i 's labor productivity at age $j < J_L$ follows a stochastic process described by

$$\log(y(j, \eta_{i,j})) = \bar{y}(j) + \eta_{i,j} \quad (17)$$

where $\bar{y}(j)$ is age profile of income. The transitory shock $\eta_{i,j}$ has an autoregressive structure so that

$$\eta_{i,j} = \rho\eta_{i,j-1} + v_{i,j} \quad (18)$$

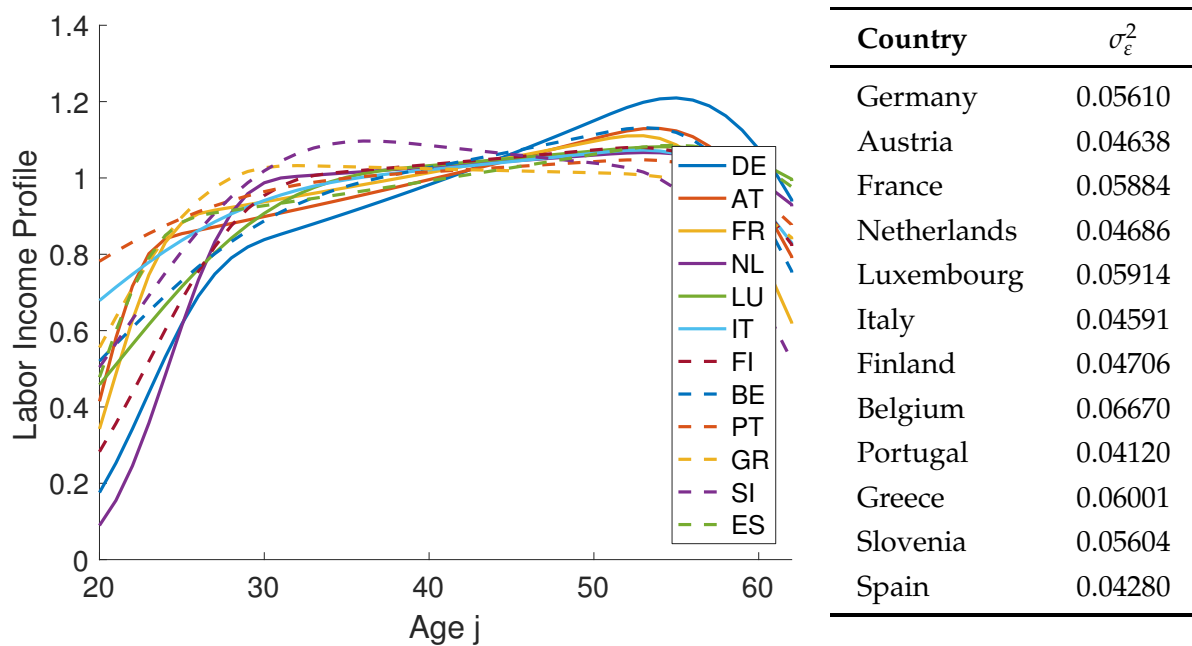
²¹ For a discussion on the accuracy of imputed rents in the presence of user costs that look similar to our wedge, see Díaz and Luengo-Prado (2008)

where $\rho \in (0, 1)$ and $v_{i,j} \sim N(0, \sigma_v^2)$ is i.i.d. across time and households.

As in Kindermann and Krueger (2014), throughout retirement, that is for $j \geq J_L$, we assume that $\eta_{i,j+1} = \eta_{i,j}$ so that the household's pension is constant and a function of the last idiosyncratic shock.

We use cross-sectional data on (normalized) gross labor earnings (from employment and self-employment) from the HFCS to estimate country-specific income processes. For the Netherlands and Slovenia we complement this data by data from the Luxembourg income study (LIS) due to current data issues.²² We again standardize household labor earnings using OECD equivalence scales. We first regress labor earnings $y_{i,j}$ on age fixed effects \bar{y}_j . In order to make labor earnings profiles a bit smoother for the simulation process, we approximate the age-earnings fixed effects using piecewise third order polynomials. In addition, to quantify the risk component of labor earnings, we use the variance σ_η^2 of the residual $\eta_{i,j} = y_{i,j} - \bar{y}_j$. Assuming an autocorrelation of $\rho = 0.95$, which is in line with estimates from the labor literature, we obtain a variance for the innovation term v of $\sigma_v^2 = (1 - \rho^2) \cdot \sigma_\eta^2$. Figure 10 shows the estimated life-cycle structure and labor income risk parameters. We discretize the autoregressive process using a standard Tauchen method with 30 nodes.

Figure 10: Life-Cycle Labor Productivity Process



²² In the future we intent to use the second wave of the HFCS to overcome these issues.

4.3.2 Taxes

While they are active on the labor market, households in country c pay an average income tax rate of $t^c \in (0, 1)$ on their labor income $wy(j, e, \alpha, \eta)$. Since there is no labor supply choice in our model, these taxes are non-distortionary and can focus on the average tax function for each country. We use data from the OECD tax database to estimate an average tax function of the form

$$t^c(y) = t_0^c + t_1^c \frac{y_i}{\bar{y}^c} + t_2^c \left(\frac{y_i}{\bar{y}^c} \right)^{\phi^c} \quad (19)$$

where $(t_0^c, t_1^c, t_2^c, \phi^c)$ are parameters that depend on country c 's tax code and \bar{y}^c is the average income in country c in the year the taxes were paid. The fact that $t^c(y)$ is increasing in y_i for all countries in our sample reflects the fact that the income tax code is progressive in all those countries. We follow Guvenen et al. (2013a) in their approach in estimating this tax function. As they do, we use the OECD data on average and marginal tax rates but apply it to the countries in our sample and use the most recently available data for 2015. The OECD provides data on the average tax rate for multiples between $\frac{2}{3}$ and $\frac{5}{3}$ of the average income of a country. In addition, it provides data on the top marginal tax rate in a country as well as the income at which the marginal tax rate is reached. This allows us to impute the average tax rate of multiples of the income above the $\frac{5}{3}$. After doing this for multiples reaching up to 6 times the average income, we then fit a line of the form described in (19) through the points.

Figure 11 shows the estimated average tax function for Germany (a country with a low homeownership rate), Italy (a county with a medium homeownership rate) and Spain (a country with a high homeownership rate). Appendix D.2.1 provides more details on estimating the tax functions as well as the estimated parameters for all countries. As reported in figure 11 the fit of the line through the points we get from the OECD data is very close. The estimated values for the parameters for all countries are reported in table D.1 in the appendix.

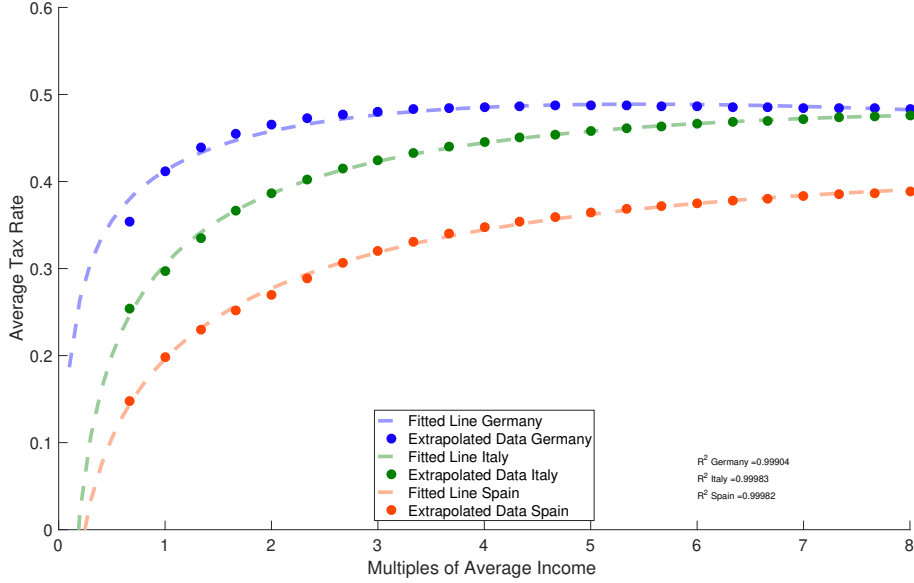
4.3.3 Pension Systems

Once the household enters retirement, it no longer pays taxes nor does it earn a labor income. Instead, it receives a net pension payment from the government $\Omega^c(\bar{y}^i)$ that depends on both the average net-income in country c as well as the average net-life-time income \bar{y}^i of household i . Specifically, its is given by

$$\Omega^c(\bar{y}^i) = \begin{cases} a_1^c \bar{y}^c + b_1^c \bar{y}^i & \text{if } \bar{y}^i \leq \bar{y}^c \\ a_2^c \bar{y}^c + b_2^c \bar{y}^i & \text{if } \bar{y}^i > \bar{y}^c \end{cases} \quad (20)$$

so that the function is piece-wise linear with an inflection point \bar{y}^c . For many countries, we will have $b_2^c = 0$ so that the pension payment no longer depends on the household's

Figure 11: Average Tax Rate Functions



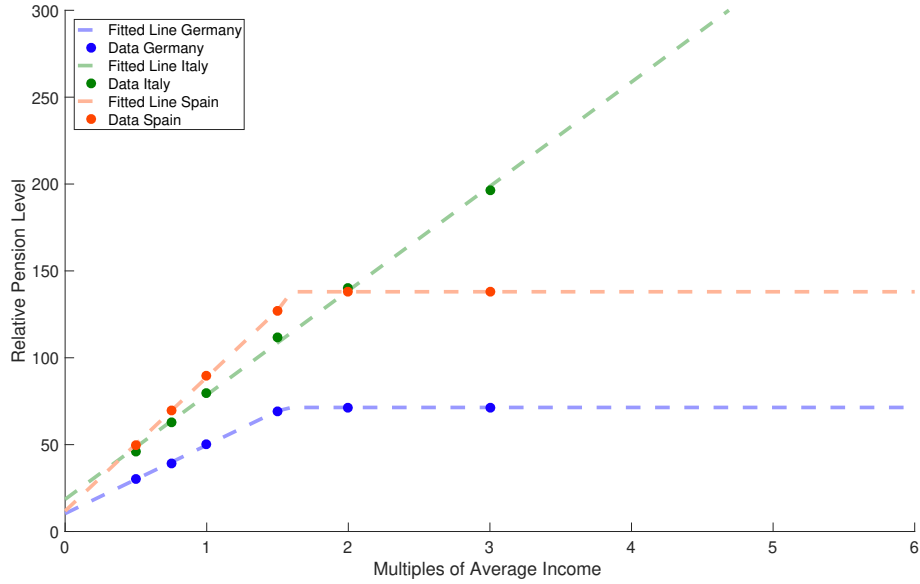
average income after it's average income exceeds the threshold \tilde{y}^c . More generally, the value a_1^c captures how much country c 's pension system emphasizes redistribution while the value of b_1^c captures how much it emphasizes the individual insurance component. This framework is again taken from Guvenen et al. (2013a) and, similar to their approach, we will use data published by the OECD on the pension systems of the countries in our sample to get the parameters for the function. The OECD publishes the pension level relative to the average net income for all countries and multiples of the wage between 0.5 and 2. We use this data to get our parameters as suggested in Guvenen et al. (2013a) but use the most recent data from 2015 for the countries in our sample. Figure 12 shows the pension functions for Germany, Spain, and France. Appendix D.2.2 provides more details as well as the parameter values for all countries in our sample.

