Housing Policy, Homeownership, and Inequality

Simone Cima and Joseph Kopecky

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Simone Cima† Joseph Kopecky‡

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Abstract

Policymakers are reckoning with widening disparities in income and wealth. Perhaps no set of policies have the potential impact the distribution of wealth than those that affect home ownership. In most countries, wealth held by all but the top of the distribution is predominantly housing wealth. Many governments have undertaken measures aimed at helping lower to middle-income households to get on the housing ladder. However, the housing market is very complicated, and such policies could end up hurting households through different channels. We aim to provide guidance on the relative impact of various housing policies and macroeconomic conditions on inequality. To do this we build a life-cycle model where households endogenously choose between buying and renting houses. In this framework we quantify how distributions of income, wealth and consumption, as well as homeownership rates, are affected by a wide range of housing policies or features, specifically: borrower-based macroprudential limits, the presence of institutional investors, taxation of rental income, and measures targeted at the construction sector. We find that all of these policies, and the interactions between them, can lead to substantial movements in inequality and homeownership rates, with supply-side policies being the most impactful. This paper also provides a solid modelling framework for future analysis in this area.

JEL classification codes: E21, G51, R21, R28, R31

Keywords: Housing policy, Macroprudential policy, Wealth inequality, Housing

⋆Disclaimer: all views expressed in this presentation are exclusively our own and do not necessarily represent the views of the Central Bank of Ireland or the Eurosystem.

†Central Bank of Ireland; Department of Economics, Trinity College, Dublin (cimas@tcd.ie).

‡Department of Economics, Trinity College, Dublin (jkopecky@tcd.ie).

1. Introduction

For the majority of people, wealth is housing wealth. Housing is simultaneously one of the most important goods consumed by individuals, while also dominating most households' asset portfolios. For this reason, Government policy that alters the distribution of homeownership, or its price relative to renting, either by design or indirectly, will also carry implications for the distributions of household wealth and welfare. These policies can for instance operate by altering relative prices of housing and rental properties, and by altering the availability of financing across agents. While some policies are created with distributional objectives, hoping to improve welfare of one group relative to another, others can have other objectives, such as serving critical functions in financial and macroeconomic stability.

In this paper, we quantitatively estimate the impact of various policy measures in a heterogeneous agent life-cycle model with endogenous selection into homeownership. This setting allows us to estimate the consequences of a wide range of factors that affect the distribution of homeownership, income, wealth, and consumption. In particular, we study changes in: interest rates, supply side constraints, taxation on rental income, macroprudential credit constraints, and the presence of institutional investors. Some of these factors, such as the presence of institutional investors, are not policies per se, but are an important factor in the housing market, that can be affected by legislation. Others, such as macroprudential credit regulations, are policies whose benefit are difficult to capture in our experiment, but have large potential implications for the allocation of credit across the distribution. We therefore emphasise that the distributional consequences of a particular policy should be taken as a partial story, and in the case of critical stability tools, may be a necessary reality that should be taken into consideration when sculpting related housing policy. We explore a number of combinations of policies, credit, and supply environments in tandem to understand whether negative distributional consequences of one might be offset by another.

Two papers that take a similar approach to understanding the role of housing policy are: Alpanda and Zubairy (2016) and Alpanda and Zubairy (2017). Both investigate the role that a set of government policies play in housing markets using general equilibrium models featuring three household types: savers, borrowers, and renters. Alpanda and Zubairy (2016) focuses on fiscal tax policies directed at housing and their output implications.[1] Using the same model, Alpanda and Zubairy (2017) instead focus on monetary and macroprudential policies and their implications for household indebtedness in conjunction with fiscal policies such as property taxes and mortgage interest deductibility. Importantly for our work, they find that there are differential effects across the three groups studied, discussing the potential redistributive natures of these policies. Our model expands on this heterogeneity by making the entrance of agents into the housing market endogenous, allowing for a more credible study of the nature of such redistribution.

The distributional impacts of macroeconomic policy more broadly are a growing concern. A

[1] Specifically they find large negative output implications for raising tax revenue through housing policy, with a long-run multiplier of around 2.

large literature has grown from work such as Doepke, Schneider, and Selezneva (Doepke et al.) that explores the role that traditional monetary policy instruments have on distributions of wealth. Traditional policy operates through wealth channels as inflation alters the real value of assets, redistributing wealth among net borrowers and lenders in the economy. Their work and others[2] also investigate the role of *unconventional* monetary policy tools such as quantitative easing. Quantitative easing alters interest rates and credit availability, similarly redistributing wealth across these groups. Relevant to our question, La Cava and He (2021) show that conventional interest rate policy may have distributional consequences that operate through local housing markets due to the greater sensitivity of high price localities to these interest rate shocks. Recent work by Amberg, Jansson, Klein, and Picco (2022) identifies five potential channels for traditional policy highlighting a number of potential channels, and provides a recent and useful overview of these potential mechanisms.

In addition to conventional housing policies we also study *macroprudential* policy. These have distributional effects because not only is housing a larger component of wealth among lower and middle class households than at the top of the distribution,[3] but common borrower-based macroprudential measures (BBMs) in the form of loan-to-income (LTI) and loan-to-value (LTV) ratios explicitly create barriers tied to existing income and wealth. Moreover, rental properties are an important source of income for those at the top of the distribution while serving as a large expense for the bottom, and any impact of credit availability on relative prices of bought and rented housing can alter both the income and consumption inequality across these groups. For this reason, we study the role of a range of policies and macroeconomic conditions across loose and tight credit regimes, and how these affect inequality, acknowledging that such regimes may serve important roles in improving welfare through financial stabilisation.

The aftermath of the Global Financial Crisis saw an explosion of macroeconomic research on the role of housing in the macroeconomy. Largely, this literature focused on cyclical debt dynamics and the outsized role that housing markets can play in financial booms and busts. These papers use heterogeneous agent models and study the role that credit constraints play on macroeconomic stability and the housing market. In doing so, Kaplan, Mitman, and Violante (2020) find weak evidence for the transmission of credit constraints to house prices, while Greenwald and Guren (2021) suggest a more important link between the two. Both the level of housing costs and the relative cost of buying a house vs renting matter for the distributional impacts that we study. Our choice of modelling housing supply through a stylised construction sector will pin down the price of housing in a way similar to Kaplan et al. (2020), but allowing for endogenous choice to fulfil housing needs via ownership or renting will allow policies to affect the *relative* cost of renting and housing. We build from this literature, using similar modelling tools to address distributional outcomes. In Greenwald and Guren (2021), the key determinant of the price-rent ratio's response to credit is the response of supply both through the construction sector, as well as an important "tenure supply"

[2]See, for example: Hohberger, Priftis, and Vogel (2020), and Davtyan (2017)

[3]For an empirical exploration of this and other stylised facts across OECD countries, see Causa, Woloszko, and Leite (2019).

channel, in which landlords supply owner versus rented housing stock. This means that in the presence of highly segmented rental and ownership markets, credit conditions may have quite large impacts on house prices.

In quite complementary recent work to ours, Castellanos, Paz-Pardo, and Hannon (2024) show that landlord entry and exit can additionally create a channel for credit conditions to alter home prices and therefore inequality as rising rent/price ratios push more poor young households into rental markets while benefiting older and richer households. Like Castellanos et al. (2024), we show that credit constraints tend to decrease homeownership rates, and like them we show that this also tends to increase inequality in both consumption and income, operating largely through an increase in the rental yield relative to house prices. Studying these policies while increasing the supply of housing[4] actually can further reduce homeownership rates, with the excess supply bought by high income landlords, but this in turn substantially lowers inequality of consumption due to much lower rental costs for the (poorer) renters.

Indeed, we find many combinations of policies and credit conditions that may increase inequality in terms of homeownership while reducing inequality in consumption, and by association the welfare of the bottom of the distribution relative to the top. While a host of policies aimed at improving homeownership exist, there is little work that quantifies their distributional impact. The value of heterogeneous agent modelling is that it allows us to understand the distributional role that policies play through transferring income from one group to another largely through changes in relative prices of these different classes of housing. In an investigation of Britain's help-to-buy scheme, Carozzi, Hilber, and Yu (2024) show that such policies largely work to increase prices and improve the financial performance of developers without helping buyers enter the housing market.

Dustmann, Fitzenberger, and Zimmermann (2022) show that income inequality is amplified when looking at income post housing expenditure. Their work documents this trend in Germany over the last three decades, showing that relative cost of ownership to rentals have driven a large share of this difference. Their work shows for housing a phenomenon, documented by Kaplan and Schulhofer-Wohl (2017), of lower income households experiencing higher inflation in the basket of goods they consume. Christophers (2021) discusses the need to understand how inequality in housing tenure, i.e. between renters and buyers, explains trends in housing wealth inequality. Work such as Bartels and Schröder (2020) show that in Germany from 2002-2017 a large contribution to increases in income inequality has been that of rental income. This is consistent with the role that rental markets play in Kindermann and Kohls (2018), who use the ECB's *Household Finance and Consumption Survey* to study the role of *wedges* in rental markets[5] in determining wealth inequality. A broad read of the literature on inequality across housing, income, wealth, and consumption

[4]As we explain in detail below, we consider either productivity of the construction sector or the availability of land permits as a proxy for government supply-side housing policies.

[5]In their life-cycle model this wedge is akin to an iceberg trade cost where only a fraction of the housing units that landlords supply arrive at the potential tenant; this is a stand in for what they call "institutional frameworks" that affect rental markets, but could also stand in for policies that make renting the same housing unit relatively more expensive.

ultimately points to consistent, but complex relationships between these. For this reason, we are interested in all four of these forms of inequality. From a welfare perspective, consumption might be the most salient, but undoubtedly policymakers are interested in housing inequality in itself, together with its relationship to income and wealth distributions. It is important to know how trade-offs between different types of inequality may arise; we see a few examples of this play out in our results.

Causa et al. (2019) show that there is a strong negative correlation between homeownership and wealth inequality in OECD countries. Removing housing from wealth increases Gini coefficients among these countries on average by about one-quarter, suggesting that any policies that reduce rates of homeownership could be a channel for increased wealth inequality. Existing empirical work shows that macroprudential rules have the potential to have distributional consequences. Georgescu and Martín (2021) use survey data on housing and consumption within the euro area to show that LTV credit limits and debt-service-to-income limits moderately increase wealth inequality. Their work attempts to simulate both the negative impact caused by constraining households, as well as the positive effects of reducing the probability of financial crises. In an agent-based model, Tarne, Bezemer, and Theobald (2022) show how it is critical to differentiate between which agents are affected by these credit restrictions. Restrictions on *buy-to-let* investors can have positive effects on equality while such restrictions on first-time buyers works in the opposite direction. Acharya, Bergant, Crosignani, Eisert, and McCann (2020) study the effects of LTI and LTV limits and find that mortgage credit is reallocated from low income to high income borrowers, with spacial effects from urban to rural counties. This relieves price pressure in "hot" markets. The banks reallocate their portfolio to take more risks in other securities and corporate credit. In the Irish mortgage market, which serves as a useful environment to study these rules, Kinghan, McCarthy, and O'Toole (2019) find that the introduction of BBMs induced wealthy borrowers to increase their down-payments, while poorer households tended to shift toward lower value housing stock. At present our work finds little impact on wealth inequality itself, which moves little in part due to financial market participation being counterfactually high,[6] however we do find substantial decreases in homeownership and increases in other forms of inequality.

