Low Homeownership in Germany - A Quantitative Exploration*

Leo Kaas†
Georgi Kocharkov‡
Edgar Preugschat§
Nawid Siassi¶

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Abstract

The homeownership rate in Germany is one of the lowest among advanced economies. To better understand this fact, we evaluate the role of specific housing policies which tend to discourage homeownership. In comparison to other countries with higher homeownership such as the United States, Germany has an extensive social housing sector with broad eligibility criteria, high transfer taxes when buying real estate, and no tax deductions for mortgage interest payments by owner-occupiers. We build a life-cycle model with uninsurable income and housing risks and endogenous homeownership in order to quantify the policy impact on homeownership and welfare. Adjusting all three policies has a strong impact on housing tenure choices, closing the gap in homeownership rates between Germany and the United States by about two thirds. At the same time, household welfare would be reduced by moving to a policy regime with low transfer taxes, but it would improve in the absence of social housing, in particular when coupled with housing subsidies for low-income households.

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†Goethe University Frankfurt, kaas@wiwi.uni-frankfurt.de
‡Deutsche Bundesbank, georgi.kocharkov@bundesbank.de
§Technical University of Dortmund, e.preugschat@gmail.com
¶TU Wien, nawid.siassi@tuwien.ac.at

1 Introduction

Germany has one of the lowest homeownership rates of the developed world, with only 44% of households owning their main residence in the year 2010.[1] Aside from culture or preferences, housing policies and institutions may be an important determinant of this phenomenon. In fact, in most countries governments intervene in housing markets in one way or another. To what extent policies promoting homeownership are successful or even beneficial for households is relatively little understood.

Housing policies in Germany differ in particular ways from those in other countries with higher homeownership. In contrast to the U.S. and several European countries, Germany has a social housing sector with broad eligibility requirements, high transfer taxes on buying real estate and no mortgage interest tax deductions for owner-occupiers. All these policies should be expected to tilt incentives towards renting, yet their impact on housing tenure choices and on the well-being of society must be properly assessed.

This paper analyzes the quantitative impact of Germany's housing policies on homeownership, wealth accumulation and welfare. To this end, we build a dynamic equilibrium model which we calibrate to reflect the factual savings and housing choices of households. In counterfactual experiments, we evaluate the positive and normative impact of housing policies by setting them to their counterparts in the United States, a country with a much higher homeownership rate and housing policies opposite to those in Germany.

We consider a life-cycle model with stochastic ageing and uninsurable income and housing risks, in which households make decisions about consumption of goods and housing services, savings and housing tenure. House prices and rents are determined in equilibrium and depend on a supply technology with diminishing returns in the construction sector. Households benefit from homeownership but are constrained by a down payment requirement for mortgages. Gains from homeownership come mainly from the fact that the market rental rate includes a premium to cover the monitoring costs of commercial landlords.

[1] According to data from the Household Finance and Consumption Survey of the European Central Bank, this is the lowest homeownership rate in the Eurozone. Within the OECD, only Switzerland has a lower homeownership rate than Germany. At the opposite extreme is Spain which has the highest homeownership rate (83% in 2010) in the Eurozone. In comparison, the U.S. stands at 67% in 2010 (U.S. Census) and the U.K. at 71% in 2004 (Andrews and Caldera, 2011).

The quantitative model takes as inputs labor income dynamics, tax and transfer policies, and existing social housing policies in Germany. First, we non-parametrically estimate age-dependent household labor income processes from the German Socio-Economic Panel (SOEP). Second, we estimate the progressive tax and transfer functions from the same data. Third, we set various housing policy parameters, such as social housing access and subsidies, house price and rental risk, real-estate transfer taxes, mortgage rates and down payment requirements, to represent the factual details of the existing environment. Finally, we calibrate the remaining parameters of the model to the German economy by matching the aggregate homeownership rate, the social housing stock and the average wealth of households.

The model reproduces well the empirical life-cycle profiles of homeownership and household wealth accumulation. In addition, it mimics the distribution of homeownership by wealth and income. This gives us confidence to use the model as a tool for policy analysis and evaluation.

We implement three policy experiments that potentially foster homeownership. First, we consider a reduction of the real-estate transfer tax (RETT) from its current level of 5% to 0.33% which is the average level of this tax in the U.S. Second, we make mortgage interest payments fully tax deductible. Third, we eliminate the social housing sector. All policies are implemented in a fiscally neutral fashion by adjusting income taxes so as to balance the government budget.

We find that these policies go a long way in explaining the low homeownership rate in Germany. Each policy experiment has significant positive effects on the homeownership rate, with a combined effect leading to a counterfactual homeownership rate of 58%, which closes the gap to the U.S. by about two thirds. Higher homeownership does not only lead to a substitution of financial wealth by housing wealth, but it also increases average household net wealth by more than 11%.

At the same time we find diverging effects of these policy experiments in terms of household welfare. The reduction of the RETT reduces welfare for newborn households by about 0.5% of consumption. The reason is that this policy reform boosts housing demand which leads to an increase of pre-tax house prices and thereby rental rates which hurts households who remain renters after the reform. Lower tax revenues further need to be offset by higher income tax rates. Both effects hurt renter and owner households simultaneously. We further look at the changes in welfare for newborn entrants in the economy differentiated by their initial labor income. The welfare losses of the RETT reduction are lowest for high-income entrants because these are more likely to become

homeowners and to extract benefits from the tax cut.

The introduction of mortgage interest tax deductions brings about positive, albeit rather small long-term welfare gains which are on average 0.1% in terms of consumption equivalence and nearly zero for young households in the bottom two income deciles. Similar to the reduction of RETT, the welfare gains are diminished by an increase of house prices and rental rates in response to an increase in housing demand. Furthermore, along the transition path after this budget-neutral tax reform, most households (except the youngest) lose.

On the other hand, abolishing social housing brings about welfare gains of 0.2-0.3% in consumption equivalence to the average household, both in the long term and during the transition phase. Without social housing, the aggregate demand for housing services is lower which reduces house prices in equilibrium. This makes homeownership more affordable and benefits in particular wealthier households whose homeownership rates increase most strongly. Furthermore, saving the expenditures for social housing allows the government to cut income taxes which benefits all households. When differentiated by initial labor income, the biggest winners of this policy are entering households with high income. Welfare gains are still positive at the bottom end of the income distribution, even though the option of renting a social housing unit at a reduced rate is gone.

As the welfare gains of abolishing social housing are much smaller for low-income entrants than for their high-income counterparts, we further study the effects of replacing the current social housing policy by direct housing subsidies targeted to the poor. This policy is associated with average welfare gains of 0.9% in terms of benchmark consumption and much larger benefits for poor entrants into the economy. In essence, direct housing subsidies for low-income households provide a better insurance device than social housing which is itself risky (because access is rationed) and which is exclusive to renter households.

To our knowledge, this is the first quantitative macroeconomic model of the German housing market.[2] Our analysis of introducing mortgage interest tax deductions in Germany is closely related to several U.S. studies.[3] Building on earlier work of Gervais (2002) and Cho and Francis (2011), Sommer and Sullivan (2018) and Floetotto et al. (2016) analyze housing policies in models

[2]See Davis and Van Nieuwerburgh (2015) and Piazzesi and Schneider (2016) for surveys of the macroeconomic housing literature which focuses mostly on the U.S.

[3]Government interventions in the mortgage market via bailout guarantees are analyzed by Jeske et al. (2013). Such policies are not relevant in the German context where down payment requirements are higher and foreclosure rates are low.

with endogenous house prices. Floetotto et al. (2016) find that homeownership rates are higher in the long run with mortgage interest deductions but welfare is lower for most households. Sommer and Sullivan (2018) follow Chambers et al. (2009) and take into account the interaction of the deductibility of mortgage interest payments with the progressive tax system. They find that repealing mortgage deductions for owner-occupiers lead to higher homeownership and welfare. The difference between the two studies comes from a larger countervailing price effect which in part depends on how the supply side is modeled.[4]

A further contribution of this paper is the analysis of the aggregate and distributional effects of real-estate transfer taxes and social housing. The existing macroeconomic literature on such policies is limited, partly due to fact that they do not matter much in the U.S. housing market.[5] Therefore, the modeling side of our paper can potentially be useful for quantitative housing market studies of other (European) countries where such policies play a prominent role. In a recent paper, Sieg and Yoon (2019) build a dynamic equilibrium model with uninsurable income risk to study social housing policies in New York City. Households can apply for different types of subsidized housing or freely rent at the market rate, but cannot become homeowners. They find that higher availability of public housing increases welfare for all renter households.

In the U.S., as in Germany, the age profile of homeownership rates increases steeply at younger ages and then flattens out, with mild decreases for retired households. Similar to our model, borrowing constraints are the main reason for lower homeownership rates of younger households in Fernandez-Villaverde and Krueger (2011) and Yang (2009).[6] Higher homeownership late in life, in combination with collateral constraints, is also crucial to explain why many households do not dissave in retirement, as would be predicted by standard life-cycle models, see Nakajima and Telyukova (2011).

Finally, several studies examine the determinants of the homeownership rate using cross-country

[4]The unsettled results of the quantitative macroeconomic literature are also reflected in the empirical study of Hilber and Turner (2014) who find that mortgage interest deductibility can have positive or negative effects on homeownership, depending on the elasticity of regional housing supply. See also Gruber et al. (2017) who utilize a quasi-experimental setup for Denmark. In their study, the deductibility of mortgage interest payments only has an effect on the intensive margin of house purchases.

[5]A larger empirical literature analyzes the effects of the RETT utilizing policy regime changes. For two recent studies, see Kopczuk and Munroe (2015) and Best and Kleven (2017). The latter finds large effects for the U.K.

[6]Halket and Vasudev (2014) show that higher mobility of younger households and house price risk are further important determinants of the age-homeownership profile. Bajari et al. (2013) and Li and Yao (2007) are interested in the effects of house prices changes on housing demand and welfare for households in different age groups.

comparisons. In his analysis of the European household-level panel data, Hilber (2007) shows that there are significant crowding-out effects of public housing for homeownership across European regions.[7] Cho (2012) utilizes a general equilibrium model and finds that mortgage markets play a dominant role in accounting for homeownership differences between the U.S. and South Korea. Kindermann and Kohls (2016) use a macroeconomic model based on distortions in the rental market to account for the negative relation between homeownership rates and wealth inequality across European countries, which is also documented in Kaas et al. (2019). Lastly, Grevenbrock (2018) builds on our model structure and examines the differences in co-residence decisions and homeownership rates in Germany and Italy.

The next section gives further details of housing policies in Germany and relates them to those in the U.S. Section 3 describes the model which is calibrated to data for Germany in Section 4. In Section 5 we conduct our counterfactual policy experiments. Welfare implications, transitional dynamics and an alternative targeted housing policy is discussed in Section 6, and conclusions are provided in Section 7. The Appendix contains a detailed account of our data and computational work, further quantitative results, and a qualitative comparison of housing market policies for a broader set of countries.

2 Housing Policy in Germany

In this section we briefly describe the features of housing policies in Germany that are relevant for our quantitative model. To highlight the fact that these policies provide relatively low incentives for homeownership, we contrast them to their counterparts in the U.S., where the homeownership rate is much higher. In Appendix C we present a detailed qualitative comparison for a broader set of countries that provides further support for the relation between homeownership outcomes and the three housing market policies that we consider in this paper.[8]

[7] Other empirical cross-country studies are Chiuri and Jappelli (2003) and Bicakova and Sierminska (2008).

[8] Appendix C contains more details on these policies and provides further references. For surveys on the German residential housing market and how it compares to other countries, see Kirchner (2007) and Voigtländer (2009). See Olsen and Zabel (2015) for a survey of U.S. housing policies.

Social Housing

Germany, as well as other European countries, entered the postwar period with a severely damaged housing stock.[9] The massive housing shortage in combination with reduced household assets and underdeveloped capital markets in West Germany led to extensive public policies to foster reconstruction. Out of the 5.2 million units that were built during the 1950s, about 63% received subsidized loans of which more than half went to the construction of social housing units. Although access to subsidized housing is generally based on income, initially more than half of the households were eligible, while the income threshold in more recent times was just below median income (Kirchner, 2007). As the quality of social housing units is relatively high, there is demand even from households close to the income threshold (see Schier and Voigtländer, 2016). Households qualifying for social housing pay a "cost based" rent regulated by law.[10] For a sample of large cities, a recent study (Deschermeier et al., 2015) estimates that the social housing rent is about 20% below the market rent for comparable units. In contrast to other European countries with notable social housing sectors (e.g. Italy, Spain or the UK), there are no options for the occupants of social housing to buy their unit.