As discussed, for a household with education e , fixed productivity shock α and last transitory productivity shock η we determine the average life-time income as the hypothetical average life-time income a household with those shocks over the entire life-time would have. This prevents having to expand the state space to include a special state for the average life-time income. Average life-time income for such a household is then given by

$$\bar{y}(e, \alpha, \eta) = \frac{1}{J_L} \sum_{j=0}^{J_L-1} y_N(j, e, \alpha, \eta)$$

Using a net-pension income rather than modeling gross pensions allows us to ignore the differences in how pensions are treated for tax purposes across countries in our sample.

Figure 12: Net-Pension Functions



4.4 World Interest Rate, Financial Markets and Adjustment Costs

To set the cost of intermediation κ , we look at data on the one-year deposit rate and the over-five-year mortgage rate for households as reported by the ECB. Between 2003 and 2016 the average of that spread was 1.91 percentage points in the Euro Area. We set $\kappa = 1.91$.

We let the maximal loan to value ratio λ vary over the life cycle. For the first 21 years, the household can access the maximal loan-to-value ratio $\bar{\lambda}$. Over the following 24 years, the loan-to-value ratio declines linearly until it reaches 0 at age 65. This is to capture the effect that old households have only a short time-span left which limits the amount of loans they can repay. To keep our model simple, we decided to use a more reduced form approach. Following data reported for all countries in Andrews et al. (2011) we set $\bar{\lambda} = 0.8$ which in 1990 did not vary substantially across countries around that value.

For the parameters of the adjustment cost function $\gamma(h, h')$, we assume that it takes the form:

$$\gamma(h, h') = \begin{cases} \gamma_0 + \gamma_1 p_h h' & \text{if } h' \neq h \\ 0 & \text{if } h' = h \end{cases} \quad (21)$$

We set $\gamma_0 = 5000 \text{ €}$ and $\gamma_1 = 0.05$ to be similar to what is found in the literature, see Andrews et al. (2011). Table 2 summarizes all parameter values for Germany.

Table 2: Summary of Calibration Data for Germany

Parameter	Description	Value
α	Shelter-share of expenditure	0.1600
σ	Curvature of utility function	2.0000
ζ	Capital intensity of production	0.3000
t_0	tax function parameter	1.0753
t_1	tax function parameter	-0.0128
t_2	tax function parameter	-0.6501
ϕ	tax function parameter	-0.1352
a_1	pensions weight average wage $\leq \tilde{y}^c$	0.1033
b_1	pensions weight life-time wage $\leq \tilde{y}^c$	0.3938
\tilde{y}^c	maximal income for pension	1.5500
a_2	pensions weight average wage $> \tilde{y}^c$	0.7140
b_2	pensions weight life-time wage $> \tilde{y}^c$	0.0000
r	average interest rate	0.0200
κ	interest rate spread	0.0191
$\bar{\lambda}$	maximum mortgage LTV ratio	0.8000
γ_0	fixed adjustment costs for house buying	5000€
γ_1	variable adjustment costs for house buying	0.0500
<i>Calibrated</i>		
τ_s	Rental market wedge	0.1363
β	Time discount factor	0.9569

5 Results

Table 3 lists results for homeownership and wealth inequality for all countries. Like in the data, we recode households with wealth holdings of less than 1% of average labor income to hold exactly this amount of net wealth.

The results in Table 3 are for the full model, where we use the country-specific income profiles, tax and pension schedule discussed above and then calibrate τ_s to match each county's home ownership rate. We will see below that the addition of taxes and pensions is particularly crucial when explaining differences in the level of consumption for young and old households but in terms of wealth accumulation, the majority of differences across countries is explained by variations in τ_s needed to match the data. Note that the rental market wedge varies quite substantially across countries. However, it is always a positive wedge, meaning that rental markets turn out inefficient in any of the economies under consideration. In the following, we want to discuss how our model

Table 3: Model Results All Countries

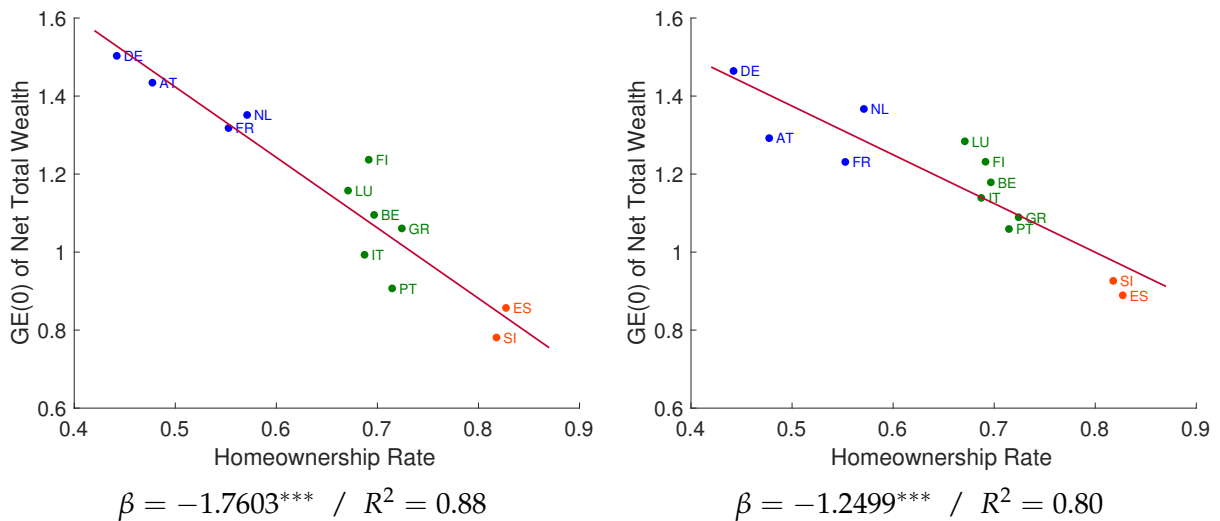
Country	HO rate Data	HO Rate Model	GE(0) Wealth Data	GE(0) Wealth Model	τ_s
Germany	44.2%	44.2%	1.503	1.464	0.1363
Austria	47.7%	47.7%	1.434	1.292	0.1006
France	55.3%	55.3%	1.318	1.231	0.1936
Netherlands	57.1%	57.1%	1.351	1.367	0.2032
Luxembourg	67.1%	67.1%	1.158	1.284	0.3827
Italy	68.7%	68.7%	0.993	1.139	0.3374
Finland	69.2%	69.1%	1.237	1.232	0.4016
Belgium	69.6%	69.7%	1.095	1.179	0.4685
Portugal	71.5%	71.5%	0.907	1.059	0.3401
Greece	72.4%	72.4%	1.061	1.089	0.4214
Slovenia	81.8%	81.8%	0.781	0.926	0.7894
Spain	82.7%	82.7%	0.857	0.889	0.7048

performs in comparison to the stylized facts identified in section 2.

5.1 Stylized Fact 1: Homeownership and Wealth Inequality

We saw that in the data, there is a strong negative correlation between wealth inequality and homeownership. Figure 16 compares the data (left panel) and the model predicted wealth inequality (right panel). Generally speaking, our model does very well

Figure 13: Homeownership and Wealth Inequality: Data vs. Model



in capturing the difference between the three groups of countries: For the group of countries with low homeownership rate (in blue on Figure 16) our model produces the highest wealth inequality, while it produces medium wealth inequality for the group of countries with medium homeownership rate (in green on Figure 16). Finally, our model produces the lowest degree of wealth inequality for the group of countries with high homeownership (in red on Figure 16). The regression coefficient in the data was larger in absolute value than in the model, at around 1.76 compared to the model's -1.25 . Nonetheless, our model reproduces a strong, significant, and robust negative correlation between homeownership rates and wealth inequality across countries.