A small, but growing, literature has studied the impact of macroprudential regulation on inequality in the context of quantitative life-cycle models, seeking to estimate the welfare cost of these policies. Mavropoulos and Xiong (2019) use panel data and a structural life-cycle housing choice model to show that BBMs worked to limit home-ownership and wealth accumulation in the post crisis era in Europe. Interestingly, while they find large decreases in wealth accumulation due to the policy, they are welfare improving due to decreases in risk. Rubio and Carrasco-Gallego (2014) do a welfare analysis of LTV ratios in a DSGE model. Their model includes two agent *types*

[6]Extensions of our model that limit the ability of households to accumulate non-housing wealth by including, for example, costs of accessing financial markets might help connect our results more closely to the literature and data on the connection between housing wealth and inequality. In the present form we have avoided adding an additional layer of *ad hoc* heterogeneity to keep from muddying our understanding of the model results.

representing borrowers and savers, with LTV tightening harming borrowers while benefiting savers. Work such as Mavropoulos and Xiong (2019) finds that macroprudential policy improves welfare on net, driven largely by the well documented positive effects of macroprudential effects on housing risk, which enter into their partial equilibrium framework exogenously and affect preferences of households directly through the reduction in foreclosure risk. While this seems reasonable, it simplifies the boom-bust cycle that is documented in Kaplan et al. (2020) and others.

Our work contributes to this literature by quantifying the effects of borrower-based macroprudential measures on the distributions of (housing and total) wealth, income and consumption. Because we are able to provide insights into the mechanisms that drive this effect, we are also able to provide insight into the potential policy options available to offset these distortions. We find that tightening loan-to-income ratios substantially reduces homeownership by the bottom 50% of the wealth distribution, having a smaller but still sizeable impact on their share of overall wealth. Gini coefficients for wealth, housing, income, and consumption all increase with such credit constraints.

We also explore the distributional consequences of a few other policies that have received less attention in the literature, and find compelling results. We highlight especially how supply can greatly alleviate or aggravate inequality caused by other policies or features of the housing market. Our treatment of the construction sector is relatively simple, but we are still able to capture the overall effect of policies that support the expansion of housing supply, such as increases in land permits or an improvement in the planning process. These lead to lower house prices overall, and as we will show below, these lower prices also come with lower rental yields and thus much lower post-housing income inequality. Perhaps counter-intuitively, a decrease in house prices does not always lead to increased homeownership, as there are rent levels low enough at which some households can decide that they are better off renting; nevertheless, welfare and consumption are always significantly more equal when house prices are lower, and for this housing supply is fundamental.

Tax policies can also have large effects on how income is redistributed between renters and landlords. In the case of rental income tax, we note how, by creating a wedge between the rent paid by renters, and the net income received by landlords, such a tax is harmful for both categories (with only owner-occupiers unaffected by it). Within our model, we quantify that the burden of the tax actually falls mostly on renters, whose rental payments rise due to the tax much more than landlords' net returns fall. Renters being also much poorer than landlords to begin with, they are hit even more relative to their income. These dynamics would thus paradoxically make a tax levied on landlords highly unequal and unfair on tenants.

The inclusion of foreign institutional investors to our baseline model greatly changes the dynamics of the housing market. By essentially competing against each other as well as the domestic landlord households for rental investment properties, they can lead to significantly lower rental yields. This is great news for tenants, who enjoy higher disposable income and consumption, but bad for domestic landlords. Needless to say, inequality in the household sector decreases as a result, but at the expense of lower homeownership rates, as well as lower overall wealth (since a significant chunk of it ends up abroad). While in a number of cases the positive effects from the fall in inequality far outweigh the effect of declines in homeownership, leading to general improvements in welfare, these outcomes are however dependent on adequate regulation, ensuring these entities act competitively and do not end up 'cornering' the housing market. On the other hand, we note how rental housing provided by the Government is conceptually similar in nature to institutional investors, and while it can provide some of the same benefits, it can potentially also avoid some of the costs. Coupled with tight macroprudential policies, the presence of institutional investors can lead to even lower homeownership rates in the population.

The rest of the paper is structured as follows: Section 2 describes our modelling framework; Section 3 outlines the calibration of the relevant parameters of our model, and the solution algorithm; Section 4 discusses the results of the various simulations of the model, and Section 5 concludes.

2. Model

We construct a heterogeneous agent life-cycle model of housing choice, with a housing and rental market. Using this model, we study the distributional implications of the change or introduction of a number of policies or characteristics of the market, with the aim of evaluating their impact from a point of view of inequality. In this section, we describe the structure and main assumptions of this model.

2.1. Households

2.1.1 Demographics and Preferences

Finitely lived households survive for a maximum of 80, annual, periods, with conditional survival probability at each age, j, given by ς_j. They work for wages during the first 45 periods of life, at which point they retire. Households maximise their lifetime utility over consumption of goods and housing services given by:

$$\mathbb{E}_0 \left[\sum_{j=1}^{N} \beta^{j-1} \varsigma^{j-1} u\left(c_j, s_j, a_{j+1}\right) \right] \tag{1}$$

where β is the discount factor, c_j household consumption of non-housing goods, s_j is their consumption of housing services, and a_{j+1} is their net wealth at $t+1$. Preferences are such that the instantaneous utility function u is given by:

$$u(c,s,a) = \frac{\left[(1-\phi)c^{1-\gamma} + \phi s^{1-\gamma}\right]^{(1-\theta)/(1-\gamma)} - 1}{1-\theta} + (1-\varsigma_j)\psi(s_{t+1}, I_h) \tag{2}$$

where the first part represents the utility from consumption and housing services; the elasticity of substitution between consumption and housing services is given by $\frac{1}{\gamma}$ and the intertemporal elasticity of substitution is $\frac{1}{\theta}$. The parameter ϕ measures the taste for housing services relative to consumption goods. Households are divided into two types, which differ solely in their preference for housing. Transfers of bequests happen only between households of the same type.

The additive ψ factor represents a "warm-glow" bequest motive similar to that used in De Nardi (2004), however unlike De Nardi (2004), households derive a warm glow from bequests of housing wealth (and only from the first housing unit if any). Specifically:

$$\psi(s_{t+1}, I_h) = \psi_1 \left(1 + \frac{I_h}{\psi_2}\right)^{1-\theta} \tag{3}$$

where I_h is an indicator equal to 1 if $h > 0$. This encourages households to remain homeowners, which is useful in our case as households in the model otherwise liquidate their lumpy housing assets to smooth consumption in retirement resulting in counterfactually low levels of homeownership in older age groups.

2.1.2 Housing Services

Consumption of housing services comes in one of two broad types, ownership and renting. Denote r_h the rental rate for housing services, and p_h the price of a unit of housing purchased. Renters receive $s(h = 0) = 1$ in home services while homeowners $s(h > 0) = \omega > 1$, providing a linear premium in home ownership associated with the first house. This provides a utility incentive to own rather than rent, but only for the first house owned (i.e., owning more than one house does not provide any additional utility to the owner, only potential financial gain from rental income). We assume that homeowners occupy their first unit, $h = 1$, of housing and rent remaining units, $h > 1$ to other households.

Homeowners can purchase housing outright or through a mortgage. Mortgage holders borrow money from banks to finance the purchase of their homes and make interest payments each period. Renters pay rental payments to landlords corresponding to a fraction r_h (the rental yield) of the house price p_h. All homeowners, with mortgage or not, face costs associated with the depreciation of their home equal to $\delta_h p_h$, as well as property taxes $\tau_h p_h$ for each housing unit they own.

2.1.3 Financial Markets

Households have access to a risk free bond, b, which pays r_b one period in the future. These bonds are offered by externally-owned financial institutions, with r_b determined exogenously. Bond interest income is taxed at rate τ_k. This is the savings vehicle of households, who cannot borrow in bonds. However, they can access mortgage borrowing (also from the same external, deep-pocketed financial institutions) to finance the purchase of housing. The interest rate on mortgage loans is equal to $r_l = r_b + \kappa$, where κ is a exogenous premium earned by the financial intermediaries who provide loans and safe assets in the form of bonds.

Borrowing is limited by macroprudential lending regulation and thus subject to maximum LTI and LTV limits. Therefore a household's maximum level of borrowing is subject to the following two constraints:

$$\begin{aligned} d_j &\leq \lambda_{LTV} p_h h_j \\ d_j &\leq \lambda_{LTI} y_j \end{aligned} \tag{4}$$

Where λ_{LTV} and λ_{LTI} denote the macroprudential loan-to-value and loan-to-income ratios respectively. Further, when households apply for a mortgage they cannot exceed retirement age, and the loan needs to be below a certain fraction of their expected remaining lifetime labour income.

At each new period, households with debt need to pay r_l% of their loan as interest repayments. The loan principal can then be repaid in full, in part, or can be refinanced (subject to remaining within the macroprudential and other limits).

2.1.4 Income process

Households' labor income is given by $W_t \ell^i_{j,t}$. Where W_t is the aggregate wage and households are subject to idiosyncratic productivity shocks given by:

$$\ell^i_{j,t} = \exp(\varepsilon^i_{j,t}) N^i_{j,t} \tag{5}$$

The term $\varepsilon^i_{j,t}$ is a transitory, mean zero, shock realised in each period, while the permanent component of households' wages follows an age specific trend $n_{j,t}$ given by:

$$N^i_{j,t} = N^i_{j-1,t-1} exp(n_j) \tag{6}$$

2.2. Government

The Government taxes labor income, interest income, and property wealth, with the respective marginal tax rates being τ^ℓ, τ^k and τ^h. It may also levy a tax τ^{rh} on rental income (this is one of the policies we look at later), i.e. each rented house will generate revenue corresponding to a fraction τ^{rh} of the rental income $r_h p_h$ it generates. Government revenues are thus given by:

$$G_{Rev} = \tau^\ell W_t N^w + \tau^k B_t r^b + \tau^h p_h N_t (+\tau^{rh} r_h p_h R_D) \tag{7}$$

where W_t is total wages earned in the economy, B_t is total financial assets (excluding debt), and R_D is the total demand for rental properties i.e. the number of properties earning rental income. These revenues are partly used to fund pension income ($Tr(\ell^i_{J_R,t})$) for retirees; the individual pension income of a household is heterogeneous and depends on labor income in the final year of working life. Government transfers to individual (retired) households are thus given by:

$$Tr(\ell^i_{J_R,t}) = \gamma_{repl}\ell^i_{J_R,t} \tag{8}$$

which says that the Government provides pension income to retirees, in proportion to their final working income; γ_{repl} represents the replacement rate of pension payments relative to an agent's income during their last year of working life. Typically, the Government will spend less than its total revenues on pensions; we assume that the rest is spent on public services providing a certain level $u(g)$ of utility to all agents equally. This means that the Government runs a balanced budget, and also that $u(g)$ can be ignored as it does not influence households' utility maximisation problem.

2.3. Production

The production of final consumption goods follows a constant returns to scale production function, with labour, the only input, equal to the number of households of working age:

$$Y_t = A_t L_t \tag{9}$$

where Y_t is total output, A_t is the aggregate labour productivity, and L_t is the labour supply, which is also equal to the number of agents in working age, N_w. As a result, the aggregate wage level is equal to $W^L = Y_t/L_t$ (pre-tax), with individual wages differing as per above.

2.3.1 Construction Sector

Housing units are built by a construction sector, which produces Y_h units every year. The simulation starts with one unit of housing per capita, and to maintain this the construction sector needs to meet demand for new housing from the new population (equal to the number of newly born households minus the deceased: $n_t N_{1,t-1} - \sum_{j=1}^{J-1} \varsigma_j N_{j,t-1}$), plus maintenance of existing properties, which depreciate at rate δ_h. We assume that depreciation forces homeowners to pay for repairs costing $\delta_h p_h$ for each unit they own, leading to a demand for construction equal to $\delta_h H_s$, where H_s is the total housing supply.