As social housing units are usually not built by the government and are financed by subsidized loans, the duration of their social housing status is limited by the maturity of the public loan. This, together with the fact that the number of approved subsidies for new social housing has been gradually reduced, has led to rationing and a decline of the stock of social housing from 19.4% in 1968 to 7.1% of all residential housing units in 2002 (Kirchner, 2007) and a further decline thereafter.

The U.S. also has a social housing sector, with currently about 1.8% of households participating.[11] In contrast to Germany, access to social housing is strictly limited to incomes below 80% of the local median income. Social housing tenants pay on average 35% of the total costs of a unit. While social housing has insurance effects as in Germany, it is unlikely that there is a crowding-out effect on homeownership at higher income deciles.

[9] See Schulz (1994) for the details of the historic development summarized here.

[10] After 2002 social housing came under the jurisdiction of the German states, and some states have replaced the cost rent by a less rigid regulation based on market prices.

[11] For this and the following numbers, see the U.S. Department of Housing and Urban Development (https://www.huduser.gov/portal/datasets/picture/about.html).

Taxation of Homeowners

The tax systems, both in Germany and in the U.S., directly affect the gains from homeownership. Germany treats owner-occupiers and landlord households asymmetrically in terms of the deductibility of mortgage interest payments. While landlords (both private households and firms) can deduct interest costs of mortgages from taxes, this is not possible for mortgages financing the residence of a homeowner. In comparison, households in the U.S. can claim mortgage interest deductions for any real estate they own.

Germany has property taxes which are fairly small and generally lower than in the U.S. Moreover, this tax is independent of tenure status and hence unlikely to have a strong effect on the choice between owning versus renting. For this reason, we omit property taxes from our analysis.

Germany has quite a low turnover rate for houses and apartments.[12] One plausible explanation for this fact are high transaction costs. Currently, average total transaction costs are 13.7% of the purchase price, of which about five percentage points are accounted for by real-estate transfer taxes (RETT), see Fritzsche and Vandrei (2019). Transaction costs are much lower in the U.S. where many states have no RETT at all. The average RETT in the U.S. is only about 0.33%.

3 Model

In this section we describe the macroeconomic model of the housing market that we apply in the following sections for our quantitative experiments. We consider a small open economy in which the safe interest rate r is exogenous. Time is discrete and the period length is interpreted as a year. We describe a stationary equilibrium in which all prices and distribution measures are constant over time.

3.1 Households

Demographics

Households live through a stochastic life cycle with five age groups $\tau = 1, \ldots, 5$. The first four groups cover the working life of the household head, and can be interpreted as 10-year age groups

[12] Using data compiled by European Mortgage Federation (2016), Germany has a turnover rate which is only about half of the 2004–2015 average for a sample of 14 Western European countries.

25–34, 35–44, 45–54, 55–64, while $\tau = 5$ is the retirement group (ages 65+). Ignoring death before retirement, $\vartheta_\tau = 1/10$ is the yearly ageing probability for $\tau = 1, \ldots, 4$, and ϑ_5 denotes the yearly death probability in retirement. To keep the mass of households constant and normalized to unity, every period a mass $\vartheta_5/(1 + 40\vartheta_5)$ of new households enters the economy into age group $\tau = 1$.

Labor Income

We model labor income at the household level to be composed of a component that is age-dependent, denoted M_τ, and a residual stochastic component $\varepsilon_{i,\tau}$ where $i \in \{1, \ldots, 10\}$ is the decile of residual income:

$$\log y(\tau, i) = M_\tau + \varepsilon_{i,\tau} \ .$$

The residual income decile i follows a discrete Markov process with age-specific transition matrix Ψ_τ. Residual income in decile i is denoted by $\varepsilon_{i,\tau} \in E_\tau$.

Retired households receive non-stochastic pension income. That is, $\varepsilon_{i,5}$ is constant. We assume that the retiree's pension decile i is identical to the residual income decile in the year before retirement, which reflects that higher earnings lead to higher pension income.[13]

Preferences

Households maximize expected lifetime utility with time discount factor β and period utility

$$u(c, s; \tau, \mathbb{I}_{h>0}) = \frac{1}{1-\gamma}\left[(c/n_\tau)^\zeta (\xi^\tau_{\mathbb{I}_{h>0}} s/n_\tau)^{1-\zeta}\right]^{1-\gamma} ,$$

where γ is the degree of relative risk aversion, c is consumption of non-housing goods, s is consumption of housing services, and ζ ($1-\zeta$ resp.) is the expenditure share for goods (housing services).[14] We divide c and s by the household equivalence scale n_τ which depends on τ to reflect possible age-dependent variations in consumption and housing demand due to household size variations over the life cycle. The shift parameter $\xi^\tau_{\mathbb{I}_{h>0}}$ equals one for all working-age households ($\tau \leq 4$), for all retired renters ($\mathbb{I}_{h>0} = 0$ and $\tau = 5$), but it may exceed one for retired homeowners ($\mathbb{I}_{h>0} = 1$ and

[13] This is a simplification of Germany's contribution-based pension system in which the pension depends on (capped) social-security contributions throughout the entire working lives of individuals. Proper modeling of such a system requires the inclusion of another state variable into the household problem.

[14] This Cobb-Douglas specification does not allow for complementarity between housing and non-housing consumption as in, e.g., Li et al. (2016).

$\tau = 5$). This feature reflects the idea that retired households may enjoy own housing more than rented housing, possibly because of an additional motive of leaving a housing bequest.[15] We do not include explicit preferences for bequests, so that all bequests are accidental and are distributed randomly to households in the first two age groups $\tau = 1, 2$.

3.2 Assets

Housing

Housing assets are denoted by $h \in \mathcal{H} = [h_{\min}, \infty)$ where $h_{\min} > 0$ is a minimum house size constraint.[16] Housing is traded at the end of the period at unit price p, and it can be owned by households or by real-estate firms. The latter are risk-neutral, perfectly competitive entities who rent out housing units at market rental rate $\bar{\rho}$. Both p and $\bar{\rho}$ are endogenous variables determined in equilibrium.

If a household owns $h > 0$ housing units, it can enjoy housing services $s \leq h$ and rent out services $h - s \geq 0$ at the market rate $\bar{\rho}$.[17] We consider such "landlord households" for two reasons in our model: First, housing becomes a less illiquid durable consumption good when its owner can easily downsize in response to negative income realizations. Second, the differential tax treatment of owner-occupiers and landlords comes into play with this feature.

When a household buys or sells housing units, it needs to incur transaction costs which are fractions t^b (buyer) and t^s (seller) of the purchase price.

We introduce idiosyncratic house value risk, as well as private rental risk described below, which may play important roles both for the homeownership decision (e.g. Sinai and Souleles, 2005) and for the decision to move into social housing. Regarding housing investments, consider a household who holds $\tilde{h}'$ housing units at the end of a period. Towards the next period, the housing unit

[15] We experimented with an additive utility gain for retired households, which did not improve the fit of the model, however.

[16] Housing has both a size and a quality dimension. Since our modeling abstracts from such multi-dimensionality, the housing measure should be understood to reflect both size and quality. As is common in the literature, we do not distinguish between houses and flats whose relative supply may matter for the overall homeownership rate. Indeed, Germany's share of houses (42%) among all housing units is smaller than the EU average (58%), but it is higher than in Spain (34%) where the homeownership rate is much higher than in Germany. Moreover, the cross-country correlation between homeownership rates and the share of houses is virtually zero (based on Eurostat data for 2016, distribution of population by tenure status and by degree of urbanization).

[17] This rules out that owner households rent additional space.

adjusts to

$$\log h' = \log(1-\delta) + \log \tilde{h}' + \chi' \ ,$$

where $\chi' \sim \mathcal{N}(-\sigma_\chi^2/2, \sigma_\chi^2)$ denotes a house value shock and $\delta > 0$ is the annual depreciation rate.[18] House value shocks have standard deviation σ_χ which reflects unit-specific variations of the value of a house.

Financial Assets

Households can save in a risk-free asset that pays the real interest rate r, and they can borrow using mortgage loans at rate r^m. Like the safe interest rate, the mortgage premium $r^m - r$ is exogenously fixed, reflecting monitoring and administrative costs of mortgage lenders which are constant per unit of borrowing.

Let a' denote the choice of net financial assets of a household who holds $\tilde{h}'$ housing units. Mortgage borrowing is subject to the down payment constraint

$$a' \geq -(1-\theta_\tau) p \tilde{h}' \ ,$$

where the down payment parameter θ_τ may depend on the household's age, and $p\tilde{h}'$ is the value of the housing unit owned by the household at the end of a period. We do not allow for default in our model which seems a reasonable abstraction given that mortgage defaults are rare events in Germany.[19]

3.3 Rental Markets and Social Housing

If a household does not own housing ($h = 0$), it either rents housing services s in the private market or from a social housing provider.[20] When renting a unit of size s in the private market,

[18] This formulation of idiosyncratic house price appreciation/depreciation is similar to Jeske et al. (2013), but does not feature mean reversion as suggested by Giacoletti (2017). The trend depreciation is required in our model which includes a construction sector and no population growth. If a housing unit is already at the minimum size constraint $h_{\min}$, we assume that its value falls to zero with probability δ, so that δ is indeed equal to the aggregate depreciation rate.

[19] The Deutsche Bundesbank estimates that the mortgage loss ratio is about 0.1% for 2004-2013 (see Bundesbank, 2014). While we do not have comparable data regarding defaults, the rate of mortgages in arrears compiled by Fitch Ratings indicates that Germany has quite a low rate (see FitchRatings (2016) and Stanga et al. (2017) about using the arrear rate to approximate defaults).

[20] The choice of housing services s, as opposed to housing units h, is not constrained from below which reflects that arbitrarily small units (e.g. rooms of any size or quality) can be rented but not owned separately.

the household pays rent ρs, where ρ denotes the idiosyncratic risky market rent for the household. Over time, the market rent evolves according to the autoregressive process

$$\log \rho' = (1-\omega)\log \bar{\rho} + \omega \log \rho + \nu' \quad , \quad \nu' \sim \mathcal{N}(-\frac{\sigma_\nu^2}{2(1+\omega)}, \sigma_\nu^2) \ ,$$

where $\omega \in (0,1)$ measures the persistence of the idiosyncratic rent and ν' is a normally-distributed rental rate shock where parameter σ_ν controls the risk in the private rental market from the renter's point of view. Therefore, market rents in the stationary equilibrium are log-normally distributed with parameters $\mu_\rho = \bar{\rho} - \sigma_\nu^2/[2(1-\omega^2)]$ and $\sigma_\rho^2 = \sigma_\nu^2/(1-\omega^2)$ so that the mean market rent is equal to $\bar{\rho}$.[21] We assume that the owners of rental units can diversify rental risks so that they receive the average market rent $\bar{\rho}$.

If a renter household is granted access to social housing, it may rent at a below-market rent $\rho^s < \bar{\rho}$ which is a risk-free policy parameter. Therefore, social housing comes at the benefits of a reduced rent as well as rent certainty. However, social housing units cannot be rented in arbitrary size or quality which we capture by an upper size constraint on housing service consumption, $s \leq \bar{s}$, where $\bar{s}$ denotes the largest available social housing unit.

Access to social housing is available to households of working age and is granted according to a rationing scheme which depends on the household's income y upon entry. Specifically, a renter household gains access to social housing with probability

$$\pi_\tau(y) = \begin{cases} \pi & \text{if } y \leq \bar{y} \text{ and } \tau \leq 4 \ , \\ 0 & \text{else} \ , \end{cases}$$

where $\bar{y}$ is the income eligibility limit (a given policy parameter) and π is a uniform rationing probability (an endogenous variable in the model). Eligibility based on income reflects that access to social housing is targeted to low-income households. However, as discussed in Section 2, a household can possibly stay in a social housing unit for several years even when income goes up. Households lose access to social housing in subsequent periods due to the following events: (i) they may decide to become an owner; (ii) they may decide to rent in the market (for instance, if they

[21] Newborn households or owner households who become renters draw the initial market rent from the same stationary distribution.

prefer to consume $s > \bar{s}$ or if the idiosyncratic market rent ρ is sufficiently low); (iii) they move out because of exogenous reasons (such as loss of social housing status or an exogenous relocation shock) which happens with probability η.

3.4 Real-Estate Firms

In contrast to household landlords, real-estate firms need to pay monitoring costs c^m per unit of rented housing. This reflects the information asymmetry between a business owner and its renters and in turn implies an additional advantage of homeownership.[22] Given that real-estate firms can diversify idiosyncratic house value risks and rental rate risks, their zero-profit condition implies the following relationship between the house price p and the rental rate $\bar{\rho}$:[23]

$$(r + \delta)p = \bar{\rho} - c^m \ . \tag{1}$$

Next to the regular housing units which are traded on the market, social housing units are also operated by real-estate firms who rent them out at below-market rate ρ^s. A distinctive feature of Germany's social housing sector is that social housing is operated by private firms who, in exchange for a subsidy to construction costs, are committed to rent control and access restrictions to low-income households for a pre-defined period (Kirchner, 2007). The commitment period of a social housing unit ends with probability Φ in which case the unit becomes a regular housing unit that can be rented out at average market rate $\bar{\rho}$. Operating social housing units also requires paying monitoring costs c^m. Similar to (1), the zero-profit condition of real-estate firms is[24]

$$(r + \Phi + \delta)p^s = \rho^s - c^m + \Phi p \ , \tag{2}$$

where p^s is the market price of a social housing unit.