We are also interested in understanding how well our model reproduces the data with respect to wealth inequality according to standard model fit measures. Table 4 reports the total variation (as sum of squares) of the GE(0) of net wealth and then reports the residual sum of squares of the GE(0) values produced by the model. Using the standard $R^2 = 1 - \frac{RSS}{SS}$ measure for model fit, our full model can explain 80% of the variation seen in the data. When we run a model version, in which we create a hy-

Table 4: Goodness of Fit: GE(0) of Net Wealth

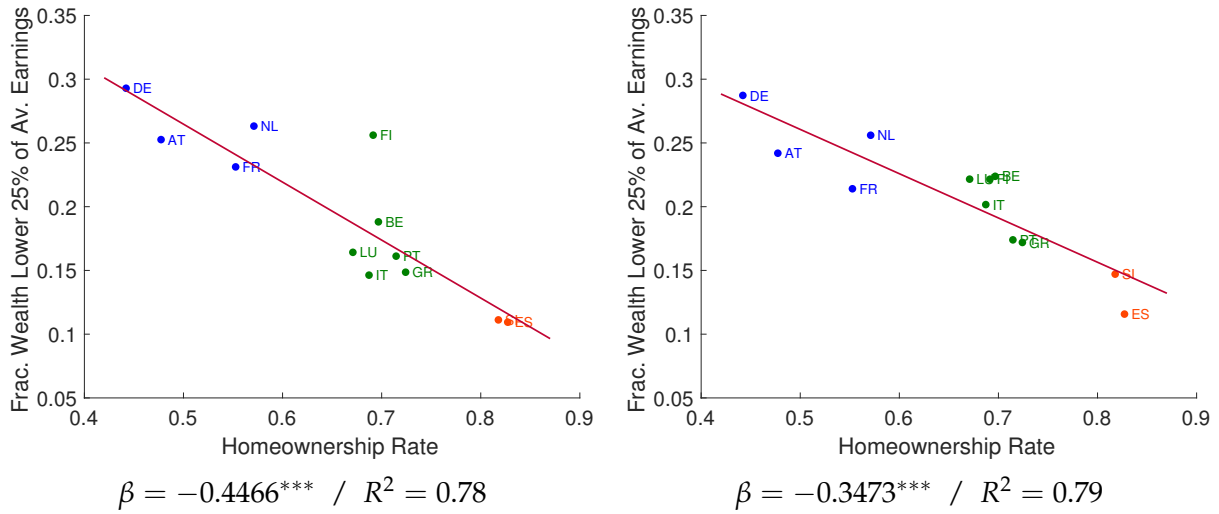
Model	SS Data	RSS	R^2
Total	0.5977	0.1199	79.94%
- only rental wedge τ_s	0.5977	0.3018	49.52%
- only income + policy	0.5977	0.3827	35.97%

brid economy by averaging income processes and fiscal policies and only vary the rent wedge over countries, our model is able to account for about 50% of the differences in wealth inequality across countries. Varying only income processes and fiscal policies, but keeping the rental wedge at a cross-country average leads to an explanatory power of 35.97%. Of course this decomposition is not orthogonal, such that the values reported do not sum up to the total explanatory power of the model. However, this non-linear decomposition indicates that the major explanatory mechanism in our model is the cross-country differences in rental market efficiency rather than differences in income processes or fiscal policy.

5.2 Stylized Fact 2: The Fraction of Low Wealth Households

The data also showed a considerable variation in the fraction of low wealth households across the different countries. Figure 14 shows the fraction of households with a wealth level below 25% of the economy wide average income. Again, model and data show a very similar picture: In economies with a lot of renters, there are many households who only hold a small amount of wealth.

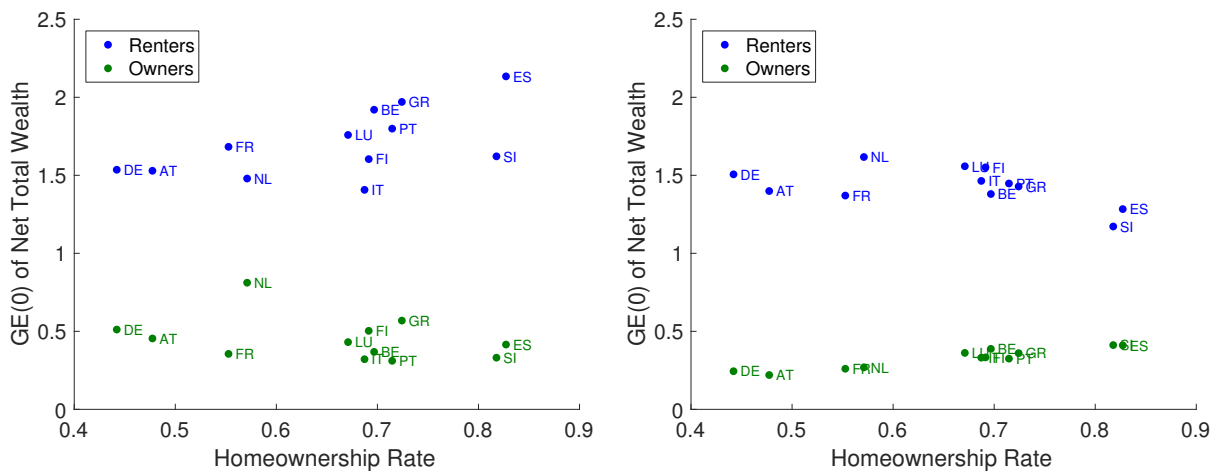
Figure 14: Homeownership and Low Wealth Households: Data vs. Model



5.3 Stylized Fact 4: Wealth Inequality by Ownership Status

One of the causes of high wealth inequality in countries with low homeownership rates was that wealth is consistently more unequally distributed within the group of renters compared to the group of owners in all countries we looked at. Figure 15 compares the GE(0) separately between owners and renters over our different countries with the model simulated counterparts. Again our model shows a very similar picture than

Figure 15: Wealth Inequality of Owners and Renters: Data vs. Model



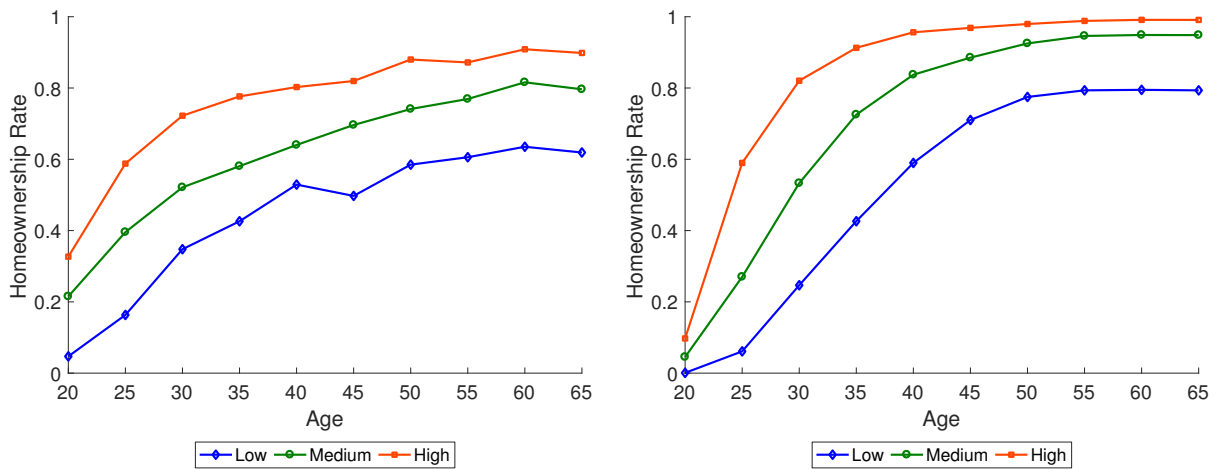
the data. The difference between the GE(0) index of wealth inequality for renters and owners is greater than 1 in both the data and the model. The only caveat might be that the index for renters is staying constant or slightly increasing with homeownerships rising in the data, while it tends to slightly fall in our model. This might speak for the fact that in high homeownership countries, those remaining 10 to 15 percent of the

population who need to rent a house form a very particular group.

5.4 Stylized Fact 5: The Life Cycle of Homeownership

Last but not least, our data showed that in countries with a lot of homeowners, households own houses much earlier in the life cycle. To this end, Figure 16 compares the life cycle of homeownership between model and data. For a better comparison, we again grouped the profiles for our three country groups. There are two patterns consistent

Figure 16: Homeownership over the Life Cycle: Data vs. Model



between model and data. First, households are owners of houses much earlier in the life cycle in countries with a high homeownership rate. Second, even when older, there is a significant difference in homeownership across different countries, meaning that especially in countries with a lot of renters, there also are a lot of old renters in the population. Of course, since our model agent's life cycle only starts by the age of 20, there are some differences between model and data especially at early stages of the life cycle.

5.5 Understanding the Mechanism

Overall, we show that our model, and especially the rental market efficiency mechanism, provide a good fit for the observations we made in our cross-country data. Having established that our model can replicate the stylized facts, we now want to investigate what is the driving factor at the household level? A higher value of τ_s incentivizes households to buy a house earlier in their life, see Figure 16. In order to fit the homeownership rate, our model increases τ_s for countries with higher home own-

ership rates. This translates into a greater incentive for households in these countries to buy a house and, as we can see from Figure 16, to buy the house earlier.

In the following section we look at the savings and consumption behavior of households for versions of the model in which the only varying element is τ_s . In other words, we will (again) be looking at a hybrid country with averages income profiles, income variance, tax and pension policies. This allows for the cleanest comparison of the implications of rental market efficiencies for household level decisions. We said that in countries with a larger wedge, households tend to become homeowners earlier in the life cycle. Which implications does that have for the accumulation of financial assets and their overall net wealth, especially at the beginning of their life cycle?