Given depreciation and construction output, the housing supply changes according to the following law of motion:

$$H_{s,t} = (1 - \delta_h) H_{s,t-1} + Y_{h,t} \tag{10}$$

To keep up with population growth and depreciation (there needs to be at least one housing units for each household at all times), for an equilibrium we have the requirement that:

$$Y_h \geq n_t N_{1,t-1} - \sum_{j=1}^{J-1} (1 - \varsigma_j) N_{j,t-1} + \delta_h H_s \tag{11}$$

The production function of the competitive construction sector is Cobb-Douglas, with inputs land L, and materials M:

$$Y_h = A_h L^{\alpha} M^{(1-\alpha)} \tag{12}$$

where A_h is the productivity of the construction sector, and α is the constant share of land in production. The amount of land permits is fixed to $\bar{L}$ and determined by the Government. The price of a unit of land is p_L (determined competitively), while we set the price of materials to 1. Profit maximisation (with respect to the amount of materials) among competitive construction firms results in the following housing investment function:

$$Y_h = A_h^{(1-\alpha)}((1-\alpha)p_h)^{(1-\alpha)/\alpha}\bar{L} \tag{13}$$

with construction increasing with prices. An equilibrium between demand and supply of housing will only be reached if the supply of housing is exactly equal to the number of households N_t, i.e. at any period the construction sector should produce exactly as many units as necessary to keep up with depreciation and population growth, and no more. This is achieved if:

$$Y_h(p_h, ...) = n_t N_{1,t-1} - \sum_{j=1}^{J-1}(1-\varsigma_j)N_{j,t-1} + \delta_h H_s \tag{14}$$

where there is only one price, p_h^*, that allows for this. In other words, in a steady state, the house price is determined by the construction sector.

2.4. Institutional Investors

In a number of simulations, housing units can also be purchased by institutional investors, who are deep-pocketed entities with funding from abroad whose business model is to purchase housing to generate rental returns. Whether or not they decide to invest in the domestic housing market depends on the level of rental returns that they can achieve; in the absence of aggregate risk, the house price does not matter to them. We assume that these investors face a certain cost of investing into the local housing market. This is given by some external funding costs that they face.

If the net domestic rental return (i.e., r_h net of rental income taxes, or $(1-\tau_{rh})r_h$)[7] is greater or equal than their funding cost (denoted by r^{ii}), plus any additional costs of owning a housing unit, i.e. depreciation and property tax, then the institutional investors will demand as many housing units as are available for them to purchase, as local housing becomes profitable for them. r^{ii} depends on external factors and is set exogenously.

We assume that institutional investors are limited in the number of housing units available

[7]Note that if these investors are set up as corporations, they would pay tax on profits rather than on the rental income itself, i.e. tax would be paid after accounting for costs, and at a lower marginal rate. We abstract from this complication here but note that we also did not deduct mortgage interest payments from the rental income subject to tax in the case of households (as would be the case when calculating rental income tax) to avoid unnecessary complications. The fact that these investors may have a more favourable tax situation due to the lower tax rate on profits can instead be approximated by assuming a lower r^{ii}.

for them to purchase. Specifically, households have first access to housing units, i.e. institutional investors can only purchase any units corresponding to the difference between the housing supply H_s and the household demand for housing H_d^{hh}.[8] Therefore, the demand for housing by institutional investors, H_d^{ii}, will be:

$$H_d^{ii} = \begin{cases} 0, & \text{if } (1-\tau_{rh})r_h < r^{ii} + \delta_h + \tau_h \\ H_s - H_d^{hh}, & \text{if } (1-\tau_{rh})r_h \geq r^{ii} + \delta_h + \tau_h \text{ and } H_s > H_d^{hh} \\ 0, & \text{if } (1-\tau_{rh})r_h \geq r^{ii} + \delta_h + \tau_h \text{ and } H_s \leq H_d^{hh} \end{cases} \tag{15}$$

By demanding any excess units not demanded by households for each level of r_h greater or equal to $(r^{ii} + \delta_h + \tau_h)/(1-\tau_{rh})$ (call this r_h^{ii}) - and thus ensuring that the market for housing always clears in these cases - institutional investors effectively render r_h^{ii} the upper bound level of rental yields. In equilibrium, with institutional investors present, we have thus that:

$$r_h = r_h^{ii} = (r^{ii} + \delta_h + \tau_h)/(1-\tau_{rh}) \tag{16}$$

3. Solution and calibration

We solve for an equilibrium that consists in a set of prices (w, p_h, r_h) such that after solving their maximization problem, households' demand for housing units is equal to the supply of housing, and the demand for rental units is equal to the rental supply. At the steady-state equilibrium, prices remain constant between periods; the population, output, housing supply and wealth grow at a constant pace.

To solve the model, we simulate it on a large number of households, and run it for a sufficient number of periods to allow for convergence to a steady state.

The procedure to determine an equilibrium is as follows:

- (1) We start from an initial guess of p_h and r_h
- (2) We estimate the optimal choices of households at every possible combination of age, wealth, housing, income, and debt, at these prices. The household optimisation problem is solved by value function iteration.
- (3) Based on the starting values of p_h and r_h, and households' optimisation, we simulate the model for a large enough number of periods until a steady-state is reached.
- (4) If at the steady-state, the housing and rental markets are not in equilibrium, we update p_h and r_h accordingly and repeat the process from (1); else, we have reached the steady-state equilibrium.

[8] If this were not the case, they would either own all or none of the housing units.

The steady-state solution of the model rests in the interactions between the market for housing units, the rental market, and the construction sector. For a solution, we have that

- The demand for housing needs to be at least equal to the population ($H_d \geq N$) to allow for every household to live in a unit, either rented or owned. We do not allow for the existence of homeless households.
- For the same reason, the supply of housing also needs to be at least equal to the population ($H_s \geq N$).
- The number of extra housing units owned by landlords (and/or institutional investors if they are a feature) must be at least equal to the number of households who do not own any housing units ($R_s \geq R_d$)

Additionally, as detailed above, there is no reason for households to demand more housing units than the population, as that would create empty housing with a cost to the owner but no benefit in terms of housing services to any tenant or rental return to the landlord. Accordingly in equilibrium:

$$H_s = H_d (= H_d^{hh} + H_d^{ii}) = N$$

$$R_s = R_d$$

where the rental supply is equal to all the housing owned by households in excess of the first unit (which is occupied by the owners N_{oo}) (plus all units owned by institutional investors, if present); rental demand is equal to the number of households who are not owner-occupiers.

$$R_s = H_d^{hh} - N_{oo} (+H_d^{ii})$$

$$R_d = N - N_{oo}$$

This set of equations taken together tells us that whenever the housing market is in equilibrium (with housing supply also equal to the population), the rental market will clear as well.

3.1. Calibration

For the calibration of the parameters used in the model, we draw from the literature, or alternatively choose parameter values so as to match real-life data for Ireland; these data are derived primarily from the 2021 wave of the Household Finance and Consumption Survey (HFCS) (Household Finance and Consumption Network, 2022). Table 1 gives an overview of all the parameters used in the model, their values in the baseline model, and their source. Here we present briefly the rationale for the internally calibrated parameters.

The discount rate β, households' preferences for homeownership ω_1 and ω_2, and the luxury of housing bequests ψ_2 were calibrated jointly to achieve a homeownership rate of 70% in the baseline

Table 1: *Calibrated parameters of the baseline model.*

Parameter	Name	Value	Source/Calibration
Household utility			
Discount factor	β	0.96	Internal
Preference for home-ownership (hh type 1)	ω_1	1.60	Internal
Preference for home-ownership (hh type 2)	ω_2	1.30	Internal
Share of households of type 1		0.6	
Preference for housing w.r.t. consumption	ϕ	0.30	
Elast. of substitution, housing and cons.	$1/\gamma$	0.8	Kaplan et al. (2020)
Inter-temporal elasticity of substitution	$1/\theta$	0.5	Kaplan et al. (2020)
Altruistic motive for bequests	ψ_1	-9.5	De Nardi (2004)
Luxury of beq. of 1st home	ψ_2	10	HFCS, Internal
Average prob. of being bequest recipient	π_{beq}	0.05	
Maximum number of housing units	h_{max}	4	HFCS, Internal
Banking sector and mortgage market			
Exogenous risk-free rate on deposits	r_b	0.00	Ireland
Intermediation wedge	κ	0.02	Ireland
Loan-to-income macroprudential threshold	λ_{LTI}	6	Policy variable
Loan-to-value macroprudential threshold	λ_{LTV}	0.9	Policy variable
Construction sector			
Land permits per capita	L	$(nN_t)/10$	HFCS, Internal
Productivity of the construction sector	A_h	1.3	HFCS, Internal
Depreciation of housing stock	δ_h	0.01	Standard
Wages			
Age-earnings profile: coeff. on age	β_{age}	0.0326379	HFCS, regression
Age-earnings profile: coeff. on age squared	β_{agesq}	-0.0004863	HFCS, regression
Age-earnings profile: constant	β_{const}	9.614493	HFCS, regression
Standard error of the white noise process	σ_ϵ	0.12	
Autoregressive coefficient	λ	0.985	
Government			
Tax on labour income	τ_w	0.34	HFCS, Ireland
Tax on interest income	τ_k	0.34	Ireland
Tax on property wealth	τ_h	0.001	Ireland
Tax on rental income	τ_{rh}	0.40	Ireland
Social security replacement rate	γ_{repl}	0.50	

scenario, with consistently high homeownership for retirees, as per the data; the resulting values are 0.96 for β, 1.3 and 1.6 for ω_1 and ω_2, and 10 for ψ_2. The HFCS also suggests that only very rarely do households own more than 4 housing units, so we set h_{max} at 4.[9] We have two household types, differing by their levels of preference for housing (ω_1 and ω_2), because in real-life data the distribution of wealth appears to be bimodal, with the largest peak around 0 net wealth; in order to achieve this in the model, we need two types of households, of which one has less strong preferences for housing and is therefore less inclined to save:[10] we set the share of households with this characteristics (type 1) at 60% of the population, giving a higher peak of the bimodal distribution at a low net wealth as per the data.

The age-earning profile of labour income was determined using the following regression on HFCS data:

$$y_i = \beta_{const} + \beta_{age} * a_i + \beta_{agesq} * a_i^2 + \gamma X_i + \epsilon_i \tag{17}$$

where y_i is the household's log labour income, a_i is the age of the reporting person minus 20 (to match our model), X_i is a vector of controls including household size, type, number of dependents and education levels, and we filtered for households whose reporting person is male, aged between 20 and 65 (i.e. with a_i between 0 to 45), and employed. The resulting age-earning curve was then scaled down such that, conditional on the steady-state population distribution, the average wage results equal to 1.

Still from the HFCS, we have that households with the lowest education level earn about three times less than those with the highest. We use this fact to determine the distance between the highest and lowest wage levels at each age, and we select 5 total skill levels. We made the transition between skill levels unlikely; this resulted in a standard deviation of 0.12 and an autoregressive coefficient of 0.985 for the idiosyncratic wage process. The creation of the respective Markov chain of transition probabilities between wage/skill levels follows Tauchen (1986).

The wedge between the interest rate on deposits and that on mortgages, κ, is set at 2%: according to Central Bank of Ireland data and our calculations, the average difference between mortgage and deposit rates since 2003 is just above 2%, while it has over time moved as low as less than 1% and as high as 3%. The same data tells us that nominal deposit rates have been well below 2% on average, with an ECB target inflation rate of 2%, i.e. a negative average real return; as our model is entirely in real terms, we select r_b to be 0%. We further select LTV and LTI thresholds of 0.9 and 6, respectively, as internal thresholds a prudent bank would set for itself in the absence of an external authority setting macroprudential policy.