[22] The informational advantage of landlord households can be related to the fact that they often live in close proximity to the rented unit.

[23] The discounted income value per housing unit is $V = [\bar{\rho} - c^m + (1-\delta)V]/(1+r)$, i.e. next period a housing unit earns income $\bar{\rho} - c^m$ and its value depreciates to $(1-\delta)V$. From $V = p$ follows equation (1).

[24] The discounted income value per social housing unit is $V^s = [\rho^s - c^m + (1 - \Phi - \delta)V^s + \Phi V]/(1+r)$, i.e. next period the housing unit earns income $\rho^s - c^m$, fraction $1 - \Phi$ retains social housing status and depreciates at rate δ (continuation value V^s), and fraction Φ becomes a regular housing unit with value $V = p$ (see footnote 23). From $V^s = p^s$ follows equation (2).

3.5 Housing Construction

There is a construction sector which produces regular and social housing units. Producing I regular and I^s social housing involves costs $K(I + I^s)$, where K is an increasing and convex function. The convexity captures the scarcity of building land and possible capacity constraints in the inputs for housing construction in a reduced form (see Davis and Heathcote, 2005, for a more explicit formulation). Profit maximization of construction firms implies that

$$p = K'(I + I^s) = p^s + \varsigma \ , \tag{3}$$

where ς is the government subsidy per unit of social housing construction.[25]

Finally, let $\bar{H}$ and $\bar{H}^s$ denote the stocks of regular and social housing. The stock-flow relations in steady state are

$$\delta(\bar{H} + \bar{H}^s) = I + I^s \ , \quad (\Phi + \delta)\bar{H}^s = I^s \ . \tag{4}$$

The first equation says that the total housing stock is constant (depreciated housing equals construction). The second equation says that the stock of social housing is constant (social housing converted into regular housing or depreciated equals construction of social housing).

3.6 The Government

The government taxes households' incomes and real-estate transactions, it pays pensions to retirees, and it subsidizes the construction of social housing. Any excess tax revenue is spent on public goods which do not affect the households' decisions. For this reason, we leave these public goods unspecified.

We use the income tax function $T_\tau(y^t)$ which we estimate separately for the different age groups τ. In line with German tax law, taxable income y^t includes labor, capital and rental income minus mortgage interest payments for those units that a landlord household rents out.

The government taxes the transfer of real estate by collecting a fraction $\tilde{t}^b$ of the purchase price. That fraction is part of the overall buyer transaction cost, i.e. $\tilde{t}^b \leq t^b$.

[25] Unlike real-estate firms, construction firms make positive profits $\Pi > 0$. In a stationary equilibrium, these firms are traded at the end of each period at price Π/r. Hence they are included in the riskless financial asset, i.e. they are owned by domestic or foreign households.

3.7 Value Functions and Household Decisions

The state vector of a household at the beginning of a period is $(\tau, i, \rho, \sigma, a, h)$. The first three components, age τ, income decile i and the current rent level ρ, are exogenous to the household's problem. $\sigma \in \{0, 1\}$ is an indicator for social housing access for a renter household. Financial and housing assets a and h are the outcomes of past savings decisions. Let $V(\tau, i, \rho, \sigma, a, h)$ be the household's value function. The household chooses consumption of goods c and housing services s, financial assets a', housing assets $\tilde{h}'$ for the next period, prior to the realization of depreciation and house value shocks, and social housing status $\tilde{\sigma} \in \{0, 1\}$, conditional on access to social housing $\sigma = 1$, solving the recursive problem

$$V(\tau, i, \rho, \sigma, a, h) = \max_{c,s,a',\tilde{h}',\tilde{\sigma}} u(c, s; \tau, \mathbb{I}_{h>0}) + \beta \mathbb{E} V(\tau', i', \rho', \sigma', a' + b', h') \tag{5}$$

subject to

$$\begin{aligned} c + a' + p\tilde{h}' &= y(\tau, i) + [1 + r\mathbb{I}_{a>0} + r^m \mathbb{I}_{a<0}]a + ph + \max(\bar{\rho}(h - s), 0) - \tilde{\rho} s \mathbb{I}_{h=0} \\ &\quad - T_\tau(y^t) - \mathbb{I}_{\tilde{h}' \neq h}(t^b p\tilde{h}' + t^s ph) \ , \end{aligned} \tag{6}$$

$$\tilde{h}' \in \mathcal{H} \cup \{0\}, \ s \geq 0, \ s \leq h \text{ if } h > 0 \ , \tag{7}$$

$$a' \geq -p\tilde{h}'(1 - \theta_\tau) \ , \tag{8}$$

$$\log h' = \log(1 - \delta) + \log \tilde{h}' + \chi' \ , \tag{9}$$

$$\tilde{\sigma} \in \{0, 1\} \ , \text{ and } \tilde{\sigma} = 0 \text{ if } \sigma = 0 \text{ or if } s > \bar{s} \ , \tag{10}$$

$$\tilde{\rho} = \begin{cases} \rho^s & , \text{ if } \tilde{\sigma} = 1 \ , \\ \rho & , \text{ otherwise} \ , \end{cases} \tag{11}$$

$$\log \rho' = \begin{cases} (1 - \omega) \log \bar{\rho} + \omega \log \rho + \nu' & , \text{ if } h = 0 \ , \\ \sim \mathcal{N}(\log \bar{\rho} - \frac{\sigma_\nu^2}{2(1-\omega^2)}, \frac{\sigma_\nu^2}{1-\omega^2}) & , \text{ otherwise} \ , \end{cases} \tag{12}$$

$$\sigma' = \begin{cases} 1 & , \begin{cases} \text{with prob. } \pi_{\tau'}(y(\tau', i')) \text{ if } \tilde{\sigma} = 0 \text{ and } h' = 0 \ , \\ \text{with prob. } 1 - \eta \text{ if } \tilde{\sigma} = 1 \text{ and } h' = 0 \ , \end{cases} \\ 0 & , \text{ otherwise} \ , \end{cases} \tag{13}$$

$$y^t = y(\tau, i) + r \max[a, 0] + \bar{\rho} \max(0, h - s)$$
$$- r^m \min \left\{ \max[-a, 0], \max[p(h - s)(1 - \theta_\tau), 0] \right\} , \quad (14)$$
$$b' \sim B(.) \text{ with prob. } \pi^I \text{ if } \tau \in \{1, 2\}, \text{ and } b' = 0 \text{ otherwise.} \quad (15)$$

Equation (6) is the budget constraint which says that expenditures on consumption, financial and housing assets must be equal to labor (or pension) income y, financial and housing assets plus interest (negative, if there is mortgage debt), rental income or rent payments, minus expenditures on taxes and transaction costs for buying and/or selling. (7) include constraints on housing units and the requirement that homeowners do not rent additional space. (8) is the borrowing constraint. Equation (9) says how the value of the housing unit $\tilde{h}'$ changes to the next period due to depreciation and due to the house value shock χ' at the beginning of the next period. (10) says that the household cannot live in social housing either if it has no access ($\sigma = 0$) or if the household chooses to rent a unit above the size constraint ($s > \bar{s}$). Equation (11) specifies the rent which equals the social housing rent conditional on $\tilde{\sigma} = 1$. Otherwise the household rents in the private market at idiosyncratic rent ρ. (12) says that the idiosyncratic market rent follows an AR(1) process over time (for a renter household) or is drawn from the stationary distribution (for an owner household). (13) says how the social housing status evolves over time: renter households ($h' = 0$) are permitted to enter social housing with probability $\pi_{\tau'}(y(\tau', i'))$. If they already live in social housing ($\tilde{\sigma} = 1$) and do not decide to become owners, they retain social housing status with probability $1 - \eta$. Taxable income is specified in (14): it includes labor or pension income, capital income, rental income with deductions for interest payments for mortgages on housing units that a landlord household rents out. Regarding the latter, we assume that the household can attribute up to the lendable fraction $(1 - \theta_\tau)$ of the value of rented housing $p(h - s)$ to the deductible mortgage. Lastly, (15) says that a household in the first or second age group receives random bequests b' with probability π^I drawn from the bequest distribution $B(.)$. The expectations operator in (5) is with respect to the realization of the house value shocks χ', rental rate shocks ν', social housing shocks as in (13), bequests (15), as well as income and ageing shocks.

The solution of this problem specifies policy functions for consumption $C(.)$, housing consumption $S(.)$, financial and housing assets taken to the next period, $A(.)$ and $H(.)$, and social housing

status choice $\Sigma(.)$. These policy functions depend on the household's state vector $(\tau, i, \rho, \sigma, a, h)$. For notational convenience, $H(.)$ denotes the housing assets $\tilde{h}'$ *before* depreciation and house value shocks occur at the beginning of the next period.

Simplifying notation, we denote the death event by $\tau' = 6$ in which case the continuation utility is $V(6, i', \rho', \sigma', a', h') = 0$. New households who enter age group $\tau = 1$ have value $V(1, i, \rho, 1, 0, 0)$ with probability $\pi_1(y(1, i))$ (access to social housing) or $V(1, i, \rho, 0, 0, 0)$ with probability $1-\pi_1(y(1, i))$ (no access to social housing), where residual income decile i is drawn uniformly from $\{1, \ldots, 10\}$ and the initial idiosyncratic market rent is drawn from the stationary distribution, i.e. $\log \rho \sim \mathcal{N}\left(\log \bar{\rho} - \sigma_\nu^2/[2(1-\omega^2)], \sigma_\nu^2/(1-\omega^2)\right)$.

3.8 Equilibrium

The equilibrium specifies value and policy functions for households, housing supply and market prices for housing and rental units, given government policy. The government fixes the social housing rent ρ^s, the income eligibility threshold $\bar{y}$, as well as the construction subsidy ς. The rationing probability π, conditional on eligibility, adjusts in equilibrium such that all social housing units are occupied. Formally, a stationary equilibrium is described by the household value function $V(.)$ and policy functions for goods consumption $C(.)$, housing consumption $S(.)$, financial and housing assets for the next period, $A(.)$ and $H(.)$, social housing $\Sigma(.)$, as well as a stationary distribution μ of households over states $(\tau, i, \rho, \sigma, a, h)$, bequest distribution $B(.)$, house prices p, p^s, rental rate $\bar{\rho}$, construction I, I^s, and housing stocks $\bar{H}$ and $\bar{H}^s$ for regular and social housing, and a social housing access probability π for eligible households such that:[26]

1. Value and policy functions, V and (C, S, A, H, Σ), solve the household's problem as specified in (5)–(15).

2. Real-estate firms maximize profits which implies (1) and (2).

3. Construction firms maximize profits which implies (3).

[26] We only consider equilibria where real-estate firms own a positive fraction of the housing stock. Depending on the parameterization, it is conceivable that all rented housing units are owned by landlord households in which case the price-to-rent ratio is too high for real-estate firms to be active in equilibrium. Given that firms (corporations and limited liability partnerships) own a significant fraction of the housing stock, this seems to be a reasonable restriction.

4. Housing market equilibrium, i.e. all housing units are occupied:

$$\bar{H} + \bar{H}^s = \int S(\tau, i, \rho, \sigma, a, h) \; d\mu(\tau, i, \rho, \sigma, a, h) \; .$$

5. All social housing units are occupied:

$$\bar{H}^s = \int S(\tau, i, \rho, \sigma, a, h) \mathbb{I}_{\tilde{\sigma}(\tau,i,\rho,\sigma,a,h)=1} \; d\mu(\tau, i, \rho, \sigma, a, h) \; .$$

6. μ is a stationary distribution, i.e. it is invariant regarding the exogenous stochastic processes for τ, i, ρ and h, the evolution of social housing status (13) and policy functions for a and $\tilde{h}$.

7. The distribution of bequests $B(.)$ is identical to the distribution of $a' + p(1-t^s)h'$ for households in age group $\tau = 5$.