Figure 17: Financial Assets and Homeownership for Young Households

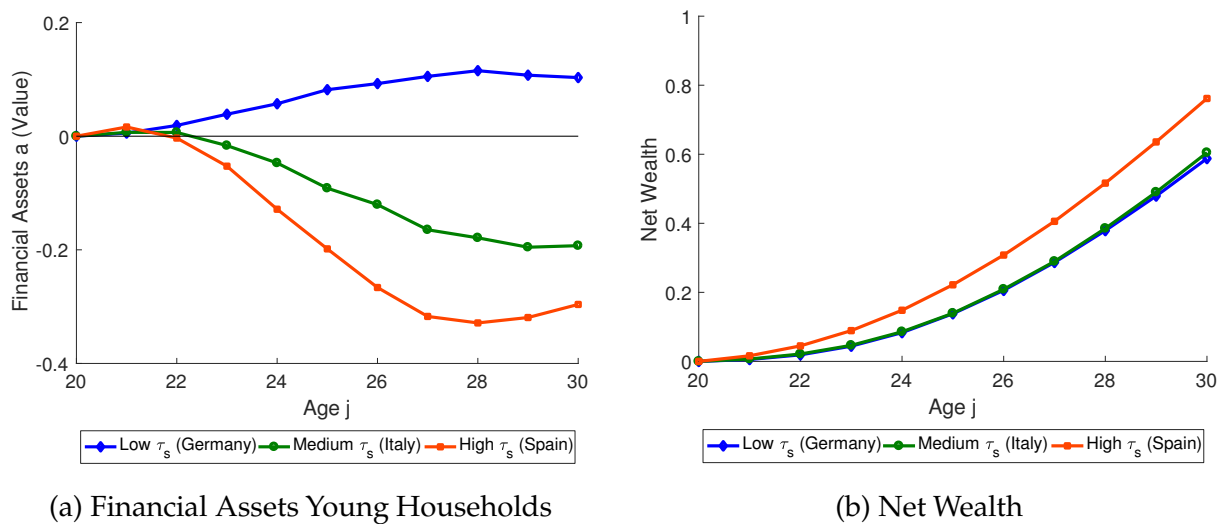
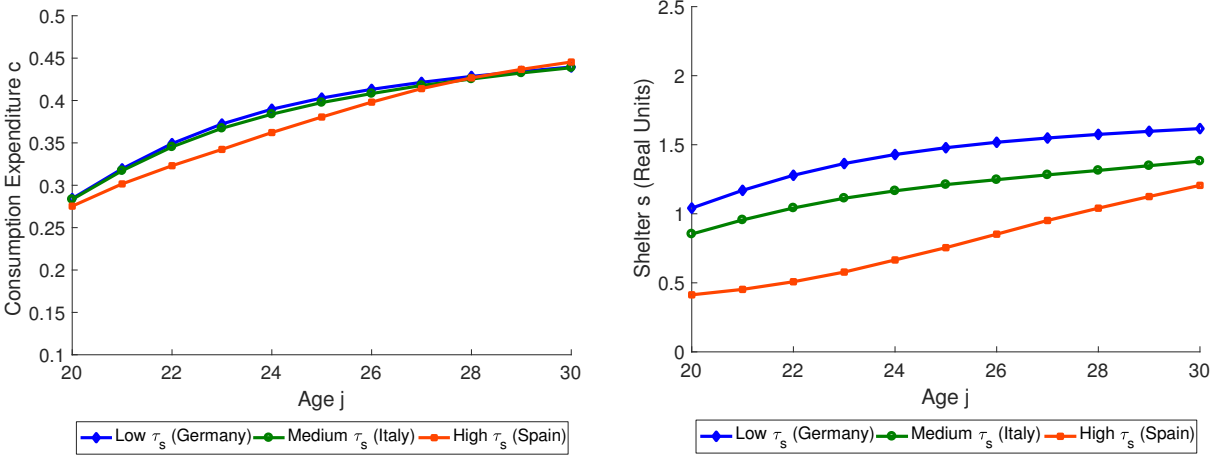


Figure 17 shows the path of financial assets for young households in a version of with a small wedge (blue), an intermediate wedge (green) and a large wedge (red). In order to quickly become homeowners, households faced with a large wedge start saving more even as young households with relatively low income (Figure 17a). At around age 27, a large part of these households starts going into debt to buy houses while households facing smaller rental market wedges do not acquire real estate yet. Figure 17b shows how this is reflected in the overall net wealth position: While households facing low rental market wedges maintain essentially zero net wealth at the beginning of the life cycle, households facing a larger rental market wedge start accumulating wealth much more quickly.

What do these differences in real estate purchasing behavior mean for consumption and saving over the life cycle? Generally speaking, our life-cycle path of income implies that households would like to borrow to smooth consumption in anticipation of higher wages later on in life. Since they cannot borrow, they simply don't save much until their incomes have risen and they start saving for retirement. When facing larger

rental market wedges, households also have an incentive to borrow to quickly buy a house. Since they have to finance a part of their real estate purchase with equity, there is now a trade-off early in life between consuming and saving to buy a house for more shelter consumption in the future. This trade-off is stronger for households in countries with a larger wedge since the difference in the effective shelter price between renters and owners is greater. Further, for households who decide to buy their house with a loan, the incentive to save will be greater than for agents who do not have any debt: Because of the interest rate spread, the interest rate on mortgages exceeds that on deposits. Everything else equal, this leads households with negative financial assets to save more than households with positive financial assets.

Figure 18: Consumption and Shelter for Young Households



(a) Consumption Young Households

(b) Shelter Young Households

Figure 18 shows the path for consumption and shelter for households in their 20s in countries with different levels of τ_s . Especially in Spain, we see the trade-off between consuming and saving for a downpayment described above: During the first few years of the life cycle, households in Spain consume less than they do in other countries in order to save up for a downpayment on a house. Shelter consumption is even more markedly different across countries, but this effect is mainly driven by variations in the shelter price, reflecting variations in rental market wedges.

To complete this picture, Figures ?? and ?? show the full life-cycle path of consumption and shelter in our model. In summary, one can say that the larger is the rental market wedge, the less equal is the shelter consumption over a household’s life-cycle. There are two reasons for this pattern. First, there are differences in households’ savings behavior early in the life-cycle. As we have seen, this is the main reason for lower general consumption early in life by households facing larger rental market wedges. Second, the fact that rented shelter is much more expensive in countries with larger wedges (relative to owning) means that households who are not homeowners yet can afford to only consume very little shelter for a given overall consumption expenditure.

Figure 19: Consumption over the Lifecycle: Model with fixed taxes and fixed pensions

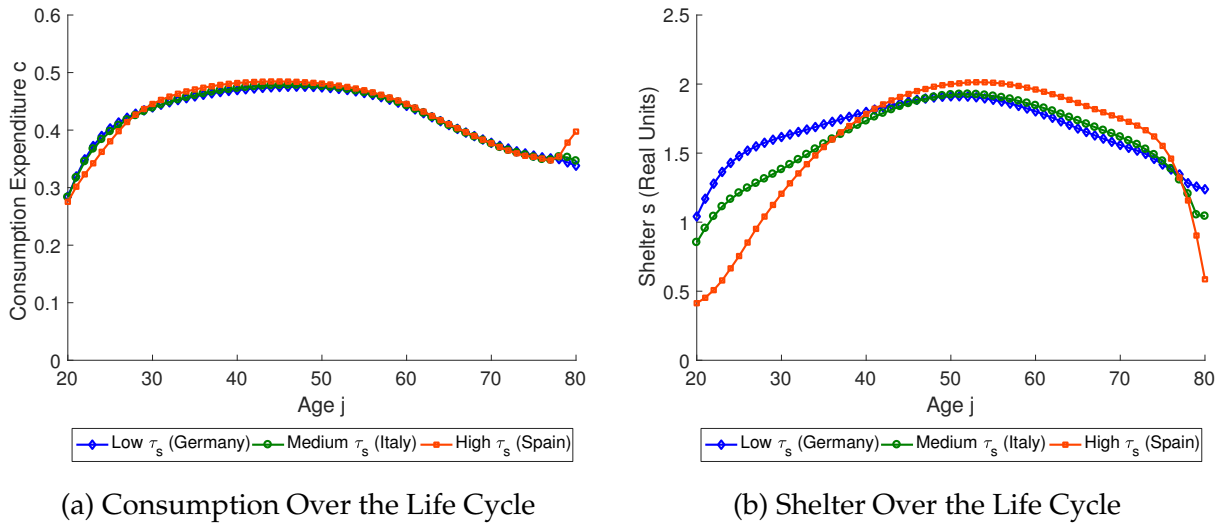


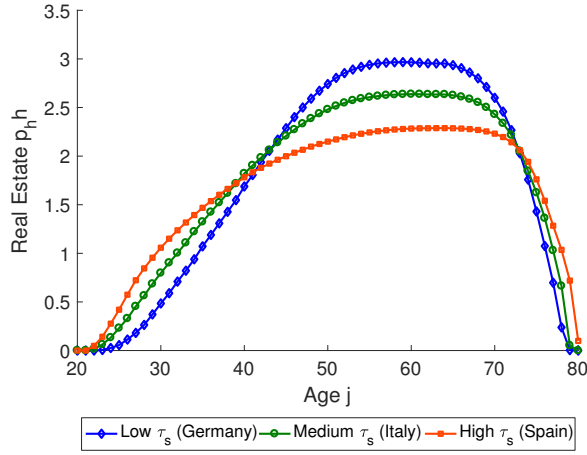
Figure 20 shows the full life cycle profile for financial assets, real estate, netwealth (the sum of financial assets and real estate holdings) as well as the homeownership rate. The large incentive to save for households who borrow to buy a house shows up with net wealth being slightly higher especially before age 60 for households in countries with high homeownership rates. This has an especially large effect at the beginning of the life cycle, as we already saw in Figure 17. A final feature worth pointing out is summarized in Figure 20b: While households buy real estate later in life when the rental wedge is low, they buy it not only for the purpose of supplying shelter to themselves, but also as an investment good where they rent out part of their real estate to other (younger) households.

6 Some Normative Implications

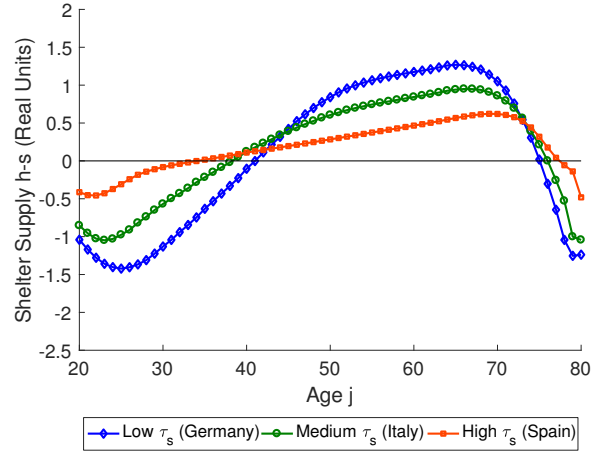
If we believe the wedges τ_s to reflect costs or inefficiencies that could be overcome, we can reasonably ask how costly the wedges are for the households who face them. We saw above that larger wedges on rental markets have two effects on household consumption: First, households consume less overall in order to save up for a house. Second, renting shelter is more expensive, which impacts young households seeking to rent. At the beginning of the life cycle, such households can only afford to consume very little shelter. Only once they are older and own a house can they consume substantially more shelter. The result of both effects is an overall less smooth shelter consumption profile than what is experienced by households in economies with small rental wedges.