For the construction sector parameters, A_h and L, we calibrate them jointly so as to achieve a steady-state equilibrium price of housing p_h that is consistent with the real-life average house price-to-income ratio in Ireland. Depending on how they are calculated (e.g. using only labour

[9]The number of housing units owner by any single household does not ever go above this number in our simulations even when left unrestricted.

[10]We could also have achieved this by having different values for β, for instance.

income vs all income, or only employees, or taking the median vs the average etc.), price to (gross) income ratios for Ireland, based on the HFCS, generally range from 5 to 7, and we settle for 5.8 in our baseline. We allow land permits L to expand with the population, and set them at $L = (nN_t)/10$, i.e. one every 10 new agents in the population;[11] the corresponding value of A_h giving us an equilibrium p_h of 5.8 is 1.3.

In terms of the tax rates, these were determined as follows: τ_k was set equal to the Deposit Income Retention Tax (DIRT), which stands at 34%; τ_w was determined as the average income tax rate theoretically paid by households in the HFCS sample when including all labour-related taxation plus credits, and this also stands at 34% based on our calculations;[12] τ_h is the approximate local property tax (LPT) rate on a house worth €300,000, based on current LPT bands, i.e. 0.1%; and the property income tax is based on the higher marginal income tax rate of 40%.

4. Results

To estimate the impact of various housing policies on outcomes such as home-ownership rates, wealth inequality and welfare (and its distribution), we rely on a baseline model as basis for comparison, and we then change some targeted parameters or features one by one, or in combination. We are interested in estimating the impact of the following housing policies:

- Tightening of borrower-based macroprudential regulation (4.2);
- Introduction of institutional investors (4.3), and interaction with macroprudential regulation (4.3.1);
- Changes in tax rates on rental income (4.4);
- Measures on the construction sector (4.5);
- A negative scenario (4.6)
- Changes in interest rates (B)

However, we first make a few general observations about the joint housing and rental markets, and inequality.

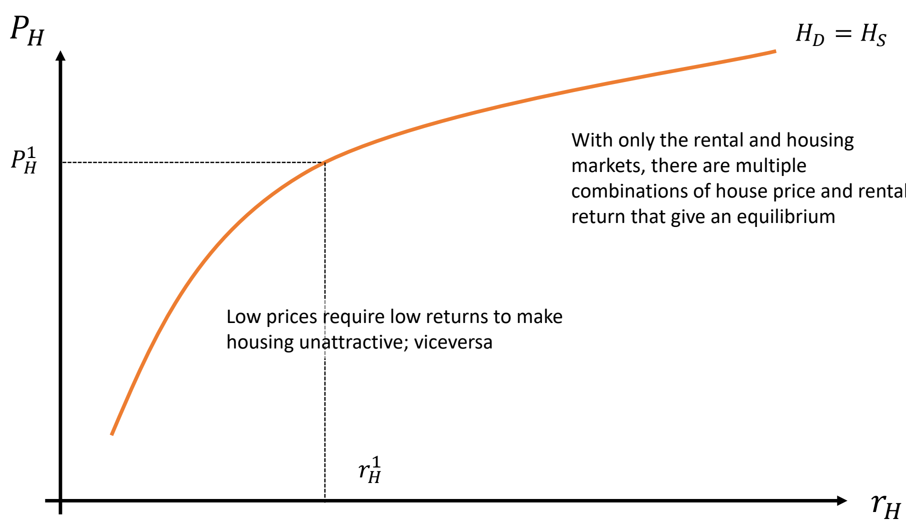
Housing demand is generally a decreasing function of house prices (if housing is a normal good), while it is increasing in rental return (which makes owning a house vs renting more attractive financially). The opposite holds for rental demand. Accordingly, if we ignore for now housing supply (suppose it is equal to N at all times), there can be a continuum of combinations of p_h and r_h

[11] For the population itself, we take survival probabilities from the Human Mortality Database (Human Mortality Database) (Ireland, 2017), and set a cohort growth rate n of 0.5%.

[12] Note that while the system is progressive in Ireland, we keep one flat tax rate in our model to simplify things.

that lead to an equilibrium in the housing market: e.g., a higher p_h, which decreases demand for housing, can be compensated for by a higher r_h to discourage renting. This would result in multiple equilibria as pictured in Figure 1.

Figure 1: *Illustration of multiple equilibria in the housing market when supply is irrelevant.*

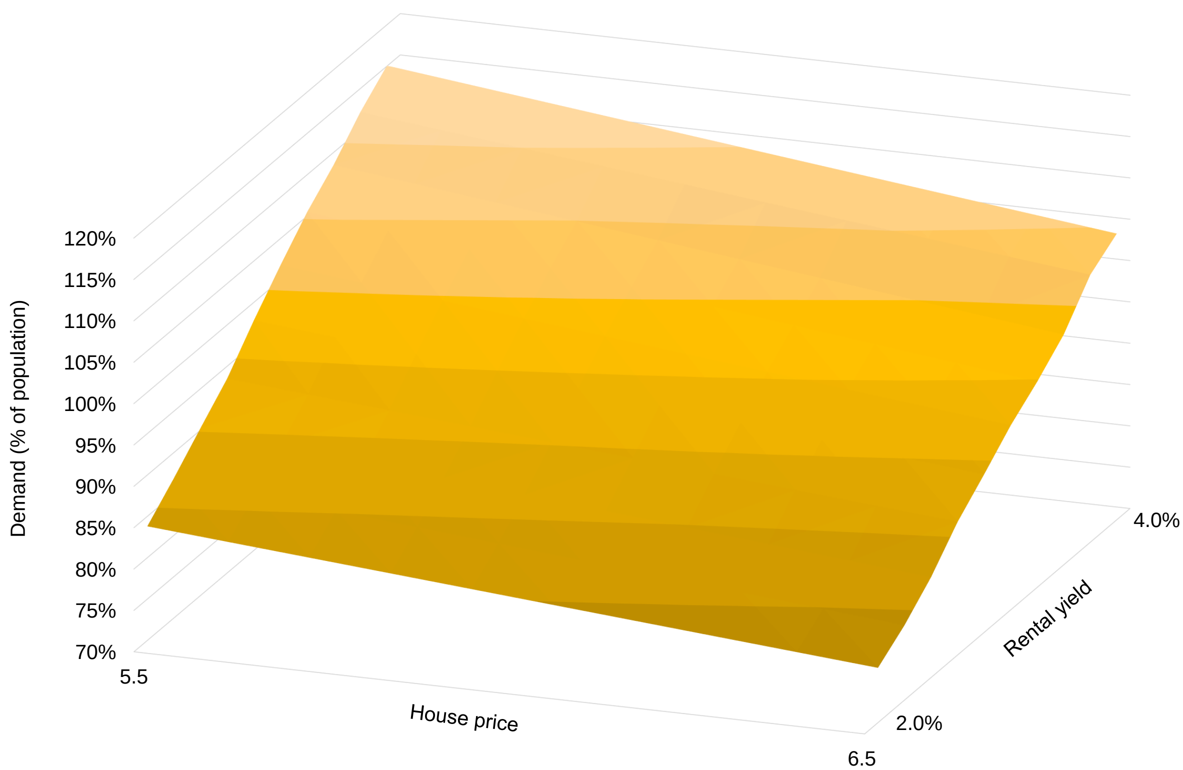


This is confirmed by model simulation results, where housing supply was set exogenously to be equal to N_t at all times, while all other parameters are calibrated to the baseline specification. Figure 2 displays the level of housing demand for each p_h and r_h combination, confirming that demand increases with the rental yield and decreases with the house price. Here we can see how demand for housing reaches equilibrium at a number of combinations of p_h and r_h, ranging from low-price low-yield equilibria to high-price high-yield ones. Note how Figure 1 is simply a representation of a slice of Figure 2, taken along the Z axis at the point where demand is 100% of the population.

Out of all these possible equilibria, are some preferable to others from a social perspective? It turns out that a low-price, low-yield equilibrium is strictly better than a high-price, high-yield equilibrium from the point of view of equality. In fact, when prices and yields are high, landlord households enjoy high levels of housing wealth from their properties and high levels of income from rent; meanwhile renters, who are poorer, find it harder to access home-ownership due to the high house prices, while also paying high rents. On the other hand in a low-price, low-yield world, renters would benefit from lower rents and easier access to housing, while wealthier households would have lower housing wealth and rental income; this would lower several measures of inequality. Indeed, we will see how in general any policy change that would lead to an equilibrium increase in p_h when keeping r_h constant, or vice-versa, will tend to lead to an increase in inequality, the opposite also being true. Housing not being a productive asset also means that no benefit accrues to the economy from more wealth being held in housing.[13]

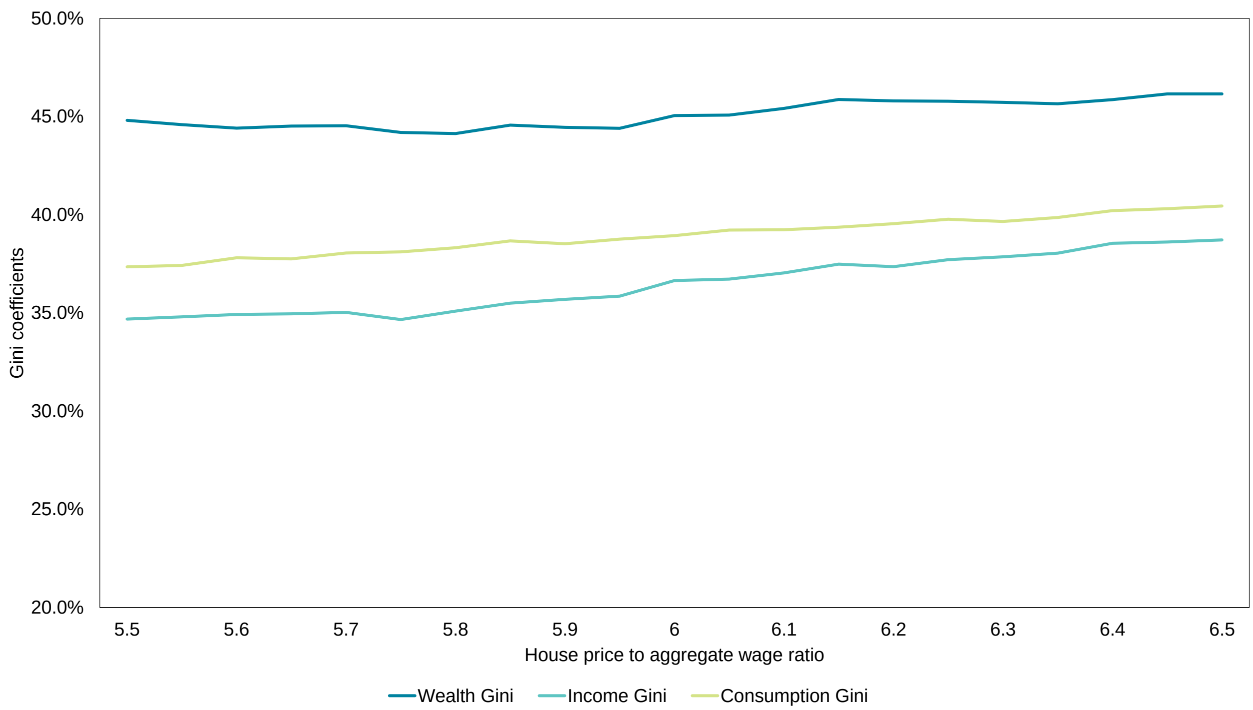
[13]This is a general remark rather than a finding of our model: remember that there is no capital in this

Figure 2: *Surface area representation of demand for housing as a percentage of population under the baseline model, by p_h and r_h.*



To illustrate this relationship between the equilibrium levels of prices and yields, and inequality, we have taken a set of combinations of p_h and r_h that lead to an equilibrium (housing demand equal to 100% of the population as per Figure 2), and calculated a number of Gini coefficients for households in these economies. As Figure 3 displays, Gini coefficients rise (net of fluctuations due to randomness in the different simulations) together with the equilibrium house prices (which also correspond to higher rental yields), indicating increasing inequality. Consumption and income inequality increase significantly more steeply than wealth inequality, which however remains the highest throughout. This can be explained by lower-income households having higher marginal propensities to consume, as is commonly found in the literature, meaning that higher rents (reducing their disposable incomes) will in great part translate to decreases in consumption rather than in saving and therefore wealth.