8. Housing stocks $\bar{H}$ and $\bar{H}^s$ are stationary, conditions (4).

Given a stationary equilibrium, the stock of owner-occupied housing is

$$\bar{H}^{ho} = \int \min \Big(H(\tau, i, \rho, \sigma, a, h), S(\tau, i, \rho, \sigma, a, h) \Big) \; d\mu(\tau, i, \rho, \sigma, a, h) \; ,$$

and the stock of rented housing owned by landlord households is

$$\bar{H}^{hr} = \int \max \Big(0, H(\tau, i, \rho, \sigma, a, h) - S(\tau, i, \rho, \sigma, a, h) \Big) \; d\mu(\tau, i, \rho, \sigma, a, h) \; .$$

Adding the two gives the total housing stock owned by households,

$$\bar{H}^h = \bar{H}^{ho} + \bar{H}^{hr} = \int H(\tau, i, \rho, \sigma, a, h) \; d\mu(\tau, i, \rho, \sigma, a, h) \; .$$

The stock of regular housing owned by real-estate firms is the residual

$$\bar{H}^{re} = \bar{H} - \bar{H}^h \; .$$

Government budget balance says that expenditures on public goods, pensions, and subsidies

for social housing construction equal revenues from income taxes and real-estate transfer taxes:

$$G + \int y(5,i)\ d\mu(5,i,\rho,\sigma,a,h) + \varsigma I^s = \int T_\tau(y^t(\tau,i,\rho,\sigma,a,h))\ d\mu(\tau,i,\rho,\sigma,a,h)$$

$$+\tilde{t}^b p \int H(\tau,i,\rho,\sigma,a,h)\mathbb{I}_{H(\tau,i,\rho,\sigma,a,h)\neq h}\ d\mu(\tau,i,\rho,\sigma,a,h)\ .$$

4 Calibration

We choose parameter values to match key features of the German economy. All income and wealth numbers are expressed in thousand euros at 2006 prices. Several parameters are calibrated outside the model, while others are calibrated such that the model matches selected data targets.

4.1 Externally Calibrated Parameters

Labor Income and Pensions

The labor income process is described by age-specific constants M_τ, deciles for residual income E_τ, as well as transition matrices Ψ_τ. We estimate these parameters using household labor income data from the German Socio-Economic Panel (SOEP) for the years 1995–2015. The dynamics of residual labor income are estimated non-parametrically, using a similar strategy as in De Nardi et al. (2019). For details about this procedure see Appendix A.

Regarding pension income, we use a gross replacement rate (i.e. gross pension income divided by pre-retirement earnings) for Germany of 42% (see OECD, 2011). To match this number, we first calculate average income across all working-age phases $\tau = 1, 2, 3, 4$ in each decile. We then set pension income to 42% of this value for each pension decile. The top and the bottom deciles are capped at 32,000 euros and 6,000 euros respectively, which are measures for the maximum and minimum annual pensions of the public retirement system (see Appendix A).

Taxes and Bequests

We specify the income tax function as $T_\tau(y^t) = y^t - \lambda_\tau (y^t)^{1-\phi_\tau}$, where λ_τ and ϕ_τ are age-specific parameters that capture the level and progressivity of the income tax system (see Feldstein, 1969 and more recently Heathcote et al., 2017). Age-dependence reflects possible factors not captured

by the model, such as the number of children or labor market participants in the household. We estimate these functions based on all households except landlords,[27] separately for all age groups τ, for which gross and net income information is available. For details and parameter estimates, see Appendix A.

Further Parameters

Table 1 shows the additional parameters that are calibrated externally. The first four rows refer to demographics. Household size is estimated from the SOEP sample, using the modified OECD equivalence scale. The choices for ϑ_τ reflect the average durations in working-age groups $\tau = 1, \ldots, 4$ and in retirement $\tau = 5$. Since there are twenty households in age groups $\tau = 1, 2$ per dying household, the probability to receive a random bequest is $\pi^I = 1/20$.

Table 1: Externally calibrated parameters.

Parameter		Value	Explanation/Target
Household size	$(n_1, \ldots, n_5)$	(1.41,1.74,1.70,1.44,1.39)	OECD equivalence scale
Ageing probabilities	$\vartheta_1, \vartheta_2, \vartheta_3, \vartheta_4$	0.1	10-year age groups
Death probability	ϑ_5	0.05	20-year retirement
Inheritance rate	π^I	0.05	Random bequests $\tau = 1, 2$
Risk aversion	γ	2	Standard parameter
Expenditure share	ζ	0.717	Consumption shares
Real interest rate	r	0.0255	Average 1991–2014
Real mortgage rate	r^m	0.0374	Average 1991–2014
Down payment req.	$\theta_1, \theta_2, \theta_3$	0.20	Chiuri and Jappelli (2003)
Down payment req.	(θ_4, θ_5)	(0.60,1.0)	No mortgage in retirement
Transaction costs	$(t^b, \tilde{t}^b, t^s)$	(0.108,0.052,0.029)	See text
Depreciation rate	δ	0.01	100-year housing lifespan
Social rent discount	ρ^s/ρ	0.80	Deschermeier et al. (2015)
Social rent eligibility	$\bar{y}$	37.8	See text
Transformation rate	Φ	0.04	Schier and Voigtländer (2016)
House value risk	σ_χ	0.104	See text
Rental rate persistence	μ_ρ	0.404	See text
Rental rate volatility	σ_ν	0.094	See text
Minimum house size	$h_{\min}$	80	See text
Supply elasticity	φ	2.34	Caldera and Johansson (2013)

Regarding preference parameters, we choose a standard value for relative risk aversion, and we set the expenditure share for non-housing goods ζ so that housing consumption equals 28.3% which is the housing share of consumption expenditures of German households in 2014 (see table

[27] Therefore, the households in the data sample cannot use the deductions due to homeownership that apply to landlord households.

Ü3.1 in Statistisches Bundesamt, 2016).

The real interest rate and the real mortgage rate are averages over the period 1991–2014.[28] We set the down payment requirements to 20% of the housing value for all households below age 55 (cf. Figure 14 in Andrews et al., 2011, and Table 1 in Chiuri and Jappelli, 2003). We further impose that mortgages must be repaid in retirement. To avoid extreme mortgage adjustments at age transitions, we set the down payment requirement for the oldest working-age group to 60%.

To measure transaction costs, we attribute the real-estate transfer tax (which varies by German state) and solicitor fees to the buyer. Brokerage fees (which also vary by state), are attributed to both buyers and sellers, and we apply population weights to obtain the numbers for t^b, $\tilde{t}^b$ and t^s in the table.

We normalize the price per unit of housing to $p = 1$, and we set the depreciation rate such that the average life span of a housing unit is 100 years.[29] Regarding social housing, we set the social rent at 20% below the market rent, that is we set ρ^s to equal 80% of the market rent ρ (see Section 2). We impose the social housing eligibility threshold to be median household labor income (37,800 euros) which is consistent with German regulation (see Kirchner, 2007) and with empirical evidence from the SOEP. Social housing units (whose private construction is subsidized) can be converted into regular private housing units (for rental or for sale) after a commitment period of 25 years (Schier and Voigtländer, 2016), which implies $\Phi = 0.04$. We set the house value risk and rental rate risk parameters based on estimates from the SOEP. We recover these parameters using self-reported price changes of homeowners and market renters who do not change their property between time periods (see Appendix A for details).

For the construction technology we use $K(I + I^s) = k_0(I + I^s)^{1+\varphi}/(1+\varphi)$ so that $K'(I + I^s) = k_0(I + I^s)^{\varphi}$. Caldera and Johansson (2013, Table 2) estimate the long-run price elasticity of new housing supply in Germany at 0.428 which leads to $\varphi = 2.34$.[30] Parameter k_0 is set internally using the equilibrium conditions (3) and (4) to ensure the normalization $p = 1$.

[28] The safe interest rate is the yield on 10-year government bonds, and the mortgage rate is the effective rate on 10-year fixed rate mortgages reported by the Bundesbank. Nominal rates are converted into real rates with CPI inflation.

[29] Indirectly $p = 1$ normalizes housing quantities which is innocuous. A formal argument is available on request.

[30] This compares to a much higher elasticity of 2.014 in the U.S. which is likely due to a more elastic supply of land (cf. Sommer and Sullivan, 2018, who estimate a price elasticity of 0.9, and Floetotto et al., 2016, who use the number 2.5). Therefore, if we used the U.S. value of the housing supply elasticity in our calibration, we would obtain *smaller* price responses in general equilibrium. In other words, our results would be closer to the partial equilibrium responses that we report below next to the general-equilibrium results.

We set the minimum house size to $h_{\min} = 80,000$ which corresponds to a value just below the 10th percentile of the housing wealth distribution in the SOEP sample.

4.2 Internally Calibrated Parameters

Table 2 shows further parameters which are calibrated internally. Average household wealth identifies the discount factor β to match the data target that we obtain from the SOEP sample. From the same data, we obtain homeownership rates for the total population as well as for retired households. These data targets identify the value of monitoring costs c^m which implicitly controls the price-to-rent ratio, as well as the preference shift parameter $\xi^5_{\mathbb{I}_{h>0}}$ for retired homeowner households. Note that the price-to-rent ratio in the benchmark model equals 18.3 which is close to the 2004–2008 average of 21.6 reported by the Deutsche Bundesbank.[31]

To set the upper size constraint on social housing, we proceed as follows. First, we compute the empirical size distributions in square meters of market rental units and social housing rental units in the SOEP data. Then, we calculate the ratio between the 99th percentiles of both distributions and find that the size of the largest social housing units is 73.1% of the size of the largest market rental units. We then set $\bar{s}$ to match this value by computing the corresponding ratio from the equilibrium rental size distributions in the model. The construction subsidy for social housing ς is set to match the share of social housing in 2002, which is 7.1% (see Kirchner, 2007). Further, the exogenous exit probability η is set internally to match the empirical move-in rate for households below the income eligibility limit $\bar{y}$. Note that the probability for social housing access π adjusts endogenously.

4.3 Model Fit

Figure 1 shows the model-generated age profiles of homeownership, net wealth, housing and financial wealth. We target the homeownership rate of households in all age groups pooled together which is 42.2% as well as homeownership in retirement.[32] The model captures rather well the increase of

[31] See the series "Price-to-rent ratio for apartments in Germany (administrative districts)" available at `https://www.bundesbank.de/resource/blob/622520/f5d7100326201cea767f4959e574eeb8/mL/german-residential-property-market-data.pdf`.

[32] The corresponding dynamics between tenure states over time are also fairly well matched and are reported in Table 15 in Appendix B.

Table 2: Internally calibrated parameters.

Parameter		Value	Target	Model	Data
Discount factor	β	0.9485	Avg wealth (thousand euros)	128.7	128.7
Monitoring cost (%)	c^m	0.0189	Homeownership rate (%)	42.5	42.2
Utility weight owner 65+	$\xi^5_{\mathbb{I}_{h>0}}$	1.37	Homeownership rate 65+ (%)	47.4	47.6
Social h. upper size	$\bar{s}$	212	99th percentile ratio $\bar{s}/s$	0.726	0.731
Social h. constr. subsidy	ς	0.1442	Social housing share	0.071	0.071
Social h. exogenous exit	η	0.0155	Social housing move-in rate	0.0128	0.0128
Construction cost	k_0	0.2898	Normalization $p = 1$	–	–

the homeownership rate during the first four age stages, as well as the slight decline in retirement.[33]

Regarding wealth, our model generates hump-shaped patterns of net wealth and its components, although it overpredicts the accumulation of net wealth during working life and the decumulation in retirement. As the bottom left graph shows, this is due to retirees owning too small housing units in the model.

Our model generates a wealth Gini coefficient of around 0.5 which is too low compared to the one in our data (0.61). This is a well-known feature of incomplete-markets models using income processes estimated from household survey data (see De Nardi and Fella, 2017, for a recent survey). In Figure 10 in Appendix B we compare additional distributional measures by age group to the data. The comparison indicates that households at the lower end of the wealth distribution in the model tend to accumulate relatively more wealth than in the data, leading to the discrepancy in the inequality measure between the data and the model.

The top graphs in Figure 2 show that our model captures rather well the hump-shaped age profiles of average gross and net income over the life cycle. Note again that only the age profile of labor income is calibrated, whereas capital and rental incomes are endogenous, as are the tax deductions of landlord households. Indeed, the model generates an adequate share of landlords (7.9% in the model versus 11.5% in the data). Table 14 in Appendix B shows that the share of landlords in the model is rather well matched by age groups and wealth quintiles.

The bottom graphs in Figure 2 show that our model generates the variations of the homeown-

[33] We evaluated the role of the tails of the age distribution in the stochastic life-cycle model for homeownership patterns. Specifically, we simulated the model for newborn households where we removed the lowest 10% and the highest 10% of actual lifetimes. As we show in Table 16 in Appendix B, both the age profile of the homeownership rate and the various wealth components are only slightly affected.