In order to assess these effects on welfare quantitatively, we will compute a form of

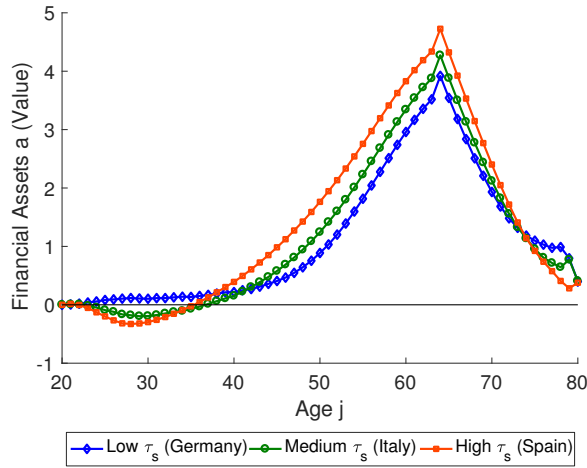
Figure 20: Saving over the Life Cycle: Varying only τ_s



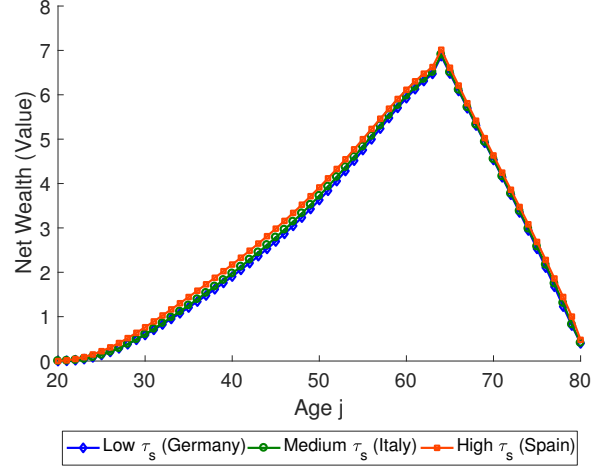
(a) Real Estate Holdings



(b) Net Shelter Supply



(c) Financial Assets



(d) Net Wealth

equivalent variation for the economy as a whole. When applied to individuals, equivalent variation typically measures changes in welfare induced by price changes. Using the individual's utility function, one can compute the change in income the individual would be willing to accept to avoid facing the price change. This is a well-defined way to measure welfare changes and does not require any assumptions beyond what was needed to define the individual's utility function in the first place. In models with a representative consumer, it is also well-defined to assess welfare changes by computing a representative consumer's equivalent variation within the well-known limitations of imagining such a representative consumer actually corresponding to anything meaningful in the real world.

Our model, however, does not allow for the construction of a representative consumer in the usual sense. Households face different income risks, are subject to different

constraints so that changes in the environment likely make some households better off while making others worse off which we cannot easily compare.

To get around this limitation, we consider what is typically called "ex-ante welfare". We think of households as imagining themselves in a situation before any shocks are realized and they could end up in the position of any household in the economy. Further, they assign equal probability of waking up in any particular household's shoes²³.

Judged this way, the social welfare attributed to either of the potential outcomes is simply the average (or expected) utility over all households in the economy. For a given rental market wedge τ_s as well as all other parameters of the economy in country c , we can define such a social welfare function as

$$W_c(\tau_s) = \int_{\chi} \beta^j \frac{(c_j(\chi, \tau_s)^{1-\alpha} s_j(\chi, \tau_s)^\alpha)^{1-\sigma}}{1-\sigma} d\mu(\chi)$$

where j corresponds to a household's age, $c_j(\chi, \tau_s), s_j(\chi, \tau_s)$ is consumption and shelter of a household with states χ facing a rental market wedge τ_s .

As a benchmark, we imagine the result a household in Germany would compute if asked to assess the current situation, where all parameters in the model are set to the values corresponding to Germany. The social welfare is simply

$$W_{DE}^* = W_{DE}(0) = \int_{\chi} \beta^j \frac{(c_j(\chi, 0)^{1-\alpha} s_j(\chi, 0)^\alpha)^{1-\sigma}}{1-\sigma} d\mu(\chi)$$

We then ask the household to assess the situation where the rental market wedge would be set to the value τ_s^c our model identified for some other country c . The welfare our household would compute is $W_{DE}(\tau_s^c)$. We then ask how much the household would be willing to have every household's consumption and shelter changed to avoid the change of the rental market wedge to τ_s^c . Call φ^c this percent change. It is implicitly given by

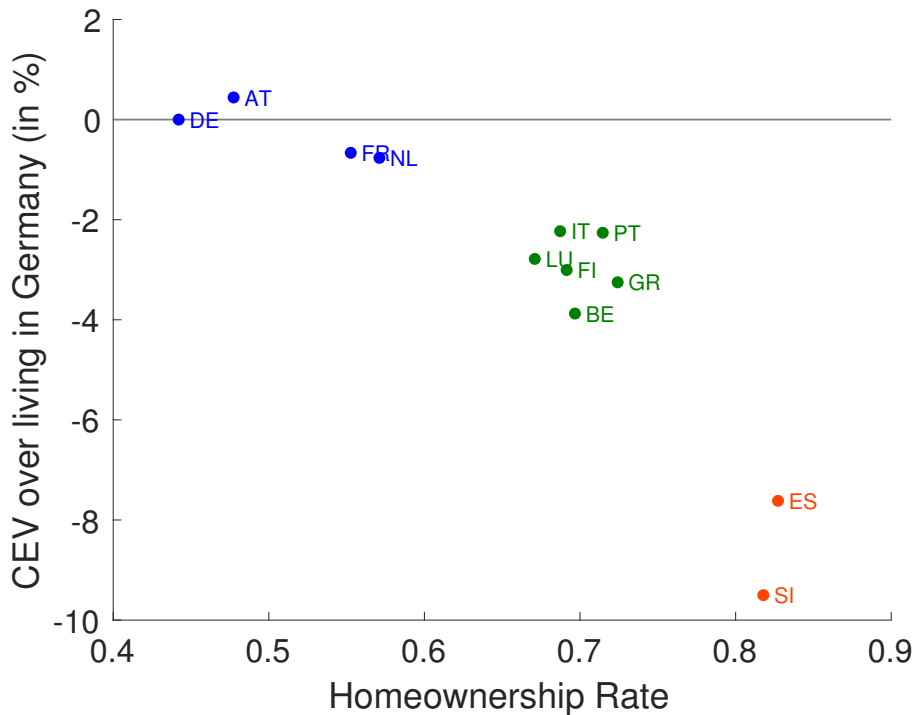
$$\begin{aligned} W_{DE}(\tau_s^c) &= \int_{\chi} \beta^j \frac{\left([(1 + \varphi^c) c_j(\chi, 0)]^{1-\alpha} [(1 + \varphi^c) s_j(\chi, 0)]^\alpha \right)^{1-\sigma}}{1-\sigma} d\mu(\chi) \\ &= (1 + \varphi)^{1-\sigma} W_{DE}(0) \end{aligned}$$

So that we get $\varphi^c = \left(\frac{W_{DE}(\tau_s^c)}{W_{DE}} \right)^{\frac{1}{1-\sigma}} - 1$.

Figure 21 shows the results from this calculation for the values of τ_s^c for each country c . Our calculations imply, for example, that the Spanish rental market wedge identi-

²³ This is a well-known type of utilitarian welfare criterion. Harsanyi (1953) and Harsanyi (1955) argue for a similar way to think about social preferences. Criticisms of utilitarianism in general, as - among many others - in Rawls (1971), or even only this particular version of it are well-known and we will not discuss them here.

Figure 21: Consumption Equivalent Variation for Household Life-Cycle Utility



fied by our model is reasonably costly. Households in Germany should be indifferent between having to face Spanish rental markets or seeing their life-cycle consumption and shelter streams be reduced by around 8% across the board.

An implications of these results is that – to the extent that they can be attributed to more inefficient rental markets – variations in wealth inequality across countries should be judged contrary to the normative intuition the reader might have: A higher degree of wealth inequality is actually a good thing. It is not a good thing because it is intrinsically valuable. But relatively more wealth inequality here is a reflection of better consumption smoothing over the life-cycle. When facing small rental market wedges, households buy real estate for investment reasons, but consume a relatively constant amount of shelter and consumption over most of their life. With large rental market wedges, households are forced to build wealth early on in life to buy a house and avoid large rental costs. This by itself leads to a more unequal distribution of consumption over the life cycle. Further, the reason why households build wealth early is that renting shelter is expensive, which means that until they are homeowners, they consume substantially less of it than they would if they faced a smaller rental wedge.

This can be summarized as a reflection of two more general observations: First, more

equality can be seen as a symptom of an underlying inefficiency.²⁴ Second, without a clear theory of wealth inequality, merely looking at data on wealth may be misleading about whether households are overall better or worse off. This is true for a cross-section of countries as well as for the dynamics of wealth inequality in any given country. One could, for example, imagine Spain implementing policy that liberalizes rental markets²⁵ and see its wealth inequality rise subsequently. Our model would say that this increase in inequality should be cherished as a sign that the reforms are working, increasing overall welfare.

7 Conclusion

In this paper, we have shown that there is a robust negative relationship between the aggregate homeownership rate and wealth inequality across 12 Euro-Area countries. We have argued that this relationship can be understood as reflecting differences between these countries in the functioning of rental markets for housing. Specifically, using a general-equilibrium life-cycle model, we have identified wedges on these country's rental markets that can explain 50% of the variation in wealth inequality seen in the data. These wedges are larger for countries with high homeownership rates and we have demonstrated that they can be seen as introducing substantial welfare costs. What does that mean for policy? Taken at face value, our normative results would indicate that countries in general, but especially those with high homeownership rates, should pursue any kind of policy that would help rental markets function more smoothly. Such policies would, in all likelihood, increase the overall cross-sectional wealth inequality but raise welfare. With the analysis done in this paper we are not, however, able to say much about what such policies would look like. For that reason we think that there is much research to be done in understanding exactly what kind of policies help or hinder the emergence well-functioning rental markets. Such research would have to go beyond static analysis of who is affected by what individual policy (such as, for example, rent control or tax subsidies for owner-occupied housing) but instead take a more historical perspective to answer the question about what determines whether or not rental markets can function well but even what it means for rental markets to function "well".