Figure 3: *Gini coefficients for wealth, housing wealth, disposable income and consumption, for each* (p_h, rh) *combination leading to equilibrium* $(H_d = N_t)$ *in the baseline model.*



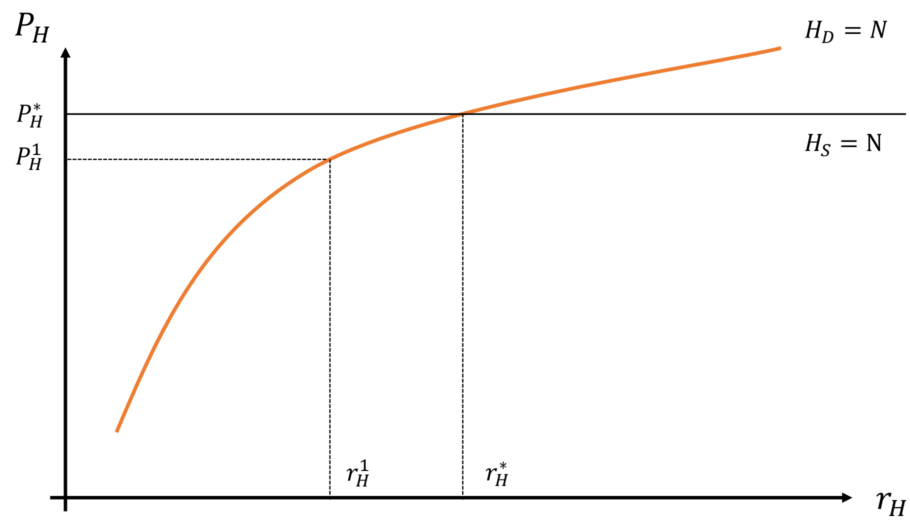
4.1. The baseline model

We now return to the complete solution to the model. Once constraints originating from the construction sector (where p_h is a determinant of construction output), are taken into account, there is a single price p_h^* that makes sure in the steady state there is exactly one housing unit for each household. Figure 4 illustrates this. While the equilibrium price of a unit of housing is

economy.

uniquely determined by the construction sector, the intersection with housing demand determines the equilibrium rental return r_h^*. This can be found, for instance, by intersecting the surface of Figure 2 with a $H_s = N_t$ plane corresponding to $p_h = p_h^*$ and finding the unique level of r_h in that intersection that also satisfies $H_d = N_t$. With the calibration of our baseline specification, p_h^* is set to 5.8 times the aggregate wage, with the corresponding optimal rental yield being around 3.15%.

Figure 4: *The construction sector determines the optimal price, while intersection with housing demand determines the equilibrium rental rate.*



Note how, from these levels, an increase in housing demand by households (for example, due to an increase in preference for home-ownership) would shift the plane in Figure 2 up, or the $H_d = N_t$ curve in Figure 4 to the left, and lead to a lower equilibrium rental return, and vice-versa.

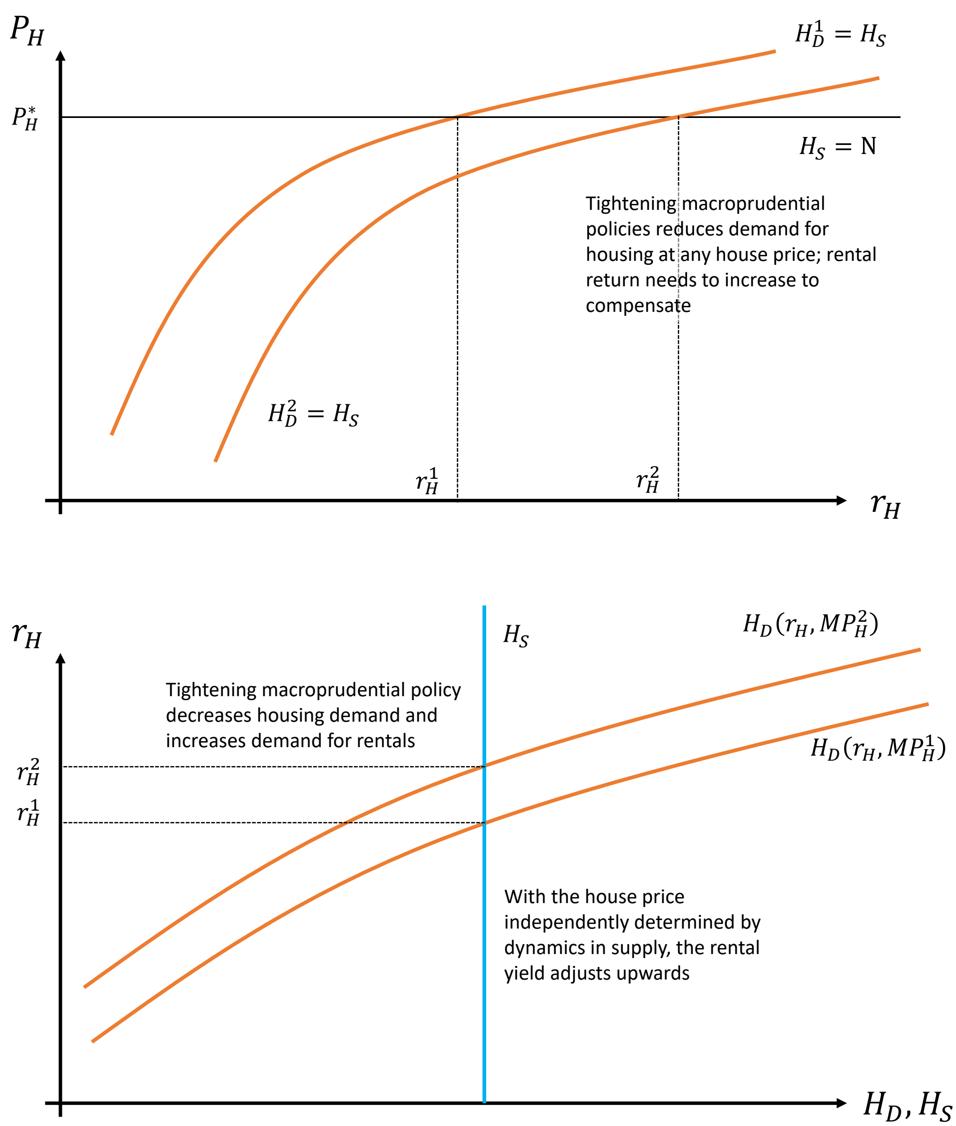
4.2. Tightening of macroprudential measures

The degree of tightness of the macroprudential measures determines, as well as the overall level of credit in the economy, whether some individual households are able to avail of mortgage debt to purchase housing, and if so how much debt they are allowed to take. This can have important distributional and welfare consequences, especially for those households who are close to, or just about meeting the LTI and LTV thresholds.

When macroprudential rules are tightened, some of the owner-occupier households who met the LTV and LTI criteria under looser regulation will no longer be able to access mortgage debt. These households, who previously contributed to housing demand, will now be part of the rental market. Even some landlord households may not satisfy the criteria for borrowing to finance the purchase of an extra housing unit, reducing their demand for extra housing (i.e. the rental supply) while at the same time the demand for rental accommodation increases.

This decrease in household demand, as outlined above, will shift the $H_d = N_t$ curve in Figure 4 to the right, resulting in a higher rental yield. The (forced) increase in the number of renters compared to a situation with looser thresholds leads to an increase in rental demand, pushing up rental prices. At the same time, the remaining existing landlords need to collectively own an additional number of housing units equal to the extra renters. In order to incentivise them to own more houses, the rental return needs to adjust accordingly. Figure 5 illustrates this graphically.

Figure 5: *Effect of a tightening of macroprudential policy forcing some households into the rental market. Seen in two different ways.*



Note how, in the absence of constraints arising from the construction sector, the shift in demand might lead to a decrease in price, an increase in yield, or a combination of both. Some empirical studies have found that indeed, in the short term borrower-based macroprudential policies lead to a decline in house price growth, and indeed these types of macroprudential policies have in most cases been introduced in order to reduce the risk of a credit-induced unsustainable boom in house prices. While this might hold true in the short and medium run (these policies aim at reducing fluctuations within this time frame), our framework suggests that in the long run, the necessity of housing construction keeping pace with population growth means that prices essentially need to be anchored to a certain level. As a result, the long-run impact of a tightening in macroprudential policies is an increase in rental yields and no change in prices; i.e., higher rental costs in absolute terms.

With respect to the welfare and inequality implications of a tightening of borrower-based macroprudential measures, the main channels through which different households are impacted by such policy changes are the following:

- The most directly impacted households, i.e. those who would have obtained a mortgage with looser policy but are instead forced to rent, lose in both welfare and monetary terms (they lose the additional utility from owning their house, and the rent is typically higher than equivalent mortgage repayments in the looser policy scenario).
- Households with enough liquid assets are generally not impacted by changes in the rules, while being benefited by an increase in rental yields if they own more than one house.
- Households that would have rented in any case (poorer) see their rental payments increasing.
- Generally, inequality is increased while welfare decreases for poorer households and increases for wealthier ones. Some households comparatively lose out when younger but are eventually benefited when older, while the negative consequences of the different policies are permanent for some others, such as lifetime renters.

These facts can be seen in Table 2, which summarises the effects of lowering the loan-to-income threshold from the original 6 to a significantly tighter 3.5.[14] In this simulation, the decline in housing demand generated by the tightening in the LTI limit leads to an increase in the equilibrium rental yield, from the original 3.15% to 3.45%, while p_h remains 5.8 times the aggregate wage.

The distributional effects of the change in policy are most obvious from the allocation of housing: while under the 6 LTI scenario (the baseline), homeownership is 70%, it falls to 66.1% under the 3.5 LTI scenario, i.e. about 4% of the population become renters but would have been homeowners if less restrictive regulation had allowed them to borrow. The increase in the number of renters is matched by a corresponding increase in the number of houses owned by landlord households, who have been incentivised to own additional housing thanks to the higher rental yield.

[14] Recall that the equilibrium price to aggregate wage ratio - which does not change with tighter macroprudential rules as the construction sector remains the same - was 5.8 in the baseline specification. A 3.5 LTI threshold would thus make a mortgage inaccessible for a large proportion of the working population unless they have sufficiently large liquid savings. In a real-life economy, such a large tightening would not typically happen all in one go - here we are only comparing two different states of the world.

There is, under the 3.5 LTI scenario, a higher percentage of the population paying rent, and also at the same time a higher level of rent paid by each renter. As a result of these dynamics, households at the lower end of the wealth distribution are the most impacted financially,[15] and see both their wealth and their consumption decline.