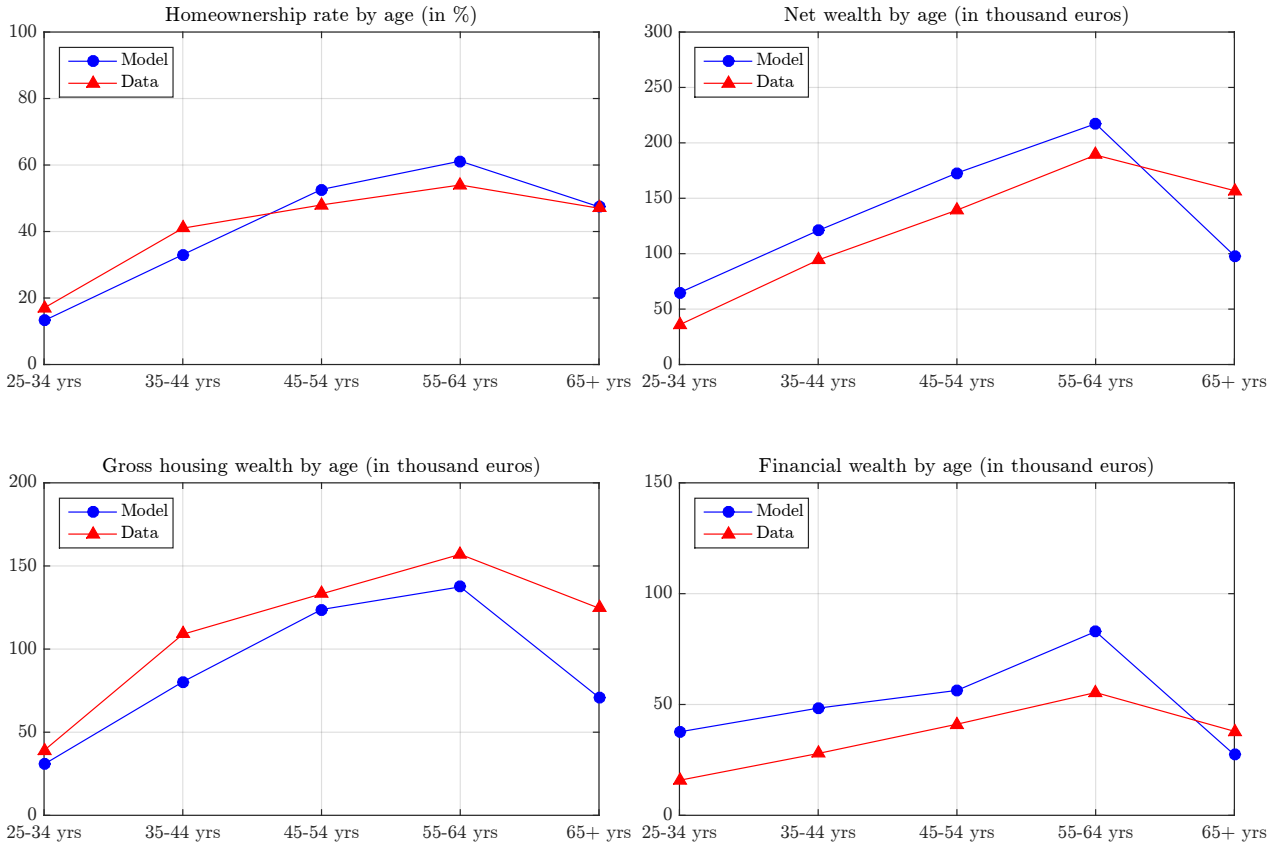

Figure 1: Model fit

ership rate by income and wealth deciles. Both in the data and in the model, the homeownership rate for the bottom four wealth deciles is below 10%, and it is above 88% for the top three wealth deciles. In other words, the homeownership status varies most between the fifth and seventh wealth deciles. In Figure 9 in the Appendix we also look at the relation between homeownership and wealth for each age group separately. The overall patterns from the lower right part of Figure 2 still hold for individual age groups except for the youngest group. One reason for this could be that we do not allow for houses being bequeathed or gifted directly to the next generation.

Regarding income variation, the model accounts for a difference of 33 percentage points between homeownership rates in the top and bottom deciles which is somewhat smaller than in the data. Homeownership rates also increase with income for any of the four working-age groups separately (see Figure 8 in Appendix B), where the fit between the model and the data is better for the older than for the younger age groups.

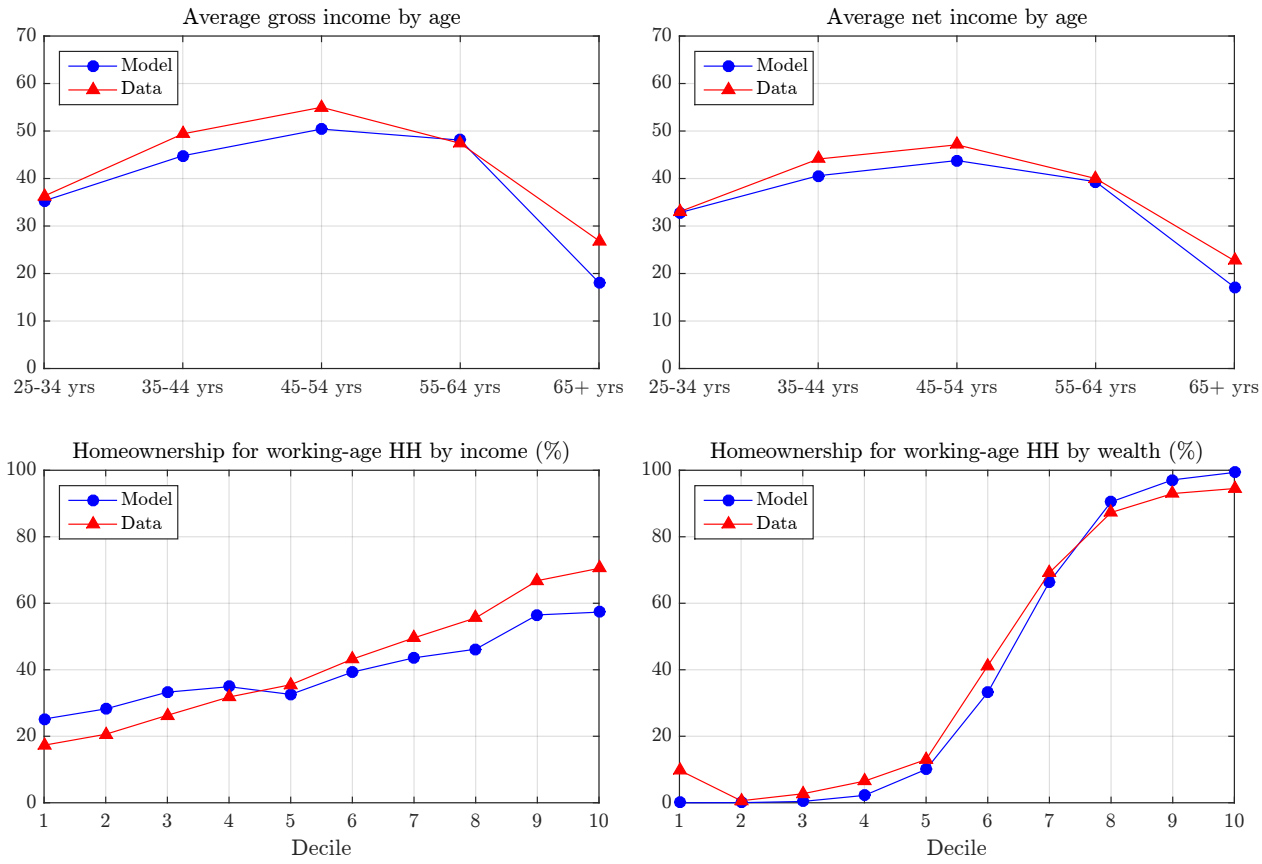

Figure 2: Model fit

5 Accounting for Low Homeownership

The good fit of our model to non-targeted moments, and in particular to the homeownership rate profiles by age, wealth and income, lends support for its use as a tool for counterfactual policy evaluation. In this section, we aim at quantifying the importance of different institutional factors for homeownership and wealth accumulation. To this end, we conduct a series of counterfactual experiments in our general equilibrium framework, where our focus is on steady-state comparisons. In particular, we explore the following four counterfactuals C1-C4 which move the German housing policies closer to those applied in the United States:

C1: The real-estate transfer tax (RETT) is set to a value comparable to the U.S., $\tilde{t}^b = 0.33\%$.

C2: Mortgage interest payments are fully tax deductible.

C3: There is no social housing.

C4: Full combination of C1-C3.

Throughout all experiments, we let the house price, the rental rate and housing construction adjust to clear the housing market. For counterfactuals C1 and C2, we further fix the share of households in social housing at the benchmark level, adjusting the social housing construction subsidy accordingly. The idea behind this adjustment is that we keep the stock of social housing largely unchanged in policy experiments C1 and C2. We further impose for all experiments revenue neutrality for the government. To achieve this, we increase/decrease the scale parameters of the tax functions λ_τ by the same proportion for all age groups to balance the government budget.[34] We then contrast our experiments with those in partial equilibrium where the house price and taxes do not adjust in order to understand the impact of the various policies on housing demand in isolation.

Homeownership Rates by Age

Figure 3 plots the age profiles of homeownership for our counterfactual experiments. As can be seen, the life-cycle profiles of homeownership rates lie higher for any individual counterfactual scenario than in the baseline economy. The effects are quite sizable for C1 (elimination of RETT) while being somewhat more moderate under C2 (mortgage interest deduction) or C3 (no social housing). This suggests that all channels contribute prominently to explaining low homeownership rates in Germany.

Quantitatively, the most important policy factor is the real-estate transfer tax (RETT). Our results suggest that cutting the RETT would shift the homeownership profile upwards by 6-14 percentage points across all working-age groups. While our model does not target housing turnover, the response in turnover to a reduction in RETT is largely consistent with empirical findings: Fritzsche and Vandrei (2019) use data on regional and time variation of the RETT in Germany to show that a one percentage point decrease of the RETT yields about 7% more transactions. In our model, 2.07% of households buy an owner-occupied housing unit each year, of which about 42% are current homeowners who move to a different house.[35] Under policy C1 (reducing the RETT),

[34] See Heathcote et al. (2017) for a similar approach of adjusting the scaling parameter. We have implemented alternative ways of balancing the budget through proportional taxes and transfers. The results of experiments C1–C4 are not affected significantly.

[35] In the data the number of transactions is lower by about one third. Most of this difference comes from a lower number of owners in the data moving to a new house (see Table 15 in Appendix B). Total tax revenues generated by RETT in our model (10.9 billion euros) are reasonably close to the data average for 2012-2018 which is 9.4 billion