²⁴ Similar in spirit to Lucas (1992), though there inequality was a reflection of incentive constraints necessary to provide some degree of insurance against idiosyncratic shocks.

²⁵ Spain did, in fact, pass such legislation a few years ago. Unfortunately, we are not aware of high-quality data on the evolution of wealth inequality in Spain since then that would allow us to test our model.

References

- Aguiar, M. and M. Bils (2015): Has Consumption Inequality Mirrored Income Inequality?, *105 (9)*, 2725–2756.
- Aiyagari, R. S. (1994): Uninsured Idiosyncratic Risk and Aggregate Saving, *The Quarterly Journal of Economics* 109 (3), 659–684.
- Andrews, D., A. Caldera Sánchez and Å. Johansson (2011): Housing Markets and Structural Policies in OECD Countries, *OECD Economics Department Working Papers (836)*, 85.
- Atkinson, A. B. (1970): On the Measurement of Inequality, *Journal of Economic Theory* 263, 244–263.
- Auerbach, A. J. and L. J. Kotlikoff (1987): *Dynamic Fiscal Policy*, Cambridge University Press, Cambridge.
- Bewley, T. F. (1986): Stationary Monetary Equilibrium With a Continuum of Independently Fluctuating Consumers, In: W. Hildenbrand and A. Mas-Colell (Ed.), *Contributions to Mathematical Economics in Honor of Gerard Debreu*, North-Holland, Amsterdam, 79–102.
- Blundell, R., L. Pistaferri and I. Preston (2008): Consumption Inequality and Partial Insurance, *American Economic Review* 98 (5), 1887–1921.
- Campbell, J. Y. and J. F. Cocco (2007): How do house prices affect consumption? Evidence from micro data, *Journal of Monetary Economics* 54 (3), 591–621.
- Castaneda, A., J. Diaz-Gimenez and J.-V. Rios-Rull (2003): Accounting for the U . S . Earnings and Wealth Inequality, *Journal of Political Economy* 111 (4), 818–857.
- Chambers, M., C. Garriga and D. E. Schlagenhauf (2009a): Housing policy and the progressivity of income taxation, *Journal of Monetary Economics* 56 (8), 1116–1134.
- Chambers, M. S., C. Garriga and D. Schlagenhauf (2009b): The loan structure and housing tenure decisions in an equilibrium model of mortgage choice, *Review of Economic Dynamics* 12 (3), 444–468.
- Chambers, M. S., C. Garriga and D. E. Schlagenhauf (2009c): Accounting for Changes in the Homeownership Rate, *International Economic Review* 50 (3), 677–727.
- Cho, S. W. S. and J. L. Francis (2011): Tax treatment of owner occupied housing and wealth inequality, *Journal of Macroeconomics* 33 (1), 42–60.
- Cocco, J. F. (2005): Portfolio choice in the presence of housing, *Review of Financial Studies* 18 (2), 535–567.
- Cuerpo, C., S. Kalantaryan and P. Pontuch (2014): *Rental Market Regulation in the European Union*, Volume 3187.
- Davis, M. A. and F. Ortalo-Magné (2011): Household expenditures, wages, rents, *Review of Economic Dynamics* 14 (2), 248–261.

- Davis, M. A. and S. Van Nieuwerburgh (2015): Housing, Finance, and the Macroeconomy, In: *Handbook of Regional and Urban Economics*, Volume 5, Elsevier B.V., 753–811.
- De Maio, F. G. (2006): Income inequality measures, *Journal of Epidemiology and Community Health* 61 (10), 849–852.
- Díaz, A. and M. J. Luengo-Prado (2008): On the user cost and homeownership, *Review of Economic Dynamics* 11 (3), 584–613.
- Díaz, A. and M. J. Luengo-Prado (2010): The Wealth Distribution with Durable Goods, *International Economic Review* 51 (1), 143–170.
- Díaz-Gimenez, J., V. Quadrini and J.-V. Rios-Rull (1997): Dimensions of Inequality: Facts on the U.S. Distributions of Earnings, Income, and Wealth, *Federal Reserve Bank of Minneapolis Quarterly Review* 21 (2), 1–23.
- DiPasquale, D. and E. L. Glaeser (1999): Incentives and Social Capital: Are Homeowners Better Citizens?, *Journal of Urban Economics* 45 (2), 354–384.
- Eurosystem Household Finance and Consumption Network (EHFCN) (2013): The Eurosystem Household Finance and Consumption Survey: Methodological Report for the First Wave, ECB Statistics Papers Series 1/2013, Frankfurt am Main.
- Fernandez, J. (2004): Estimacion del Riesgo en un Proceso de Salarios en Espana.
- Fernandez-Villaverde, J. and D. Krueger (2011): *Consumption and Saving Over the Life Cycle: How Important Are Consumer Durables?*, Volume 15.
- Flavin, M. and S. Nakagawa (2008): A model of housing in the presence of adjustment costs: A structural interpretation of habit persistence, *American Economic Review* 98 (1), 474–495.
- Flavin, M. and T. Yamashita (2002): Owner-Occupied Housing and the Composition of the Household Portfolio, *Journal of Political Economy* 110 (2), 345–362.
- Flavin, M. and T. Yamashita (2011): Owner-occupied housing: Life-cycle implications for the household portfolio, *American Economic Review* 101 (3), 609–614.
- Gervais, M. (2002): Housing taxation and capital accumulation, *Journal of Monetary Economics* 49 (7), 1461–1489.
- Gokhale, J. and L. J. Kotlikoff (2002): Simulating the Transmission of Wealth Inequality Simulating the Transmission of Wealth Inequality, *American Economic Review* 92 (2), 265–269.
- González, M. and J. Pijoan-Mas (2005): The flat tax reform: a general equilibrium evaluation for Spain, *Documentos de Trabajo (CEMFI)* (5), 1.
- Gruber, J. W. and R. F. Martin (2003): Does Housing Wealth Make Us Less Equal? The Role of Durable Goods in the Distribution of Wealth, , forthcoming.
- Güvenen, F., B. Kuruscu and S. Ozkan (2013a): Taxation of human capital and wage inequality: A cross-country analysis, *Review of Economic Studies* 81 (2), 818–850.

- Guvenen, F., B. Kuruscu and S. Ozkan (2013b): Supplemental (Online) Appendix for Taxation of human capital: A cross-country analysis, *Review of Economic Studies*, forthcoming.
- Han, L. and W. C. Strange (2015): *The Microstructure of Housing Markets. Search, Bargaining, and Brokerage*, 1. Ausgabe, Volume 5, Elsevier B.V.
- Harsanyi, J. C. (1953): Cardinal Utility in Welfare Economics and in theory of risk taking, *Journal of Political Economy* 61 (5), 434.
- Harsanyi, J. C. (1955): Cardinal Welfare, Individualistic Ethics, and Interpersonal Comparisons of Utility, *Journal of Political Economy* 63 (4), 309–321.
- Henderson, J. V. and Y. M. Ioannides (1983): A Model of Housing Tenure Choice 1.
- Hintermaier, T. and W. Koeniger (2016): Debt Portfolios and Homestead Exemptions, *American Economic Journal: Macroeconomics* 8 (4), 103–141.
- Hubert, F. (1998): Private Rented Housing in Germany, *Netherland Journal of Housing and the Built Environment* 13 (3), 205–232.
- Huggett, M., G. Ventura and A. Yaron (2011): Sources of Lifetime Inequality, *American Economic Review* 101 (December), 2923–2954.
- Jappelli, T. and L. Pistaferri (2010): Does consumption inequality track income inequality in Italy?, *Review of Economic Dynamics* 13 (1), 133–153.
- Johansson, A. (2011): Housing Policies in OECD Countries: Survey-based Data and Implications.
- Jones, C. I. (2015): Pareto and Piketty: The Macroeconomics of Top Income and Wealth Inequality*, *Journal of Economic Perspectives* 29 (1), 29–46.
- Kaas, L., G. Kocharkov and E. Preugschat (2015): Wealth Inequality and Homeownership in Europe.
- Kindermann, F. and D. Krueger (2014): High Marginal Tax Rates on the Top 1%? Lessons from a Life Cycle Model with Idiosyncratic Income Risk, *National Bureau of Economic Research (Working Paper 20601)*.
- Kopczuk, W. (2015): What Do We Know about the Evolution of Top Wealth Shares in the United States?, *Journal of Economic Perspectives* 29 (1), 47–66.
- Kopecky, K. A. and R. M. H. Suen (2010): Finite state Markov-chain approximations to highly persistent processes, *Review of Economic Dynamics* 13 (3), 701–714.
- Krueger, D., F. Perri, L. Pistaferri and G. L. Violante (2010): Cross-sectional facts for macroeconomists, *Review of Economic Dynamics* 13 (1), 1–14.
- Kuhn, M. and J.-V. Rios-Rull (2015): 2013 Update on the U.S. Earnings, Income, and Wealth Distributional Facts: A View from Macroeconomics, mimeo, University of Pennsylvania.
- Kumhof, M., R. Ranciere and P. Winant (2015): Inequality, leverage, and crises, *American Economic Review* 105 (3), 1217–1245.