Households who own one housing unit, who are typically in the middle of the wealth distribution, are relatively unaffected by the changes in policy as they neither pay rent nor receive rental income.[16] This suggests that, for households who do end up owning a house eventually, the tightening in the LTI threshold merely represents a shift in the age at which they are able to purchase (with corresponding decrease in consumption and utility in the additional years of renting). In fact, they may overall benefit from the change in policy should they eventually become landlords. However, there are a number of households who, as a result of the tightening, become lifetime renters.

At the upper end of the wealth distribution, there are more second and further houses being owned by landlord households, who receive a higher rental yield on each of them compared to a situation under an LTI threshold of 6. This leads to a significant increase in both their wealth and their consumption (and thus utility). All the above point to a marked increase in inequality as a result of the change in policy. Indeed, the Gini coefficients on housing wealth, total wealth, disposable income (after rent payments), and consumption all increase considerably. Utility levels decrease sharply for the poorer and increase only slightly for the wealthier.

What happens when the macroprudential limit being tightened is instead the loan-to-value ratio? While the LTI threshold limits some households' access to credit due to their income levels, the LTV threshold does so based on their liquid wealth. Some young, high-income households, for instance, may be able to meet the LTI requirements but not the LTV ones as they have not yet been able to accumulate sufficient liquid wealth. The need for a larger deposit both delays home-ownership and incentivises saving behaviour. On the other hand however, most other households would typically be able to meet a tighter LTV limit more easily than a tight LTI limit. Consider the following: at prices at a multiple of 5.8 times the average wage as per baseline specification, an average-wage household saving 15% of their income every year would need about 4 years to save for a 10% deposit and 8 for a 20% deposit on a house at such a price. Tightening the LTV requirement could therefore delay their purchase. However, with a deposit of 10% they would need a loan for 90% of the house price, i.e. about 5.3 times their income, while with a 20% deposit the required loan would be about 4.7 times their income. Both would be inaccessible with a tight LTI limit in any case. Indeed, for many households, a tight LTI limit means that, in order to be able to get a loan, a significant part of the purchase price of the house would need to come from a deposit, and this is typically higher than the deposit required by the LTV limit itself.[17] Results of lowering the LTV limit from 90% to 75% (in

[15] Renters always tend to be the poorest households, as the extra utility from home-ownership means that it is typically optimal for households to own a house if they can afford it.

[16] As previous renters, they had been affected earlier in their life, but this does not seem to translate into significant deviations in wealth or consumption relative to comparable households under the 6 LTI simulation.

[17] In the same example of the average-wage household, an LTI limit of 3.5 with a purchase price of 5.8

Table 2) confirm that such a policy change does not have a particularly large effect on inequality; however, it is likely that tightening LTV limits further would start having a significant impact at a certain point.

4.3. Institutional investors

As seen, the main features of institutional investors in our framework are that (i) they are externally funded and deep-pocketed; (ii) they are targeting a minimum return r_h^{ii} (which depends on their cost of funding, r^{ii}, and other factors as detailed in equation 16), at or above which they will acquire as many units as possible; (iii) they will do so regardless of price (as there are no short-term price fluctuations within our model).

Due to these characteristics, the presence of institutional investors will provide an anchor to the rental yield, in any situation in which this would naturally be higher than r_h^{ii} in their absence. Suppose for instance that in the absence of institutional investors, demand for housing would be insufficient at r_h^{ii}, meaning that not enough households would be willing to invest in rental property for that rental return, leading to a shortage of housing demand and excess rental demand.

While without institutional investors this would lead to r_h adjusting upwards, the institutional investors are happy with the return and will therefore purchase any units that are not claimed by any households, essentially anchoring the rental yield at r_h^{ii}. This would be the highest rental yield achievable.[18] Figure 6 displays the mechanism at play.

In a situation in which institutional investors are present, in combination with constraints from the construction sector, the marginal household would essentially be facing a given house price as well as rental yield in the long term. Households' welfare and inequality will mainly be affected in the following ways:

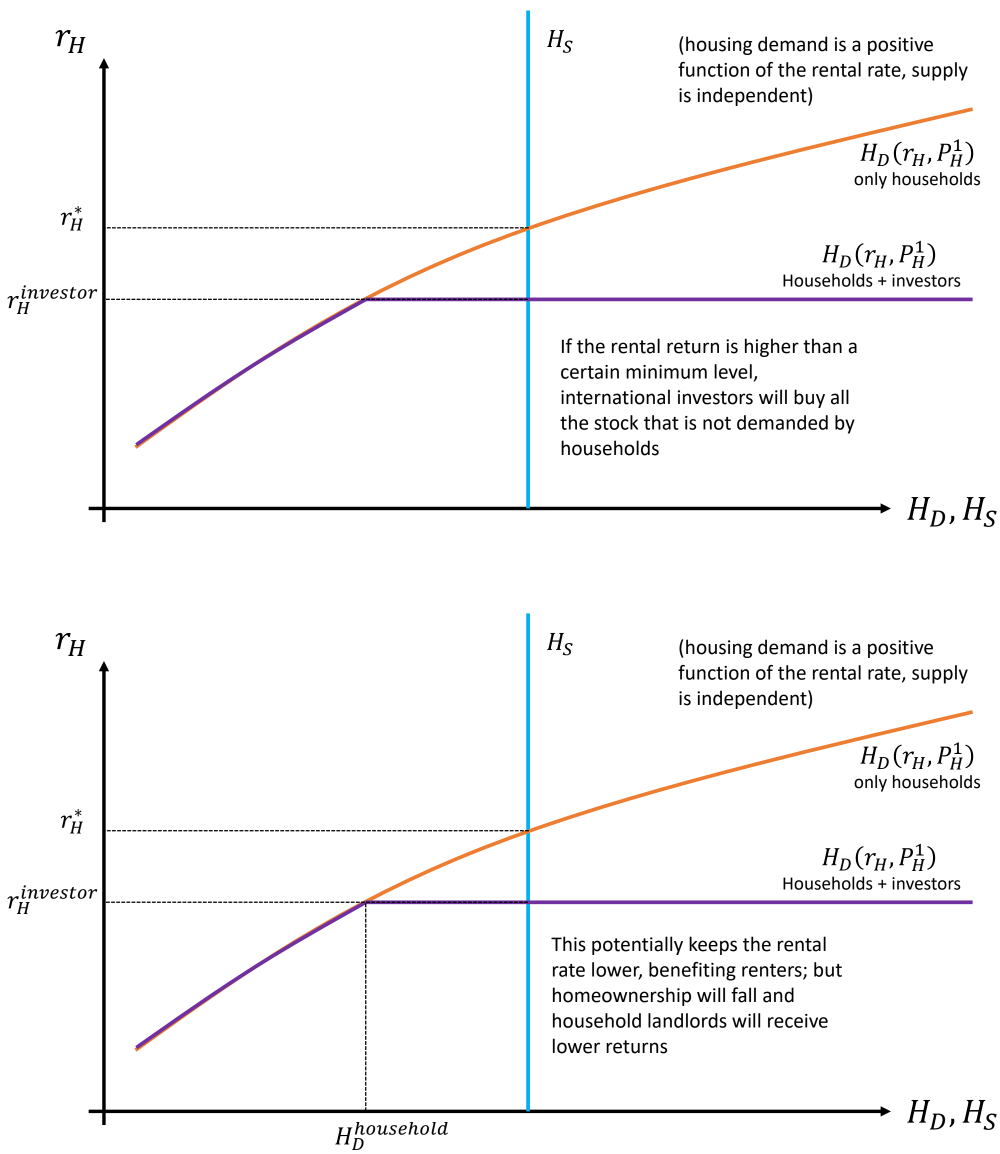
- Renters, especially those who would have never owned a house throughout their life (i.e. the poorest), benefit from a lower rent.
- On the other hand, household landlords receive a lower return on their investments and have generally lower housing wealth (fewer houses for investment).
- There are a number of households who now rent and would have been homeowners otherwise. Homeownership levels decrease.

As these changes effectively lead to an increase in disposable income for renters, while also lowering investment income and housing wealth for landlords, leading to significantly lower income and consumption inequality. The extent to which this happens depends on the distance between the

would require a deposit of 2.3 times the household's income, or about 40% of the purchase price, i.e. the LTI limit itself effectively enforces an LTV limit of 60% on this particular household.

[18] Any $r_h < r_h^{ii}$ is also possible but would entail no presence of institutional investors in equilibrium, going back to the situation in the baseline.

Figure 6: *The presence of institutional investors pins the rental return. This might reduce household sector home-ownership and wealth levels at the top, but also rents.*



equilibrium rental return without institutional investors, and r_h^{ii}: the greater this is, the larger the effect.

Figure 7: *Impact of the presence of institutional investors in the housing market on the distribution of housing wealth, consumption and total wealth, with LTI of 6 and r^{ii} of 1/3%.*

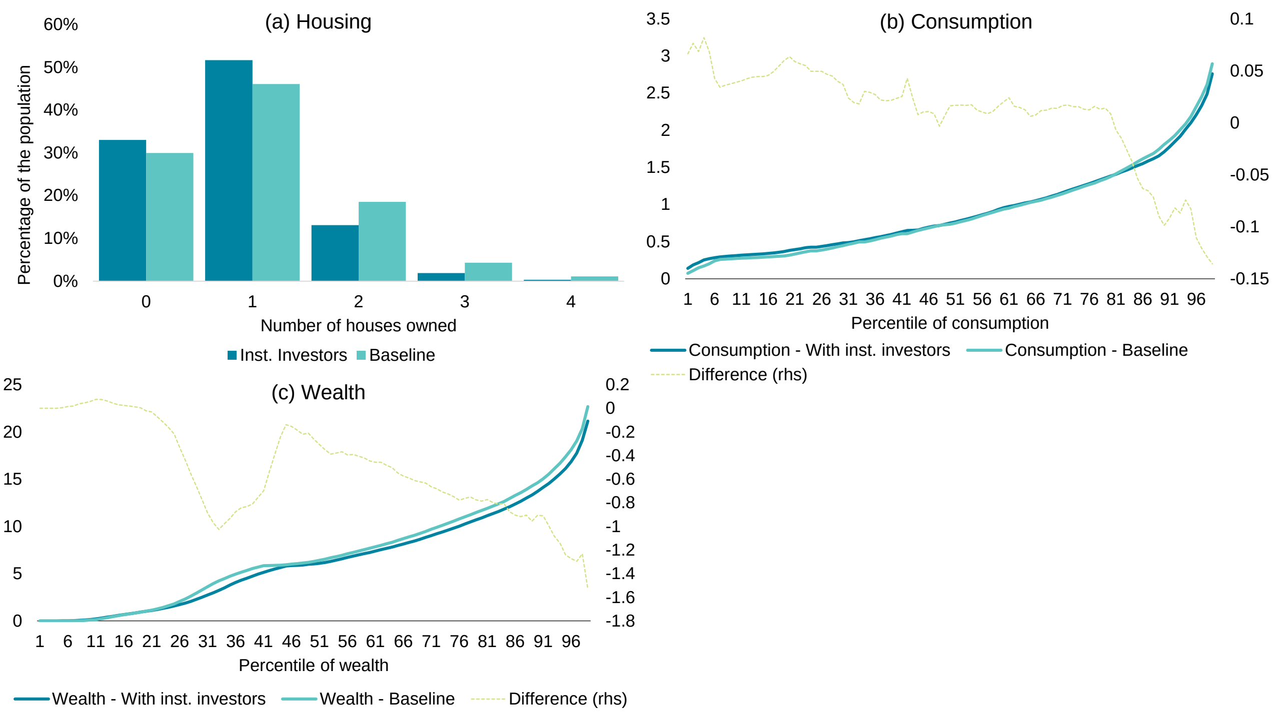


Figure 7 displays how the distributions of housing, consumption and wealth change when we add institutional investors to the model. We assume r^{ii} equal to 1/3%, leading to $r_h^{ii} = 2.4\%$ as per equation 16. As this is significantly far from the 3.15% rental yield that would prevail in the absence of institutional investors (see above), the effects are quite noticeable. The entrance of institutional investors into the housing market leads to fewer households owning two or more houses, and more of them owning 1 or none. Homeownership indeed declines by 3 percentage points compared to baseline. Wealth declines across the whole distribution (as less housing is in the hands of households, and its return is now lower), but more so for the wealthier households. Despite the fall in housing and overall wealth, a lot of households gain in terms of consumption, with an average household in the bottom 30% of the consumption distribution consuming an extra 5% of the aggregate wage compared to the same type of household under the baseline model. This is thanks to significantly cheaper rents when institutional investors are introduced. On the other hand, the wealthiest households significantly reduce their consumption, as their wealth suffers a large decline.