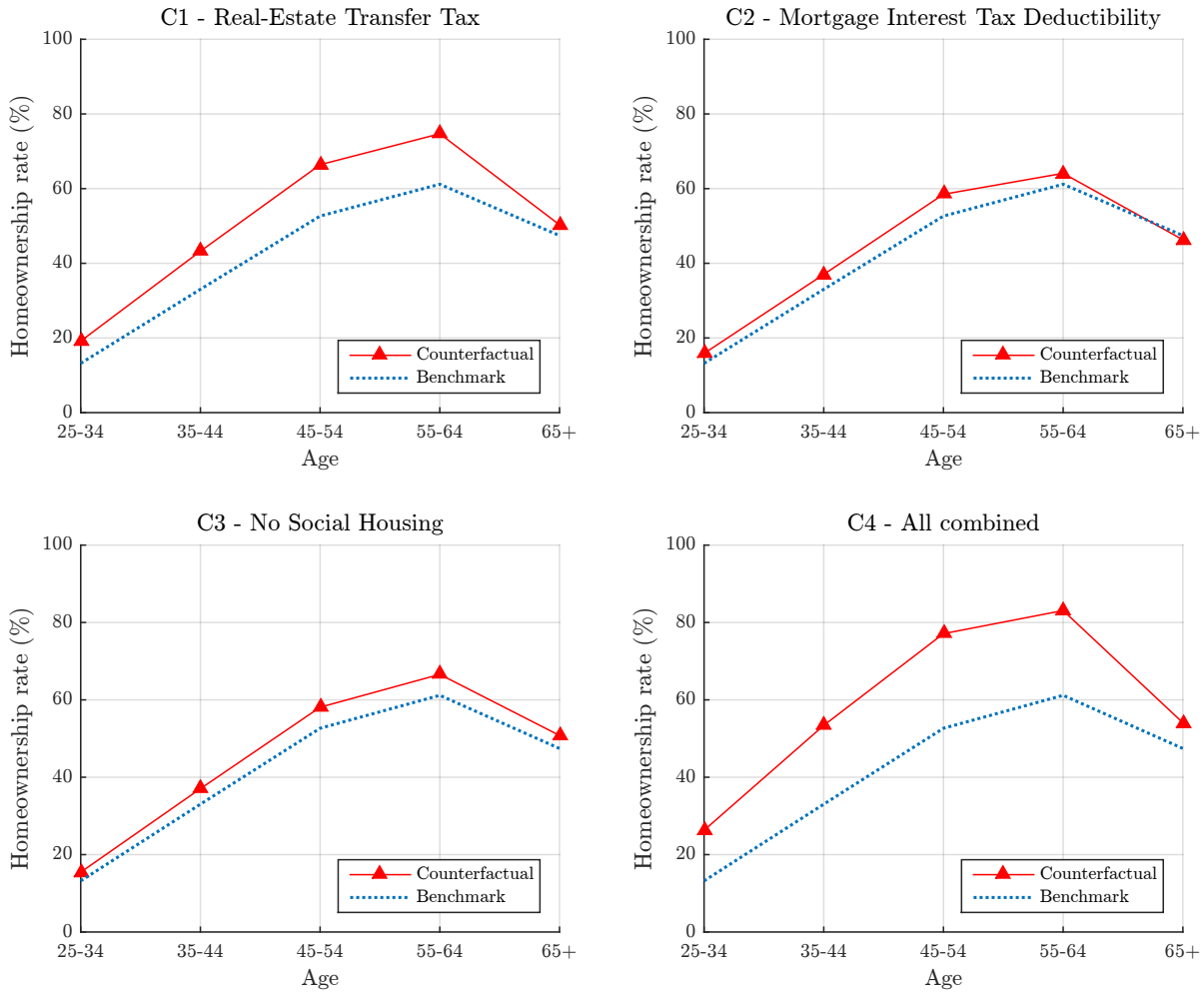

Figure 3: Homeownership rate by age for counterfactual experiments

the share of households buying a house increases to 3.03% in general equilibrium (with price and tax adjustment) or to 2.99% (without tax adjustments). This suggests that for each percentage point decrease of RETT there are about 9% more transactions which is in line with the empirical estimate.[36] The study by Petkova and Weichenrieder (2017) looks at the effects of RETT changes on purchases of single houses in Germany and finds a tax elasticity of transactions of 0.23 which is close to the average elasticity of 0.21 in our model.

Halket and Vasudev (2014) perform a related counterfactual experiment for the U.S. by abolishing total transaction costs, and they find that the homeownership rate increases by three percentage

euros (CPI-deflated in 2006 prices).

[36] A potential reason for the slightly larger elasticity in our model could be that we consider all housing units, and that transactions of smaller units (apartments) are more sensitive to changes in transaction costs than transactions of single-family homes.

points. The countervailing price effects in their case appear to be larger than in our model.[37]

Turning to the other counterfactual experiments, the removal of social housing shifts the life-cycle profile of homeownership upwards by five percentage points for the middle- and older-age groups and by a bit less for the youngest age groups. Without the option to rent at a reasonably low and safe rate, some households with sufficiently high savings find it more attractive to buy a home. Finally, our results suggest that making mortgage interest payments fully tax deductible has a positive 3-6 percentage points effect on homeownership for all working-age groups, but reduces homeownership slightly for retirees.[38]

The combined effect is depicted in the bottom right panel of Figure 3. We find that homeownership rates would be as high as 53% in the second age group, and around 80% for the middle- and older-age groups if all policy channels were adjusted simultaneously. The overall homeownership rate under the combined scenario increases to 58%. That is, the homeownership gap between the U.S. and Germany is closed by about two thirds when all three housing policies are set to U.S. levels.

Homeownership, Wealth Accumulation and House Prices

To shed more light on these findings, Table 3 reports a selection of aggregate statistics. Our results suggest that lower transaction costs or no social housing lead to more wealth accumulation in conjunction with higher homeownership. Mortgage interest deductibility also fosters housing investments, but higher indebtedness and less financial investments nearly offset the impact on total wealth. Under any policy change, households would invest a larger share of their portfolio in housing wealth, while assets invested in financial wealth decrease even in absolute terms.

Interestingly, although all three policies C1–C3 promote homeownership, they have quite distinct implications for house prices as well as for the price-to-rent ratio. The house price falls when social housing is abolished (C3), but the reverse is true when the RETT is cut (C1) or when mortgage interest can be deducted (C2). These results are intuitive: without the option of sub-

[37] Our model does not include transaction costs other than taxes and fees. In a robustness check we added five percentage points additional transaction costs on the price. While this moves turnover rates closer to the data, the effect of the RETT deduction on the homeownership rate remains robust. Welfare effects in general equilibrium are somewhat smaller than those reported in Section 6 but remain negative.

[38] One might envision another policy change that introduces mortgage interest deductions together with the taxation of imputed rents. Such a policy shift is justifiable on the grounds that the tax base should include the additional (imputed) income generated from any mortgage whose interest is deductible. Quantitatively, this policy change leads to a dramatic decline of the homeownership rate relative to the benchmark, however. This is consistent with the findings of Gervais (2002) and Floetotto et al. (2016) for U.S. calibrations.

Table 3: Counterfactuals: General equilibrium and revenue neutrality

	Benchmark	RETT C1	Mort Ded C2	No Social H C3	Combination C4
Homeownership (%)	42.5	50.7	44.7	46.5	58.0
– 25-34 yrs	13.2	19.2	15.9	15.5	26.3
– 35-44 yrs	33.0	43.2	37.0	37.0	53.4
– 45-54 yrs	52.7	66.4	58.5	58.1	77.1
– 55-64 yrs	61.2	74.7	64.1	66.6	83.1
– 65+ yrs	47.4	50.3	46.3	50.8	54.1
Total wealth	128.7	139.0	131.2	133.0	142.9
– Housing	85.7	107.2	92.7	93.1	121.3
– Financial	46.7	37.7	43.9	44.0	31.3
– Mortgage	-3.6	-6.0	-5.5	-4.1	-9.7
House price	1.000	1.019	1.008	0.997	1.013
Price-to-rent ratio	18.38	18.49	18.43	18.35	18.46
Rationing prob π (%)	1.28	1.62	1.36	0	0
ΔGov't BC (per HH)	–	0	0	0	0
–ΔRETT Rev	–	-0.266	0.019	0.025	-0.262
–ΔIncTax Rev	–	0.270	-0.018	-0.110	0.178
–ΔSocHous Subs	–	0.004	0.001	-0.085	-0.085
ΔDemand (in %)	–	0.80	0.37	-0.18	0.54
–Income Q1	–	1.93	0.45	-0.62	0.92
–Income Q2	–	1.91	1.12	-0.69	1.48
–Income Q3	–	1.11	0.73	-0.41	0.35
–Income Q4	–	-0.12	0.02	-0.04	-0.42
–Income Q5	–	0.03	-0.15	0.43	0.68

NOTE: All monetary values in thousand euros.

sidized housing, overall demand for housing services goes down, so that house prices as well as the price-to-rent ratio fall; conversely, with a lower RETT, housing demand goes up –especially across lower-income households– which increases the price-to-rent ratio. Similarly, the effect of tax deductibility of mortgage interest raises the price-to-rent ratio and the house price, this time through a rising housing demand of middle-income households. Finally, in the combination of all counterfactuals (C4) the house price and the price-to-rent ratio are higher than at the benchmark level. Again this is induced by a surge of housing demand in the lower- and middle-income groups.

The adjustment of prices in general equilibrium is attenuated by the adjustment of income taxes. If taxes were fixed at the benchmark level, the cut of RETT would lead to an even stronger

increase of housing demand which induces a larger increase of the house price, hence mitigating the policy impact (see Table 13 in Appendix B).

Housing Demand

To better understand the impact of different policies on housing demand, we present in Table 4 the model implications under the scenario where the house price, and hence the rental rate, are fixed and where taxes do not adjust to balance the government budget. That is, we ignore the reaction of housing supply and tax policy to the different policy changes. A first observation is that the effect of the reduction of RETT on homeownership and wealth is a bit stronger than in the benchmark scenario: because the house price does not increase, it becomes even more attractive for households to invest in housing, both for their own consumption as well as for investment purposes. For a similar reason, the introduction of mortgage interest deductibility has a larger effect on housing investment and wealth when prices are fixed. Indeed, under both C1 or C2, housing demand increases substantially for all income groups. Tax deductibility has a particularly strong impact on the demand of middle-income groups whose decision to take up a mortgage in order to finance a home is most responsive to the policy change.

On the other hand, the effect of the removal of social housing is weaker when house prices and rents are fixed. Compared to the benchmark scenario, the homeownership rate increases to 46.2%, which is due to the fact that the option value of entering a subsidized unit is gone. However, overall housing demand falls because both renters and homeowners want to live in smaller units than before. In general equilibrium, this decline in housing demand leads to a fall of house prices (and less housing construction) which pushes up the homeownership rate to 46.5%. Without this price decline, the increase of homeownership is slightly smaller.

Table 4 further presents the impact on the government budget in partial equilibrium (without price or tax adjustments). For instance, cutting the RETT imposes a cost on the government of 328 euros per household, while no subsidies to social housing implies a revenue increase of 86 euros per household. When price changes in general equilibrium are taken into account, these numbers change only little (see Table 13 in Appendix B).

Table 4: Counterfactuals: Partial equilibrium with fixed taxes and house prices

	Benchmark	RETT C1	Mort Ded C2	No Social H C3	Combination C4
Homeownership (%)	42.5	53.3	46.0	46.2	59.2
– 25-34 yrs	13.2	20.5	16.3	15.2	26.1
– 35-44 yrs	33.0	45.1	38.1	36.8	53.6
– 45-54 yrs	52.7	68.1	58.7	58.0	76.9
– 55-64 yrs	61.2	77.1	65.0	66.4	84.3
– 65+ yrs	47.4	54.5	48.9	50.5	57.3
Total wealth	128.7	142.5	132.8	132.4	146.2
– Housing	85.7	111.8	94.6	92.5	124.0
– Financial	46.7	36.9	43.6	44.0	31.7
– Mortgage	-3.6	-6.2	-5.5	-4.1	-9.6
House price	1.000	1.000	1.000	1.000	1.000
Price-to-rent ratio	18.38	18.38	18.38	18.38	18.38
Rationing prob π (%)	1.28	1.28	1.28	0	0
ΔGov't BC (per HH)	–	-0.328	-0.066	+0.086	-0.426
–ΔRETT Rev	–	-0.265	0.025	0.022	-0.261
–ΔIncTax Rev	–	-0.084	-0.097	-0.021	-0.250
–ΔSocHous Subs	–	-0.021	-0.006	-0.085	-0.085
ΔDemand (in %)	–	2.86	1.13	-0.68	2.89
–Income Q1	–	3.97	1.25	-1.12	3.22
–Income Q2	–	3.65	1.82	-1.21	3.60
–Income Q3	–	2.89	1.30	-0.95	2.46
–Income Q4	–	2.07	0.82	-0.54	2.13
–Income Q5	–	2.43	0.73	-0.02	3.23

NOTE: All monetary values in thousand euros.

Homeownership Rates by Wealth Decile

Differences in homeownership rates across European countries are largely accounted for by the bottom and middle deciles of the wealth distribution (see Kaas et al., 2019). In Figure 4 we show how the four counterfactual experiments affect the homeownership rate across deciles of the wealth distribution. None of the policy changes has a sizable effect on homeownership rates in the bottom three deciles of the wealth distribution, but quite significant effects for households in the middle deciles. In particular, the combined effect of all policy changes raises the homeownership rates in the middle deciles by more than 60 percentage points.