- Lucas, R. E. (1992): On Efficiency and Distribution, *The Economic Journal* 103 (418), 511–530.
- Nakajima, M. and I. A. Telyukova (2011): Home Equity in Retirement.
- Organization for Economic Cooperation and Development (OECD) (2013): Housing Markets and Structural Policies in OECD countries, OECD Economics Department Working Papers 836, Paris.
- Pham-Dao, L. (2016): Public Insurance and Wealth Inequality: A Euro Area Analysis.
- Piketty, T. (2014): *Capital in the Twenty-First Century*, The Belknap Press of Harvard University Press, Cambridge, MA.
- Piketty, T. and E. Saez (2006): The Evolution of Top Incomes : A Historical and International Perspective, 96 (2), 200–205.
- Rawls, J. (1971): *A Theory of Justice*, The Belknap Press of Harvard University Press, Cambridge, MA.
- Rossi, P. and E. Weber (1996): The social benefits of homeownership: Empirical evidence from national surveys, *Housing policy debate* 7 (1), 1–36.
- Saez, E. and G. Zucman (2016): of Economics, *the Quarterly Journal of Economics* 131 (May), 519–578.
- Shorrocks, A. F. (1980): The Class of Additively Decomposable Inequality Measures, *Econometrica* 48 (3), 613–625.
- Silos, P. (2007): Housing Tenure Choice and Wealth Distribution in Life Cycle Economies, *The B.E. Journal of Macroeconomics* 7 (1), 1–24.
- Storesletten, K., C. I. Telmer and A. Yaron (2004): Cyclical Dynamics in Idiosyncratic Labor Market Risk, *Journal of Political Economy* 112 (3), 695–717.
- Voigtländer, M. (2009): Why is the German Homeownership Rate so Low?, *Housing Studies* 24 (3), 355–372.
- Voigtländer, M. (2014): The stability of the German housing market, *Journal of Housing and the Built Environment* 29 (4), 583–594.
- Yang, F. (2009): Consumption over the life cycle: How different is housing?, *Review of Economic Dynamics* 12 (3), 423–443.

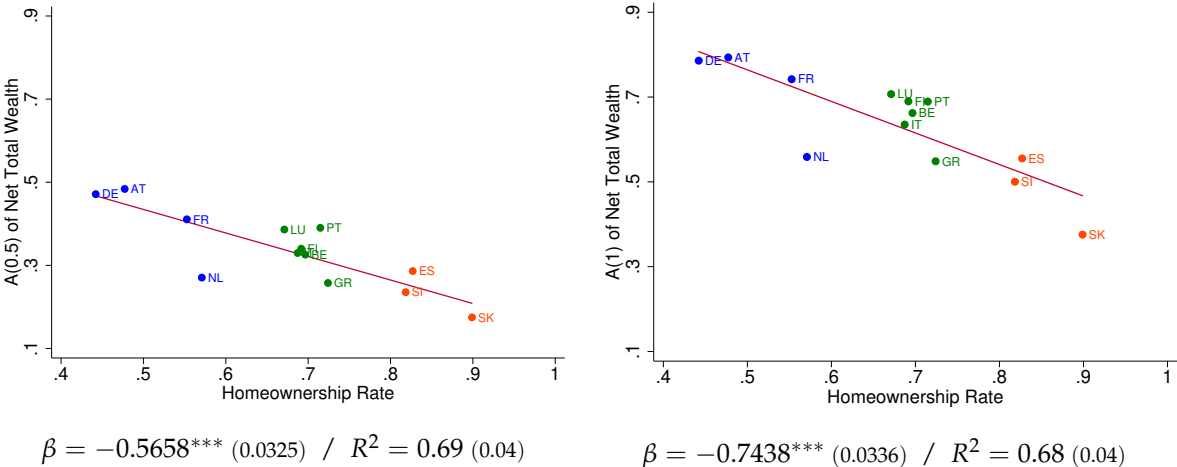
A Computational Method

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B Additional Data Work

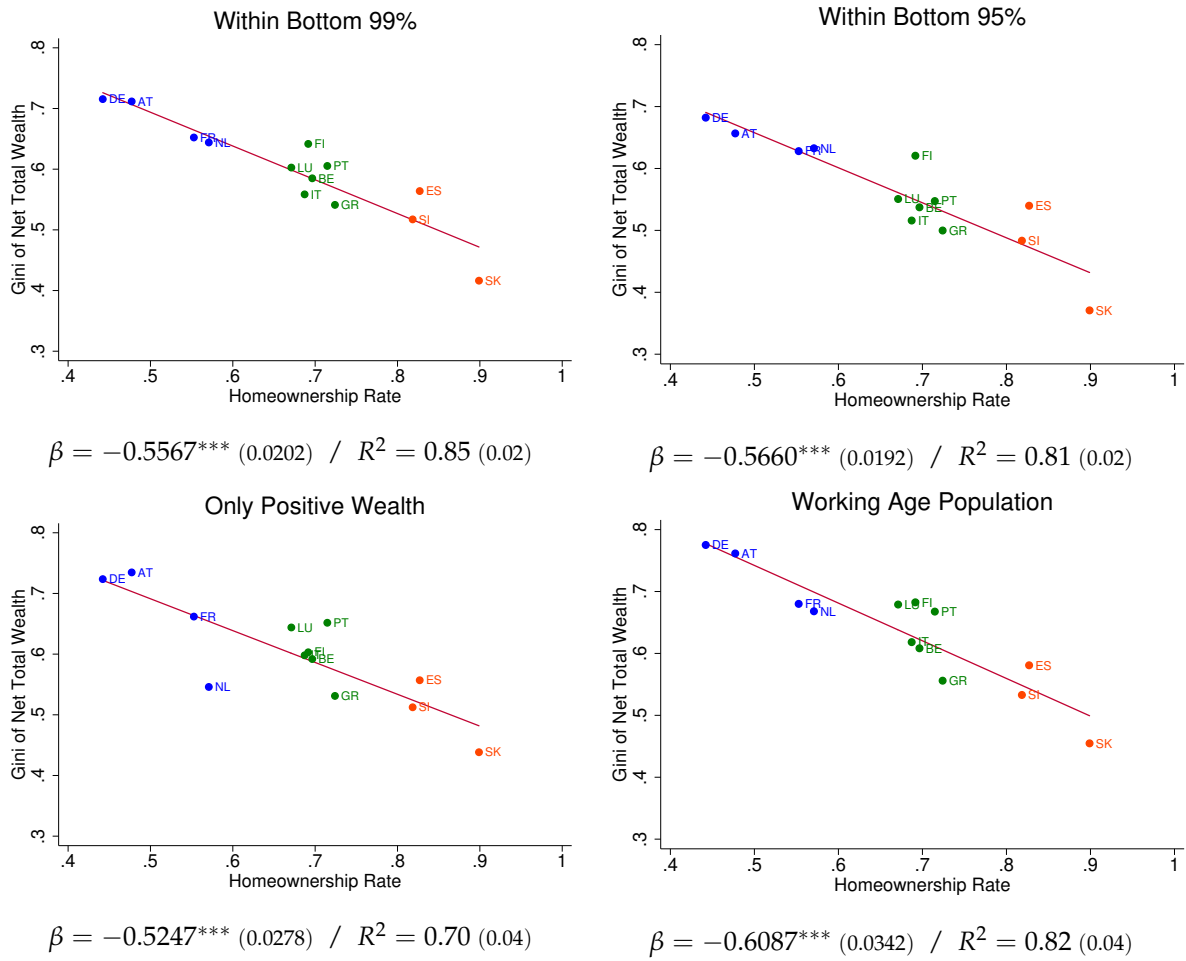
B.1 Measuring Wealth Inequality using adjusted GE(0)

Figure B.1: Atkinson index of wealth inequality



Source: Own calculations based on HFCS.

Figure B.2: Sample selection



Source: Own calculations based on HFCS.

C A Formal Decomposition of the GE index

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D Calibration

D.1 Estimating Income Profiles and Processes

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D.2 Using OECD data to estimate Tax and Pension Policy across Countries

D.2.1 Tax Schedules

We follow Guvenen et al. (2013a) (henceforth "GKO") in their strategy to match the country-specific tax schedules. For every income level, we derive a function that gives the average tax rate at

$$\bar{\tau}\left(\frac{y}{\tilde{y}}\right) = t_0 + t_1 \frac{y}{\tilde{y}} + t_2 \left(\frac{y}{\tilde{y}}\right)^\phi \quad (22)$$

To obtain the parameter values, we use the OECD's data on average and top marginal taxation following the strategy described in GKO. For our data, we use data from the 2014 tax database which gives us the values for $\bar{\tau}\left(\frac{y}{\tilde{y}}\right)$ for $\frac{y}{\tilde{y}} = \left\{\frac{2}{3}, 1, \frac{4}{3}, \frac{5}{3}\right\}$. We also get the top marginal tax rate and the cut-off \tilde{y} above which the top marginal tax rate is paid. From there, we can extrapolate a tax schedule for more points above $\frac{5}{3}$ and then fit a curve through the points to get estimates for $\{\tau_0, \tau_1, \tau_2, \phi\}$. Instead of using data from 2003 as in GKO, we use data from 2009, the year of our survey. We do this as there were some significant changes to the German tax code since 2003. The process is described in more detail in Guvenen et al. (2013b) but we will outline it here for the sake of completion.