Overall, the presence of institutional investors, bringing down the equilibrium rental yield, can lead to a decrease in income and consumption inequality thanks to lower rents, at the cost of reduced homeownership, wealth and domestic ownership of the housing stock. Under the assumptions we have discussed, institutional investors have the potential to significantly lower inequality by making the poorest households better off. There are however several important caveats to consider.

First, relaxing the strong assumption that institutional investors are only allowed to purchase those housing units that are not demanded by households could significantly change things, and generally for the worse.[19] In this case, homeownership by the domestic households would fall even further, and for some households that would have not been the optimal choice in terms of their utility.[20] This can easily happen if, for instance, these investors are also owners of the construction companies, essentially cutting households off new housing supply.

If additionally, the institutional investors do not face competition among each other (say, because of high barriers to entry), their presence would not force the rental yield down (there is no need to compete with other similar investors to offer renters a lower rate), but they would still purchase as many housing units as possible. In such a scenario, we would only see the negative effects of the investors' presence through decreased homeownership of the population and lower wealth levels at the middle and upper end of the distribution, without actually benefiting households at the lower end via lower rental rates. Ensuring that institutional investors operate in a competitive environment, and do not essentially corner the market for new housing, are thus fundamental prerequisites for the potential positive effects discussed above to materialise.

Note finally on the other hand, that while we see institutional investors as outside deep-pocketed agents, they might also represent the domestic Government buying (or building) social housing and renting it out at a favourable rate, or at cost. In this case, the resulting equilibrium rental rate might be even lower than r_h^{ii}, since the Government is typically not looking for a return, and does not need to pay taxes to itself. That would lead to even less inequality, at the expense again of reduced homeownership and lower wealth at the upper end of the distribution; in addition, compared to 'external' institutional investors, all housing wealth, as well as all rental income, would stay within the domestic economy.[21]

The above are all scenarios that can fundamentally change the impact of institutional investors on the housing market and on inequality, and worth exploring in further work.

4.3.1 With tightening of macroprudential rules

When the presence of institutional investors is coupled with a tightening of macroprudential regulation, the effects of policy tightening can be significantly different than when demand for

[19]Suppose for instance that who ends up buying a property is decided by a lottery if there is excessive demand: in this case, institutional investors would be in for a chance to get every single housing unit. We do not simulate this scenario for brevity.

[20]That is instead the case if institutional investors are restricted in their purchases to only housing not already demanded by households, as detailed above.

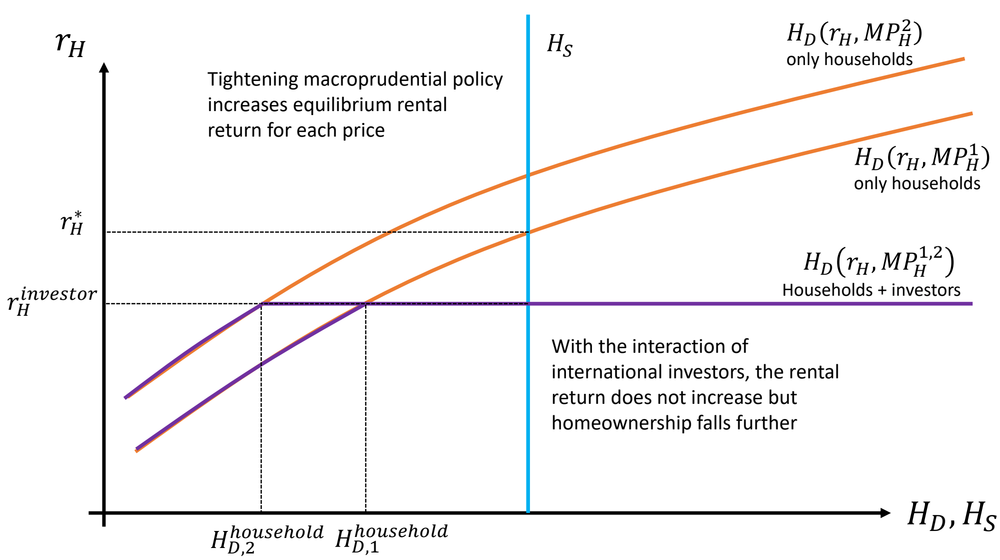
[21]In this situation, two separate rental markets might develop, with two different rental rates, unless social housing is open to every household equally and allocation between the public and the private rental markets is random. If rental markets become segregated, this could allow the very poorest to rent at lower prices while landlord households maintain their returns in the private rental market.

housing is only determined by households. We saw above how when macroprudential policy is tightened, the equilibrium rental yield increases due to additional demand for rental and less demand for owned housing at each price.

However, the presence of institutional investors (before tightening) implies that the equilibrium rental yield is r_h^{ii}. With only households in the market, tighter BBMs require an increased rental yield for the housing market to clear, as more household landlord demand is required and this can only be incentivised with higher returns. With institutional investors this is not the case, however, as they will purchase any extra units that are no longer demanded by households and maintain the yield at r_h^{ii}.

In this case, the net result of a tightening in macroprudential policy would then be, differently from the household-only version of the model, a drop in the number of household landlords (as well as homeownership in general) but no change to yields, as illustrated in Figure 8. The households who would have been able to get a mortgage with looser regulation (and would have decided to do so) lose the extra welfare from homeownership. Also, a number of landlords who would have got extra properties using mortgages under looser regulation lose rental income from these properties; this income goes instead to the institutional investors. Note as well that the rental income paid to institutional investors leaves the domestic economy and therefore does not finance any other household's consumption or saving.[22]

Figure 8: *A tightening of macroprudential policies when institutional investors are present lowers the number of housing units owned by domestic households (whether they are an investment or owner-occupied).*



Due to the low rental yield equilibrium imposed by the institutional investors, household demand for housing is significantly lower compared to baseline, as r_h^{ii} provides little prospective

[22]The same holds for the previous section. However, recall that this does not impact production as there is no capital in the economy.

return to landlords, while many renter households find renting more convenient. The tightening of macroprudential regulation further reduces housing demand, as we have seen in Section 4.2. This results in a sharp drop in homeownership, which falls from 67% in Section 4.3 (and 70% in the baseline) to only 61.9% (compare Table 2). At the same time, however, measures of inequality (apart from housing wealth inequality), barely move. This is in contrast to the strong increase inequality between the baseline and the scenario in Section 4.2.

The difference from Section 4.2 in terms of effects of macroprudential policy on inequality is that those who are pushed towards renting due to tighter policy do not have to pay higher rents, as was instead the case when the LTI limit was tightened from the baseline simulation. Similarly, a prospective landlord who is unable to access a loan loses less under this scenario, since prospective returns are lower anyway. In other words, the welfare losses from not being able to access a loan are much lower now that the opportunity cost of not being able to own a house (i.e. the rental yield) is also lower. As a result, we have that tightening macroprudential regulation with institutional investors already present has a much smaller effect on inequality; conversely, introducing institutional investors when macroprudential policies are already tight greatly reduces income and consumption inequality, but also homeownership, with an unclear effect on wealth and housing wealth inequality.[23]

4.4. Tax on rental income

In our baseline specification, we have rental income tax standing at 40%. This creates a large wedge between what renters pay, and the income eventually accruing to landlords. Reducing it might potentially reduce the burden to renters, increase the net return to landlords, or both. Here, we look at the effects of changing this tax rate within our framework, with the caveat that the high level of complexity of the (fiscal) implications of such a tax would warrant further in-depth study.

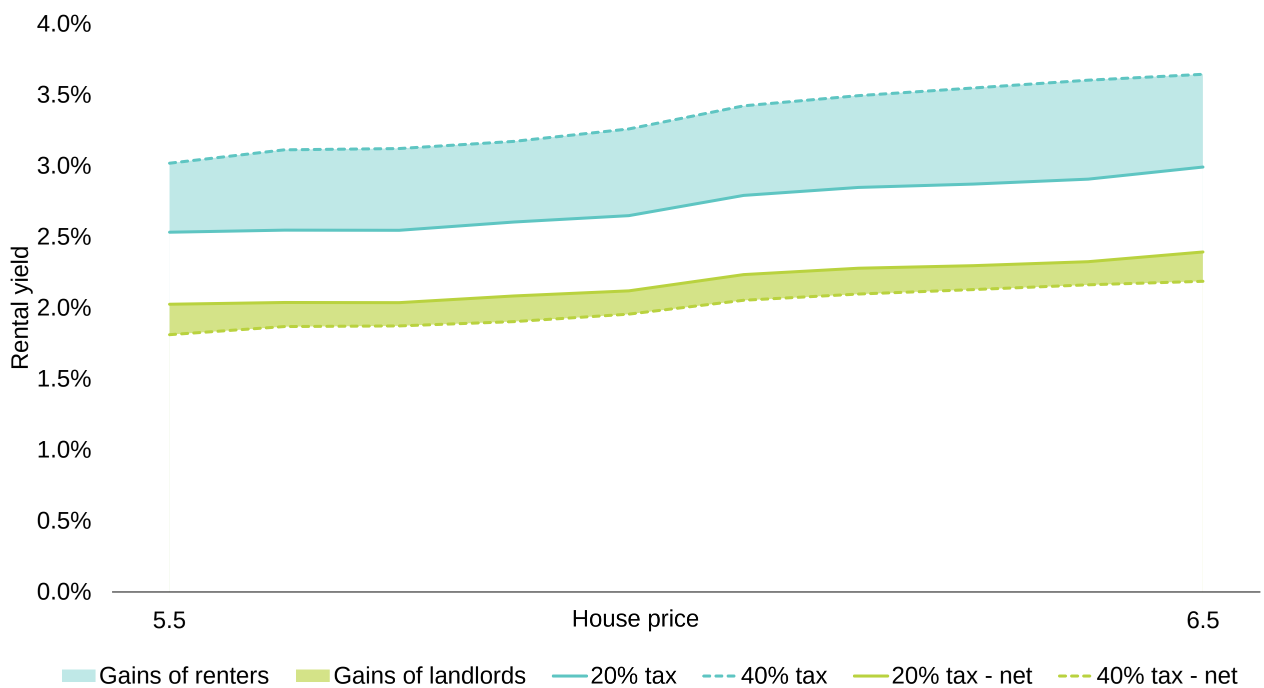
Does the majority of the tax burden fall on renters, increasing their payments, or does it fall mostly on landlords, by reducing their effective after-tax rental yield? Who bears the burden of the tax can have potentially very different implications for inequality, and it can depend heavily on calibration and indeed the interaction with other policies. In addition, in the real world the revenue generated from such a tax can be used in a number of ways that can further contribute to or mitigate inequality. For instance, the Government could use the tax revenue to decrease other tax rates, subsidise house building, or on social spending (including social housing), etc., all with very different implications, some of which we separately discuss in other sections.