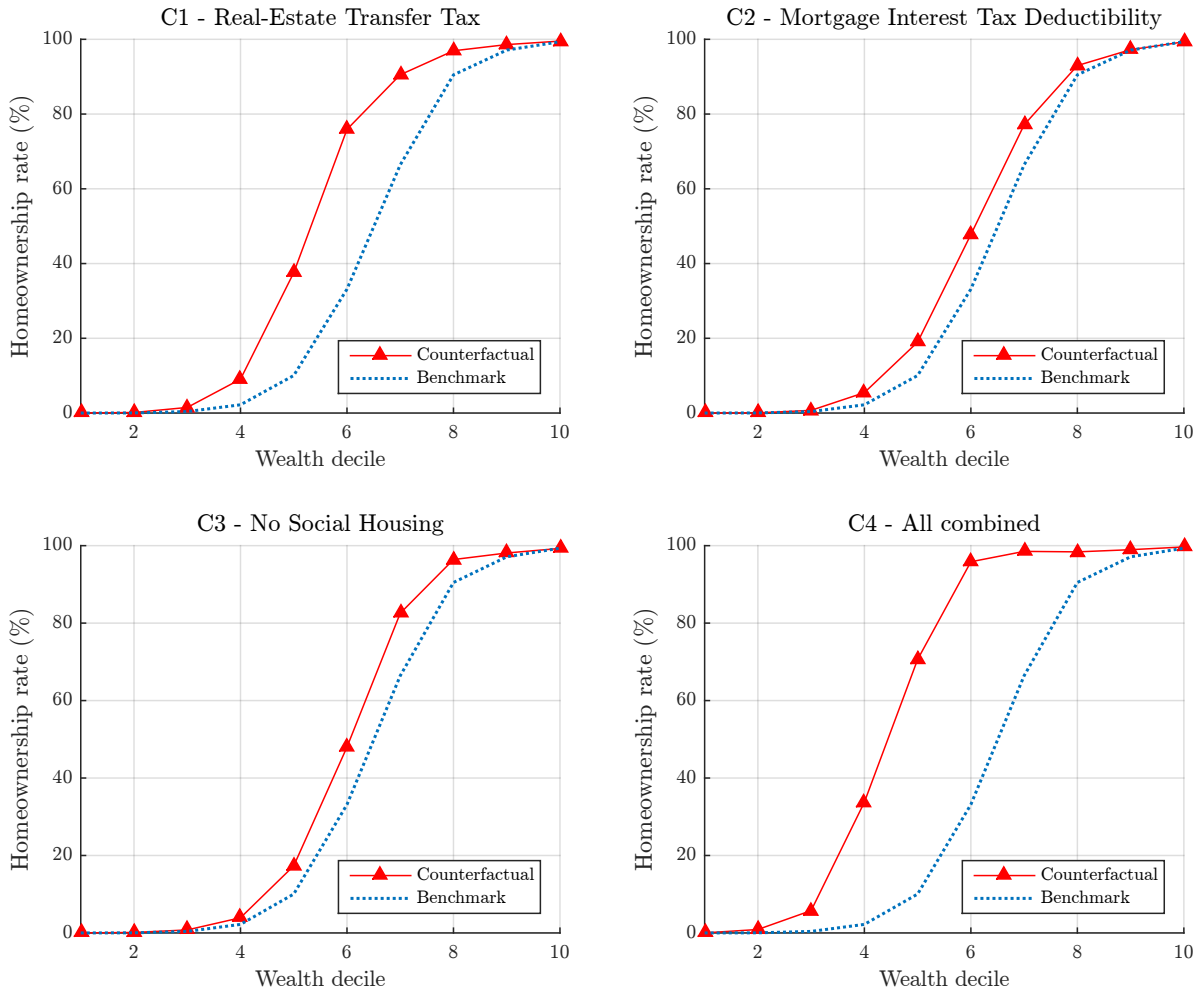

Figure 4: Homeownership rate by wealth decile in counterfactual experiments (for working-age households).

Discussion

Our analysis suggests that housing policies can play an important role for explaining the gap in the homeownership rates between Germany and the U.S. In Appendix C we survey housing policies for a broader set of countries and argue that differences in these policies are qualitatively consistent with the observed variation in homeownership rates.

Clearly, there are many other differences between countries that might affect homeownership rates. In what follows, we discuss the effects of differences with regard to income risk and house price risk between Germany and the U.S. That is, we take our benchmark calibration and change the idiosyncratic income and house price processes and let prices adjust in equilibrium.

Specifically, we estimate the labor income process and the tax schedule for the U.S. using Panel Study of Income Dynamics (PSID) data and the parameters of the U.S. public pension system following the same procedure as for the German data (see Appendix A). We then rescale labor income levels to match the mean of the benchmark economy. We find that income risk in the U.S. is higher (the standard deviation of labor income goes up by 22%) and pensions are lower. Turning to house price risk, we estimate the U.S. parameters again from PSID data using the same procedure as for the German data (see Appendix A). The idiosyncratic house value risk that we measure for the U.S. is slightly lower than the one in Germany.

Implementing these changes within our benchmark calibration and letting the house price adjust results in an increase in the homeownership rate to 51.1%. Homeownership over the life cycle increases the most for the youngest and the oldest age group. The average wealth increases to 168,000 Euros. The much lower upper cap on public pensions in the U.S. (half of the German value) induces larger savings which are partly invested in housing. Somewhat lower house price risk additionally implies that more households prefer homeownership.

6 Welfare and Policy

In this section we (i) analyze the welfare consequences of the three housing policies we consider in the previous section, and, (ii) discuss an alternative housing market policy which is targeted to low-income households.

In our model housing policies affect welfare both through insurance and efficiency aspects of homeownership. First, households face uninsurable income and housing market risks and are bound by borrowing constraints. Generally, changes in housing policies may attenuate or aggravate the exposure to such risks. Moreover, homeownership provides utility gains (for retirees in our model) and it has monitoring cost advantages, but it also entails transaction costs. At the same time, borrowing constraints prevent some households from realizing the gains from homeownership. Policies that foster homeownership (such as a lower RETT or mortgage-interest deduction) help households to become owners and thereby tend to increase their welfare. Next to such direct effects, however, each policy also has indirect consequences: The government needs to adjust income taxes to balance its budget, and prices, rents and housing supply adjust in general equilibrium. In the

following analysis we disentangle these direct and indirect effects of the policy experiments. It turns out that the direct gains that possibly motivate these policies can be partly or fully reversed by indirect equilibrium effects.

6.1 Welfare Implications of the Policy Reforms

We evaluate welfare in terms of percentage consumption equivalence to the benchmark economy of a newborn after drawing the first income realization. In this way, we can discuss the welfare consequences of the housing policies for households entering the economy in different segments of the income distribution. While the emphasis of our welfare analysis is on long-term outcomes (steady-state comparisons), we also examine the impact of policy changes for existing households along the transition path in order to identify the winners and losers of housing policy reforms.

In each of the four cases C1–C4, we look at several versions of the counterfactual economies. First, we compute the welfare results for the partial equilibrium with fixed prices and the same taxes as in the benchmark. Second, we allow for house prices and rents to adjust in equilibrium, keeping taxes fixed. Finally, we look at fiscally neutral versions of the experiments where prices *and* taxes adjust. The results are presented in Figure 5.

Reducing the RETT to U.S. levels (C1) without adjusting prices and taxes leads to an increase in welfare of around 1.1-2.0% across all entering income groups because households face lower transaction costs when buying or selling a home. Additionally, more households realize the utility and cost gains from homeownership mentioned at the beginning of this section. When the house price and rents are allowed to increase in equilibrium, this positive direct effect is diminished by more than 50%. Once taxes adjust to account for the lost revenue, the welfare consequences from reducing the transfer tax become negative for newborn households in all income groups with average losses of around 0.5% in consumption equivalence terms.

To gain a better understanding of the sources behind the welfare loss generated by the RETT reduction, we look at a partial-equilibrium variant of experiment C1. There, we replace the lost RETT revenue by higher income taxes but leave prices unchanged. Effectively, this policy experiment replaces a distortionary tax (RETT) by higher income taxes which are non-distortionary in our model. We find that this policy adjustment itself, perhaps unsurprisingly, leads to average welfare gains (cf. Figure 11 in Appendix B). Across initial income deciles, all newborn households

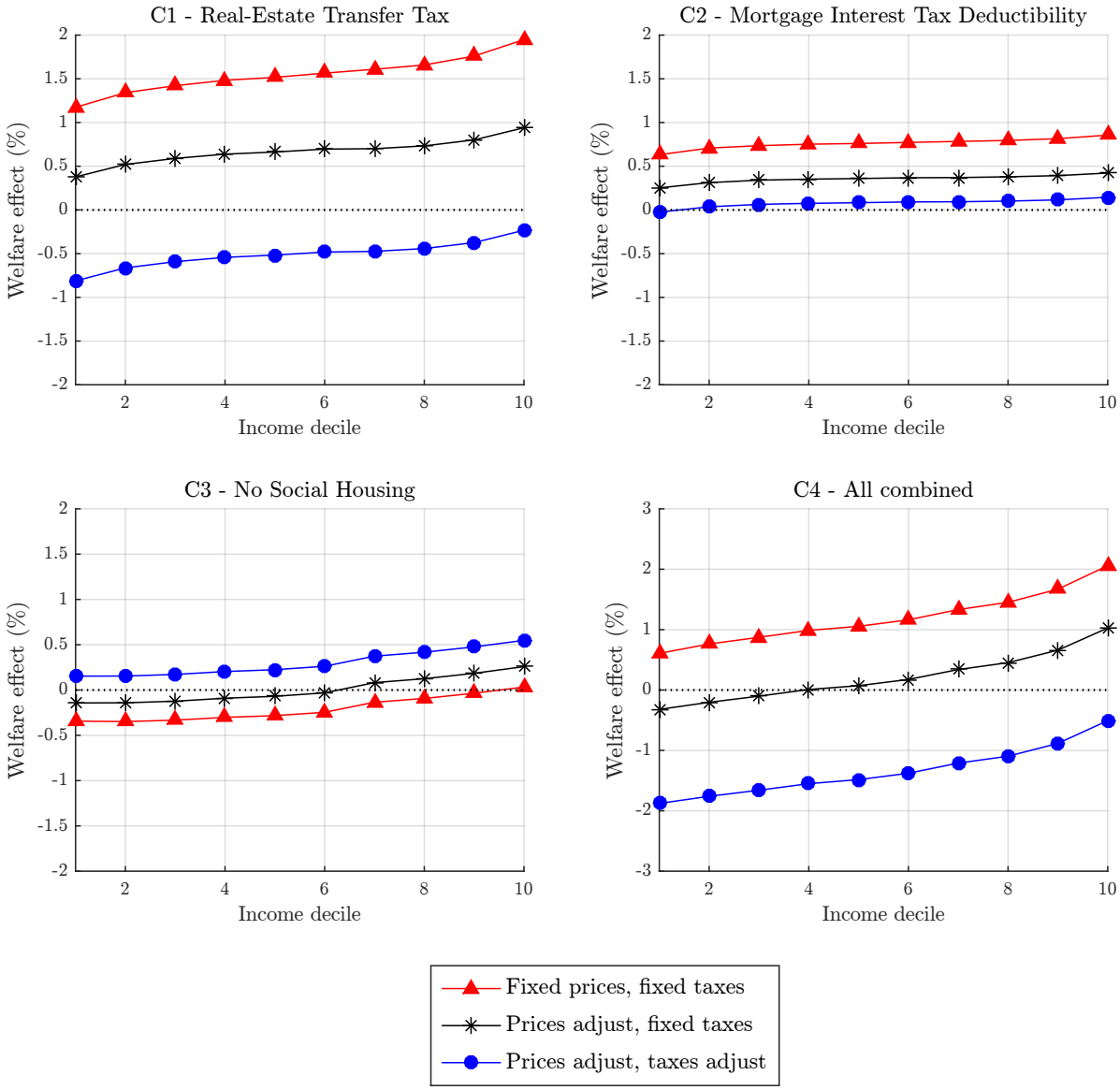

Figure 5: Welfare effects by income decile for counterfactual experiments (in consumption equivalent variations)

benefit from lower RETT (despite higher income taxes) with the exception of newborn households in the lowest decile who are least likely to become homeowners and to benefit from the RETT reduction. Therefore, it is the general-equilibrium increase of house prices and rents which ultimately hurts households.[39] Here again the poorest households lose most: They must pay a higher

[39]The increase of the house price in our model is smaller than extrapolations of empirical studies on the price impact of RETT variations in Germany would suggest. Koetter et al. (2019) obtain a semi-elasticity of -1.2 (i.e. a one percentage point increase of RETT induces a 1.2% decline of house prices), whereas our semi-elasticity is -0.55 (based on the experiment without income tax adjustments, cf. Table 13). The implied semi-elasticities of Petkova and Weichenrieder (2017) are somewhat larger.

rent (unless they are lucky enough to enter social housing) and they are least likely to become owners. It is worth mentioning that this negative welfare result is not driven by our modeling and calibration of house price and rental risk.[40] Other changes of our model may well lead to different welfare conclusions. For instance, the price effect would be smaller when housing supply is more elastic, as it is in the U.S. Further, we are assuming that homeowners can costlessly downsize their home by renting out space. If such adjustments are inhibited, the welfare costs of the RETT would be larger, so that its reduction may be more beneficial than it is in our model.

The full deduction of mortgage interest payments (C2) has comparable welfare consequences to C1, although on a smaller scale. While the partial-equilibrium welfare effect is positive, it becomes virtually zero when price and income tax changes are taken into account. Indeed, a simple back-of-the-envelope calculation shows that the house price increase alone offsets the average gains from the tax subsidy.[41] Similar to experiment C1, households who enter the economy with lower incomes lose more (or gain less) than their richer counterparts. The explanation is that lower-income young households are less likely to become homeowners later in life and hence benefit less from the introduction of mortgage interest tax deductions. At the same time, they also pay higher income taxes and they suffer from higher rents in general equilibrium.