We want to get the average tax rate of a grid of relative incomes $\frac{y}{\tilde{y}}$. For $\frac{y}{\tilde{y}} > \frac{5}{3}$, we have to use the information on the top marginal tax rate to construct the average tax rate. To do, we first compute the marginal tax rate at $\frac{5}{3}$ implied by the average tax rates supplied by the OECD. Call $\tau_m\left(\frac{y}{\tilde{y}}\right)$ the marginal tax rate function. If the cut-off \tilde{y} is below $\frac{5}{3}$ we don't have to do much since all income above $\frac{5}{3}$ will be taxed at the top marginal tax rate. If \tilde{y} is greater than $\frac{5}{3}$, we first compute the implied marginal tax rate

at $\frac{5}{3}$. Call $\tau_m\left(\frac{y}{\tilde{y}}\right)$ the marginal tax rate function. Then we have

$$\tau_m\left(\frac{5}{3}\right) = \left[\bar{t}\left(\frac{5}{3}\right) \frac{5}{3} - \bar{t}\left(\frac{4}{3}\right) \frac{4}{3} \right] * 3$$

We then linearly extrapolate the marginal tax to the top tax rate:

$$\tau_m\left(\frac{y}{\tilde{y}}\right) = \begin{cases} \tau_m\left(\frac{5}{3}\right) + \frac{\tau_m\left(\frac{5}{3}\right) - \tau_m\left(\frac{\tilde{y}}{\tilde{y}}\right)}{\frac{\tilde{y}}{\tilde{y}} - \frac{5}{3}} \left(\frac{y}{\tilde{y}} - \frac{5}{3}\right) & \text{if } \frac{y}{\tilde{y}} < \frac{\tilde{y}}{\tilde{y}} \\ \tau_m\left(\frac{\tilde{y}}{\tilde{y}}\right) & \text{if } \frac{y}{\tilde{y}} \geq \frac{\tilde{y}}{\tilde{y}} \end{cases}$$

With the marginal tax rate in place, we can compute the tax payment for any level of income and by implication the average tax rate. The tax payment $\tau(y)$ for $y > \frac{5}{3}\tilde{y}$ is given as

$$\tau(y) = \begin{cases} \bar{t}\left(\frac{5}{3}\right) \frac{5}{3} + \tau_m\left(\frac{\tilde{y}}{\tilde{y}}\right) (y - \frac{5}{3}) & \text{if } \tilde{y} \leq \frac{5}{3}\tilde{y} \\ \bar{t}\left(\frac{5}{3}\right) \frac{5}{3} + \frac{1}{2} \left(\frac{y}{\tilde{y}} - \frac{5}{3}\right) \left(\tau_m\left(\frac{y}{\tilde{y}}\right) - \tau_m\left(\frac{5}{3}\right)\right) & \text{if } \tilde{y} < \frac{5}{3}\tilde{y}, y \leq \tilde{y} \\ \bar{t}\left(\frac{5}{3}\right) \frac{5}{3} + \frac{1}{2} \left(\frac{\tilde{y}}{\tilde{y}} - \frac{5}{3}\right) \left(\tau_m\left(\frac{\tilde{y}}{\tilde{y}}\right) - \tau_m\left(\frac{5}{3}\right)\right) & \\ + \tau_m\left(\frac{\tilde{y}}{\tilde{y}}\right) (y - \tilde{y}) & \text{if } \tilde{y} < \frac{5}{3}\tilde{y}, y > \tilde{y} \end{cases} \quad (23)$$

The average tax rate is then simply $\bar{\tau} = \frac{\tau(y)}{y}$.

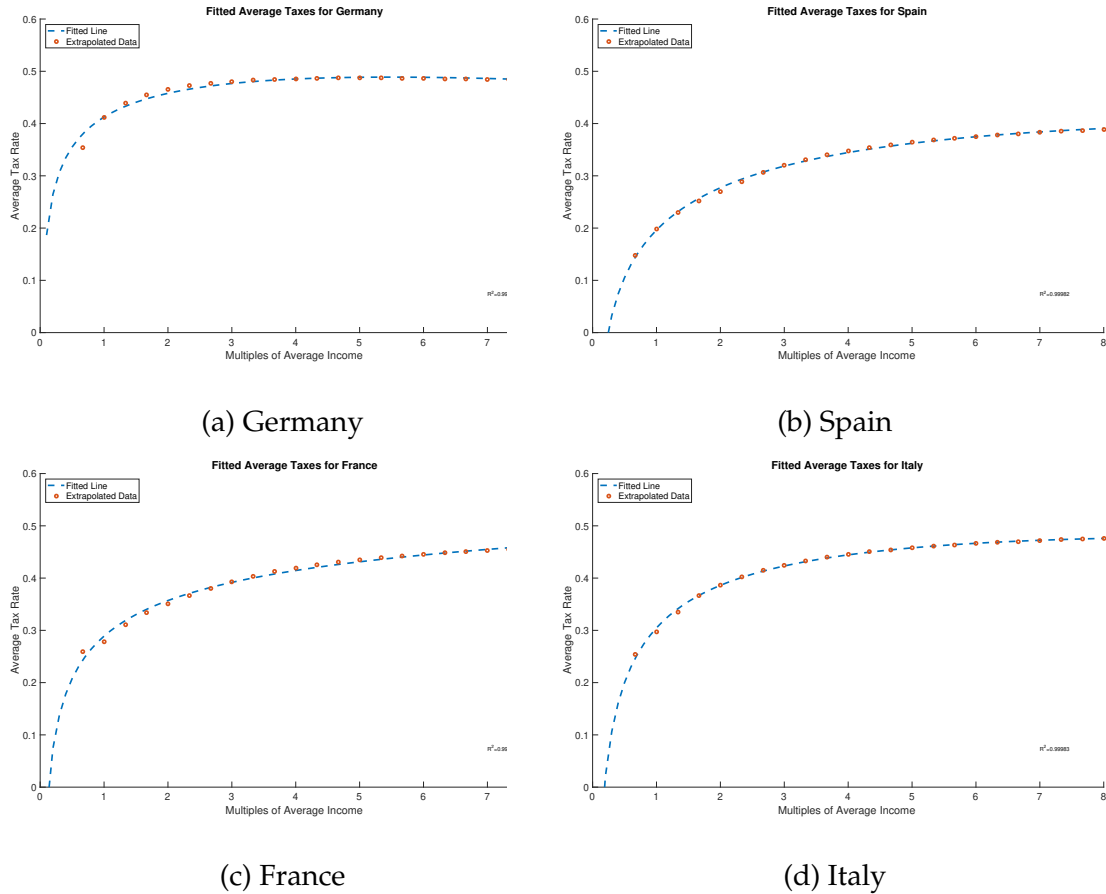
Table D.1: Parameters Tax Function Germany

	t_0	t_1	t_2	ϕ	R^2
Austria	0.7315	-0.0118	-0.3941	-0.2829	0.9992
Belgium	0.9942	-0.0128	-0.5579	-0.2606	0.9997
Germany	1.0753	-0.0128	-0.6501	-0.1352	0.9990
Spain	1.5718	-0.0079	-1.3676	-0.0969	0.9998
Finland	2.0698	-0.0160	-1.7608	-0.0990	0.9999
France	0.6883	0.0007	-0.4000	-0.2661	0.9993
Greece	0.7568	-0.0021	-0.5098	-0.2736	0.9999
Italy	0.7868	-0.0067	-0.4753	-0.2956	0.9998
Luxembourg	0.9180	-0.0145	-0.6378	-0.2700	0.9996
Netherlands	0.7985	-0.0080	-0.4691	-0.2853	0.9999
Portugal	0.7295	-0.0025	-0.5110	-0.2988	0.9998
Slovenia	1.0677	-0.0005	-0.7205	-0.1340	0.9982

To estimate the tax function, we use the grid $y = \left\{ \frac{2}{3}, 1, \frac{4}{3}, \frac{5}{3}, 2, \frac{7}{3}, \dots, 6 \right\}$, compute the average tax rate using equation (23) and then fit a function of the form in (22) through

the points. Table D.1 shows the estimates as well as the fit of the estimated tax function with the points extrapolated from the OECD data. Figure D.1 shows the extrapolated tax rates as well as the value of the estimated tax function for selected countries:

Figure D.1: Extrapolated and smoothed Tax functions



D.2.2 Pensions

Instead explicitly modeling the taxation of pensions, we follow GKO in just using a function for net pensions once a household is in retirement. The pension $\Omega(\bar{y}_i, \bar{y})$ as a function of the individual average life-time earnings and the average earnings in the economy is given by

$$\Omega(\bar{y}_i, \bar{y}) = a\bar{y} + b\bar{y}_i$$

Using the data from Pensions at a Glance 2015, we get the following parameters:

Table D.2: Parameters Pension Functions from OECD

	a_1	b_1	a_2	b_2	\tilde{y}^c
Austria	18.63	71.86	125.80	0.00	1.50
Belgium	22.17	40.40	66.40	0.00	1.15
Germany	10.33	39.38	71.40	0.00	1.55
Spain	11.80	76.96	138.00	0.00	1.60
Finland	16.60	46.56			
France	18.97	44.27	41.40	31.70	2.00
Greece	20.69	52.02	88.90	17.80	2.00
Italy	18.53	60.05			
Luxembourg	39.66	47.13			
Netherlands	29.36	65.15			
Portugal	24.47	62.66			
Slovenia	15.39	39.88	82.10	5.10	2.00

E Robustness

E.1 Income Inequality Across Countries

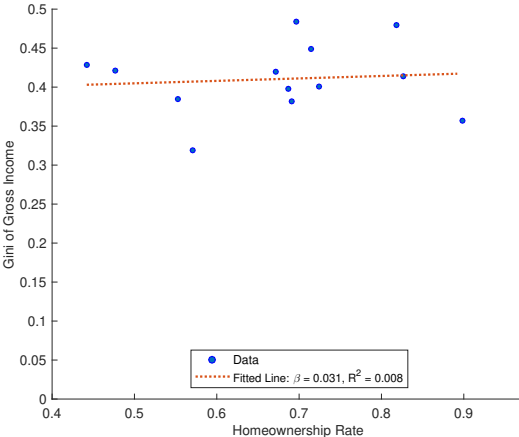
As mentioned in the main text, there is variation in the inequality of pre-tax income across the countries in our sample. Importantly for us, however, this variation is uncorrelated with the variation in the homeownership rate across the same countries.

We use the self-reported overall household income from the HFCS and compute the weighted Gini coefficient of the data in our sample. Figure E.1a plots the results of that calculation by the homeownership of the country. We saw before that countries with a larger homeownership rate had a lower level of wealth inequality. If this was driven by those countries also having a lower degree of income inequality, we should see that indeed countries with a higher homeownership rate also had lower levels of income inequality. Figure E.1a shows that this is not the case.

One may be worried about the quality in our data: The HFCS relies on the households' replies to the survey, which may be imprecise. Further, the HFCS contains a relatively small sample size for some of the countries. Figure E.1b shows that the relationship between homeownership and income inequality is basically the same if we use data on income inequality from the OECD.

Figure E.1: Income Inequality and Homeownership across Countries

(a) Income Data from the HFCS



(b) Income Data from the OECD