The welfare effects of abolishing social housing (C3) are quite different. The partial-equilibrium welfare impact is negative for almost all entering income groups, due to the loss of the option of a low and risk-free rent in social housing. Once the house price is allowed to decrease in equilibrium, entrants in the top four income deciles start to benefit. Further, the reduction of income taxes due to the saved social housing subsidies make all newborn households winners of this policy with an average welfare gain of 0.3%. The gains are larger for households entering the economy in higher income deciles who are more likely to become homeowners (and thus to buy at a lower house price) and less likely to benefit from social housing subsidies.

The combination of all three policies (C4) decreases welfare when house prices and taxes are adjusted in equilibrium. Households entering the economy at the bottom end of the income dis-

[40] In an earlier version of this paper without housing market risk, we also found an overall negative welfare effect of a RETT reduction which was induced by an increase of prices and rents.

[41] In the model, mortgage deductibility costs the government 19 euros per household per year (cf. Table 3). At the same time, every year 1.17% of households are new homebuyers, buying a home which costs on average 202,000 euros before the policy change. As the house price increases by 0.8%, the total extra expenditures of new homebuyers per year and per household are $0.008 \cdot 0.0117 \cdot 202,000 = 18.91$ euros.

tribution face a welfare loss comparable to a consumption decrease of about 2% while the richest entrants lose around 0.5%.

Welfare Effects During the Transition

The welfare analysis above applies to long-term situations where the economy has fully adjusted to a new stationary equilibrium. Policy experiments C1, C2 and C4 bring about an increase of house prices and therefore a larger housing stock in steady state. The buildup of this housing stock may require a consumption sacrifice for the generations alive during the transition period. To measure the welfare impact on these households, we consider the transitional dynamics in response to the four policy experiments of interest. Note that there are peculiar differences between these experiments: While the tax policy changes (C1 and C2) are effective immediately, the elimination of the social-housing construction subsidy only slowly lowers the stock of social housing, as tenants can still live in their units until they lose their social housing status. See Appendix D for a detailed description of the computational procedure.

In Figure 6 we show the dynamics of the homeownership rate following the policy change. The figure indicates quite a fast transition to the steady state for counterfactuals C1 and C2 and a much more gradual change for C3.[42]

The welfare effects for households alive at the time of the policy change largely confirm our steady-state results. Table 5 shows that a large majority of households lose from C1 and C2 and most households gain from C3. Comparing different age groups, the results are more nuanced. While in C1 and C3 the different age groups (with the exception of retirees) are similarly affected, welfare losses associated with C2 accrue mostly to the older age groups, whereas the youngest households gain. The latter observation is in line with the steady-state results which showed positive (albeit small) welfare gains of an MID policy for future generations. Intuitively, younger (and unborn) households gain from the option of having lower mortgage costs in spite of the house price increase. On the other hand, older households alive at the time of the reform do not have large mortgages but need to pay higher income taxes (due to fiscal neutrality) or face higher rental costs (due to the house price increase).

[42]Interestingly, in their analysis of a RETT policy reform in the U.K., Best and Kleven (2017) find a large positive and immediate response in the number of house transactions.

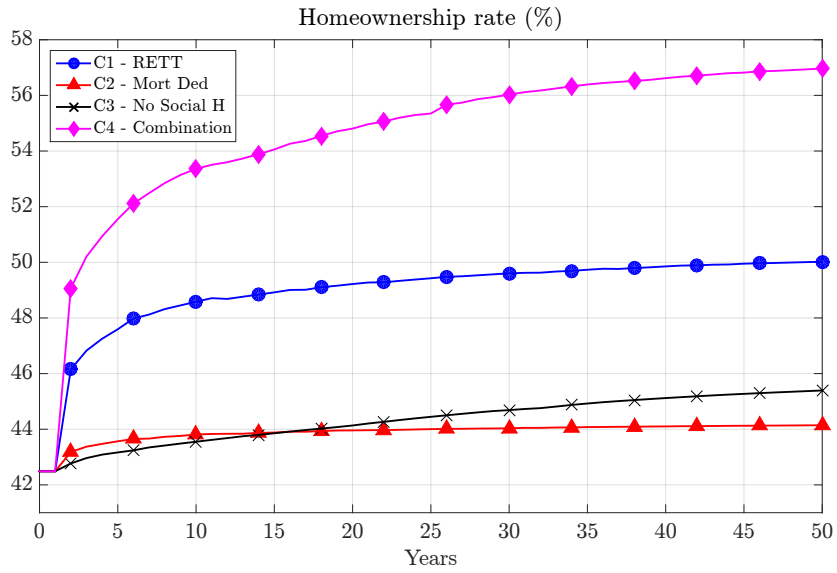

Figure 6: Homeownership rate along the transition path

Table 5: Welfare effects for the population alive at the time of the reform

	RETT C1	Mort Ded C2	No Social H C3	Combination C4
Fraction of winners (%)	15.9	27.0	88.8	17.7
– 25-34 years	17.5	99.4	82.1	20.9
– 35-44 years	22.9	51.2	84.9	31.1
– 45-54 years	20.1	8.0	82.9	27.2
– 55-64 years	21.6	2.9	90.7	19.0
– 65+ years	6.7	0.3	96.2	4.1
Average welfare effect† (%)	-0.56	-0.16	0.22	-0.59

NOTES: Fraction of households who benefit from the reform and average welfare effect for the population alive at the time of the reform. † In consumption equivalent variations.

Despite the welfare gains associated with the abolition of social housing (C3), the full reform package (C4) would bring about average welfare losses for all cohorts alive at the time of the policy change. However, the losses are still smaller (0.59%) on average than those for newborn households in the long-run stationary equilibrium (1.3%).

6.2 Targeted Housing Subsidy

Our results suggest that conventional policies of low transaction taxes and mortgage interest tax deductions would raise the homeownership rate in Germany, but would not bring about welfare gains for households, especially at the bottom end of the income distribution. On the other hand,

abolishing social housing improves welfare for all newborns, with the largest welfare gains accruing to high-income households. The main reason for the negative effect of social housing is that households dislike higher house prices and market rents which, in turn, are due to a larger demand of households with access to subsidized units. Additionally, higher-income households pay a larger share of the extra income tax revenue required to finance the government's construction subsidies. Regarding its role as a redistributive policy, an important drawback of social housing is that it is not exclusively targeted to the lowest income groups and that its access is rationed with a random lottery scheme.

Triggered by a recent sharp increase in rental rates and a housing shortage in metropolitan areas, there is a recent debate on how to reform social housing in Germany (see e.g. Breyer and Krebs, 2018). In the following we explore one of the proposals which replaces the current system of social housing in Germany by a housing subsidy for low-income households.[43] In particular, we implement a policy which abolishes social housing (as in C3) in combination with targeted housing subsidies which are paid to all households (both owners and renters) in the lowest two income deciles, proportional to their (imputed) rental expenditures. The percentage rate of the subsidy is set so that government spending on this subsidy is equal to social housing spending in the benchmark.[44]

We look at a fiscally neutral version of the experiment with fully adjusted house prices. Detailed results are presented in Table 6 and welfare results are shown in Figure 7, again differentiated by the income decile of households upon entering the economy.

Providing housing subsidies to poor households instead of social housing leads to a homeownership rate of 46.1%. The increase relative to the benchmark is partly driven by a decline of the house price which is induced by lower housing demand from middle-income households. More housing transactions further bring about an increase of RETT revenues which allows the government to cut income taxes.

[43] Germany already operates a social program of housing subsidies (*Wohngeld*). The entitlement to the program depends on income and household size. In 2004, around 9% of German households benefited from the program; however, subsequently, recipients of social benefits (Hartz IV) were excluded from this program so that *Wohngeld* spending dropped by more than two thirds. This program enters implicitly in the estimated tax functions that we use in the model. In our policy experiment, we consider a substantial expansion of the existing housing subsidy programs.

[44] We do not claim that this type of in-kind benefit should be part of an optimal policy mix. Our model with exogenous labor income is not suited to study optimal tax-transfer schemes.

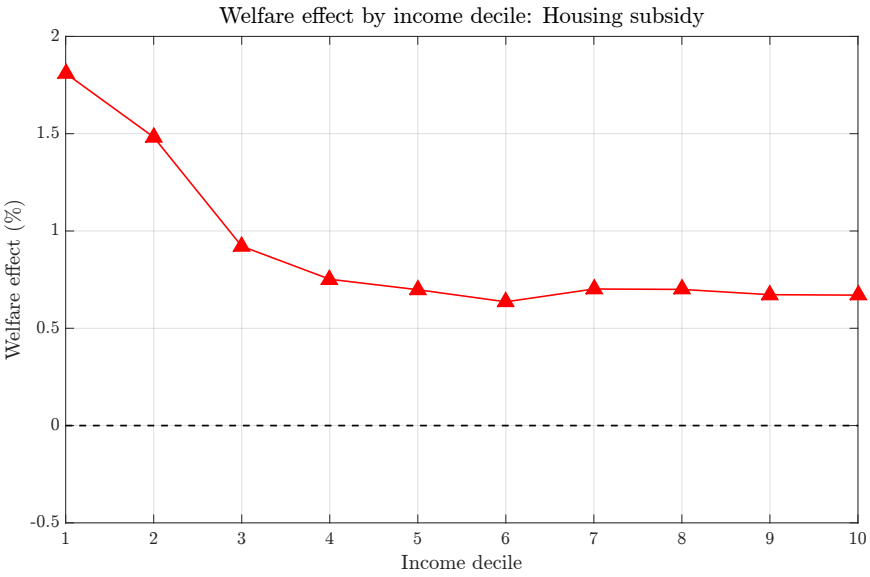

Figure 7: Welfare effects by income decile

Table 6: Housing subsidy

	Benchmark	Housing subsidy
Homeownership (%)	42.5	46.1
– 25-34 yrs	13.2	15.0
– 35-44 yrs	33.0	36.5
– 45-54 yrs	52.7	57.5
– 55-64 yrs	61.2	66.2
– 65+ yrs	47.4	50.6
Total wealth	128.7	132.1
– Housing	85.7	92.4
– Financial	46.6	43.9
– Mortgage	-3.6	-4.1
House price	1.000	0.998
Price-to-rent ratio	18.38	18.36

NOTE: All monetary values in thousand euros.

The policy delivers average welfare gains of around 0.9% in terms of consumption equivalence. Welfare gains are particularly large (1.5-1.8%) for households entering the economy in the lowest two deciles.

While the price decrease of the policy is one reason for the welfare gain, housing subsidies also provide better insurance as they are given both to homeowners and to renters and are not subject to stochastic rationing.

Interestingly, targeted housing subsidies even benefit households who enter the economy in the

upper deciles. These households would rather choose this policy than fully abolishing social housing without further redistribution (experiment C3), see the comparison of welfare gains in Figures 5 and 7. Even though C3 brings about larger tax cuts and lower house prices, rich entrants also value the additional insurance of housing subsidies because of the income mobility they face.[45]

7 Conclusions

In this paper, we examine the institutional reasons behind Germany's low homeownership rate. For this purpose we build a quantitative macroeconomic model with overlapping generations who face uninsurable income and housing risks and who decide about consumption of goods and housing services and about savings in terms of liquid financial assets and illiquid housing wealth. Our model incorporates a social housing sector and specific tax policies which are also relevant features of housing markets in other European countries.

German tax policies which disadvantages homeowners, such as real-estate transfer taxes and an income tax law without mortgage interest deductions, explain a large fraction of the homeownership rate gap to countries like the U.S. where the homeownership rate is more than 20 percentage points higher. Changing these tax policies does not lead to welfare gains, however. This is because higher income taxes are required to balance the government budget and because house prices and rents increase in response to stronger housing demand.

A further important determinant of low homeownership is the provision of social housing to renter households who are more likely to enter such housing units when they have low income but who may continue to pay a subsidized rent even when income goes up. Abolishing social housing not only raises the homeownership rate, but also brings about long-run welfare gains for all households entering the economy in different income deciles. Our results indicate that welfare gains are even larger, and especially more targeted towards lower-income households, when social housing is replaced by housing subsidies paid to lower-income households.

Our findings are based on a specific model of the housing market which necessarily abstracts from many interesting features. By assuming that housing can be consumed in arbitrarily small units at the going market prices, we do not capture differences in match quality that are likely to

[45] Our analysis ignores a potentially beneficial aspect of social housing coming from a reduction of social segregation across neighborhoods. Note, however, that subsidies can also be adapted to local rents to facilitate social mixing.

be larger when transaction costs are higher. In such situations, the welfare gains of a lower RETT might be larger than in our model. We also abstract from any spatial dimension of the housing market. When rents and house prices differ across regions, poorer households will find it harder to buy a home in a more expensive city, given that there is a minimum house size for owning. Understanding the implications of these aspects for homeownership choices and for the effects of housing policy should be important for future research.

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