The interaction with other policies can be significant. Are expenses on maintenance, property taxes, or mortgage income deducted from the tax? Do institutional investors pay the same tax rate on their rental income or do they pay a (higher or lower) tax on their profits? For the sake of this exercise, we limit ourselves to observing what changes when the tax rate on rental income is reduced, within the setting of our baseline model, from 40% to 20%. In order to concentrate on the

[23]This depends on the degree of tightening of policy and the level of r^{ii}.

change in the tax rate alone rather than the use of the revenue it generates, we assume that any shortfall in tax revenue from the reduction in the tax is taken from the provision of public services, which as explained above do not impact household decisions, or their income and wealth.

Figure 9: *Lowering τ_{rh} benefits both renters and landlords, but not in equal measure*



The result of the reduction in τ_{rh} is, unsurprisingly, a decrease in the equilibrium rental yield. Both renters and landlords gain thanks to the reduction in the tax,[24] with the first paying a lower rent and the second receiving a higher after-tax rental income relative to the baseline specification. From the original 3.15%, the equilibrium (gross) rental yield falls to 2.60%. This represents a fall of over 17% in the level of rental payments by renter households compared to baseline, with rents as a proportion of average income falling from 18.3% to 15.1%, meaning that each single renter is better off by about 3% of average income (see also Table 2 for more statistics). Despite the decrease in yields, landlords are also better off because thanks to the decrease in tax, their after-tax return is still higher compared to the after-tax return under the baseline simulation. From getting taxed 40% on a yield of 3.15% (net yield, 1.89%), they are now taxed 20% on a yield of 2.60%, with net yield of 2.08%. That is a 10% increase in after-tax income.

All households (apart from owner-occupiers) benefit from a reduction in the tax, but renters significantly more so than landlords under this calibration. We show this in Figure 9, where we have evaluated the equilibrium rental yields and net rental yields (i.e., respectively, what renters pay and what landlords receive after tax) at income tax rates τ_{rh} of 40% and 20%, across a number of different

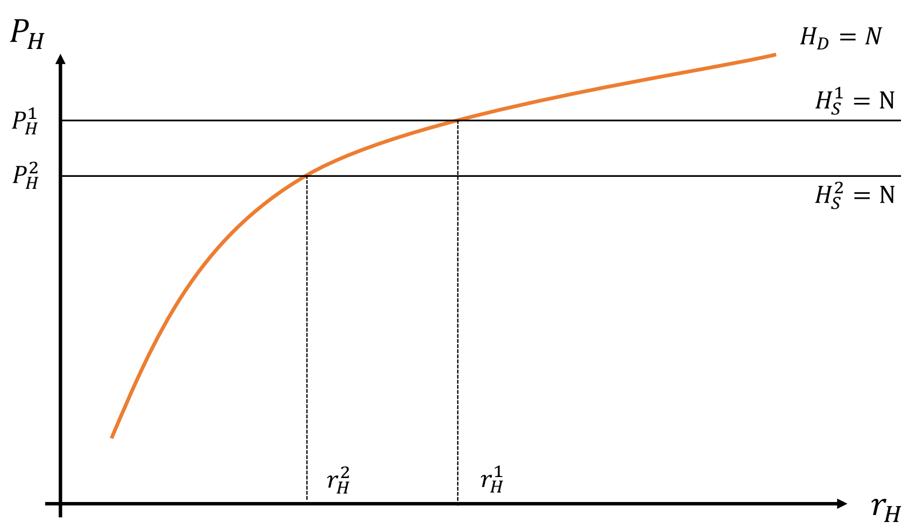
[24]Again, we are agnostic as to what the Government does with the tax revenue. In the real world it could as well use the revenue in ways that benefit all households more than they are harmed by the tax.

levels of p_h. At all p_h levels, the gains made by renters are several times as large as those made by landlords when the tax rate is decreased. This suggests that the burden of the tax falls mostly on renters. It thus appears as though, despite the fact that it is a tax levied on landlords' income, rental income tax (at least under our calibration) is a regressive tax, as it hits poorer households more than wealthier ones (in monetary terms, but even more so in proportion to their income). Indeed, while housing and wealth inequality increase with the reduction in the tax (presumably, because landlords have an even higher net return now),[25] income and consumption inequality both significantly decline, and utility rises on average but especially so that of poorer households.

4.5. Measures on the construction sector

We have seen above how the construction sector determines the steady state level of p_h regardless of housing demand. The specific level of p_h that allows for housing supply to match the population therefore must be dependent on characteristics of the production function of the construction sector. As low-price, low-yield equilibria are preferable from an equality standpoint, inequality can be reduced if construction expands at any given price level. When this happens, a lower price is required for the construction sector to be able to meet housing supply requirements, leading to a lower equilibrium price. Figure 10 displays this graphically.

Figure 10: *Expanding construction permits leads to a lower p_h allowing for $H_s = N_t$. This in turn leads to a lower equilibrium r_h*



An increase in construction output can be achieved in a number of different ways, with similar implications. We look at a couple of them below.

In our first simulation, we assume that the number of land permits is increased by 20% in every period. This leads, as predicted, to a decrease in the equilibrium p_h and r_h, from 5.8 and 3.15% to

[25] And also, there is effectively more money going around, because we did not change any other tax rate.

5.3 and 2.95%. As suggested from Figure 3 and displayed in Table 2 in the Appendix, moving to a lower-price, lower yield equilibrium significantly lowers Income and consumption inequality. This is because lower house prices coupled with lower rental yield leads to significantly lower rental payments (which are $p_h \times r_h$), which benefits poorer households who can enjoy higher disposable income and consumption. Rent as a percentage of the average wage falls from 18.3% to 15.6%.

As it is cheaper, households can more easily afford housing (if they so wish), with or without loans, but note that this does not necessarily lead to higher homeownership: some households are happy to rent at the lower r_h, as the *financial* incentive to own housing falls significantly. Utility improvements compared to baseline are indeed largest for renting households, and the homeownership rate actually falls. Due to the lower price and return of housing (which still has a higher return than deposits), the wealth of homeowners and landlord households is negatively affected by the lower house price and lower returns from the properties they rent; however, consumption only decreases at the top 20% of the distribution, while it increases for everyone else.

Overall, the decrease in house prices seems to benefit more households than it harms, and those households who are worse-off compared to when prices are higher remain among the wealthiest in any case. For instance, the average increase in consumption for households in the bottom 25 consumption percentiles is of about 1.5% of the annual aggregate wage (2% for the lowest 10 percentiles) relative to households in the same percentiles under the scenario with lower permits.

Next, we simulate an increase in the productivity of the construction sector, with A_h going from 1.3 to 1.4. While this is not per se a policy, there are a number of real-life Government policies that can help achieve an improvement in construction productivity, for example providing efficient planning and legal systems in which the construction firms can operate. The outcome of this scenario is very similar to an increase in land permits, as seen from Table 2: indeed, to households it obviously does not matter how the expansion in supply is achieved. As above, who benefits from the lower r_h and p_h are renters (due to lower rental costs), as well as homeowners with only one property (if housing is cheaper, they can buy earlier and enjoy the additional utility from housing), while landlord households lose on wealth and consumption.

On this simulation, we further tighten LTI limits to 3.5 to see how the policies interact. As happens for the baseline simulation, even with the increased housing supply at all p_h levels, tightening the LTI threshold from 6 to 3.5 will lead to lower demand for housing, and an equilibrium with higher rental yield (namely 3.25%), the same house price (5.2) and higher inequality. However, rent per average wage remains well below baseline (16.9% vs 18.3%). Housing, wealth, and income inequality all increase compared to baseline, but consumption inequality decreases and utility improves for the poorest.

Because house prices in equilibrium are lower thanks to the increased productivity of the construction sector, fewer households are affected by the LTI limit even when it is tightened: with p_h of 5.8 and LTV of 90%, a household needs an income of 0.87 for a 90% loan at 6 LTI and 1.49 for an LTI of 3.5; with p_h of 5.20, the equivalent incomes required fall to 0.78 and 1.34, respectively.

Indeed, in this particular case the increase in construction sector productivity seems to more or less offset the effect of tightening the LTI limit, leading to a situation that is comparable to the baseline in terms of inequality (and indeed a slightly better outcome in term of utility, but with a lower homeownership rate (compare Table 2)).

Other policies that can achieve similar results to an expansion in land permits or increases in productivity, by affecting the construction sector rather than demand, include, for instance, subsidies on house prices (this however generates a cost to the Government, and therefore a trade-off), or a decrease in the cost of materials or labour in the construction sector.[26]

4.6. A not implausible negative scenario

In the simulations above, we have analysed the distributional impact of policy changes around a relatively favourable baseline scenario. The reality is, however, that a number of advanced economies are far from our baseline scenario at the moment, being concurrently faced with insufficient supply of housing, high rents, tight regulation, high taxation, etc. Here, we simulate a scenario where we combine a number of the above policies in an unfavourable way, to show how quickly they can add up and contribute to significant inequality. Namely, we set land permits to 80% of the baseline rate, we allow for institutional investors (but with a relatively higher r^{ii} of 1%), we set the LTI limit to 3.5, and we increase the rental income tax rate to 45%. This combination is unfortunately far from implausible.[27]

Under this scenario, a large number of households end up being much worse off. As displayed in Table 2, all inequality measures increase substantially compared to the baseline and all other scenarios examined, with the homeownership rate also falling from 70% to 63%. The equilibrium p_h jumps to 6.55 and the equilibrium rental yield reaches 3.82%; together, this implies that renters spend 25% of the average wage on rent under this scenario.[28] For all homeowner households, wealth increases substantially compared to the baseline simulation, as housing is more expensive but also of higher return - in fact, the wealthiest households gain the most wealth, and increase their consumption levels accordingly. On the other hand, renters see their limited wealth further reduced due to the high rental rates. Their net income and consumption - and thus utility - all fall sharply.

What can policymakers do when faced with a similar scenario of high inequality, and a large number of vulnerable renters? We hope that results highlighted in this paper can shed some light into this. We believe that supply-side measures should be prioritised, as we have shown that when the construction sector can build more housing and/or at lower cost, outcomes for households are unequivocally and strongly positive. A review of rental income taxation (for

[26] While labour is not an input for construction firms in this model, a reduction in its cost would of course improve supply in a real economy.

[27] Indeed, it is not far from the current situation in Ireland: household landlords pay a marginal tax of around 50% on rental income when including all types of taxation (but mortgage repayments are deductible); the planning process is slow and inefficient; construction sector productivity is low by euro area standards; a large proportion of the rental market is in the hands of foreign investment funds; LTI and LTV limits for first-time buyers are respectively 4x and 90% currently.

[28] Note that renters typically earn much less than the average, so this is an ever heavier burden to them.

household landlords) could end up benefiting renters and decreasing inequality. Appropriate regulation of institutional investors, especially if they operate within a small market with limited competition, might be warranted: while our results in 4.3 point out that they can have certain positive effects, it is important to avoid a situation in which they end up dominating the rental market. On the other hand, provision of public social housing would provide the same benefits we identified in institutional investors, with reduced welfare costs and risks.

5. Conclusions

In this paper, we have analysed the effect of a number of different housing market policies on inequality, employing a heterogeneous agent overlapping-generations life-cycle model with housing and rental markets. We find that through limiting availability of credit to lower income households, macroprudential regulation has a meaningful impact on rates of home ownership, with implications for income, wealth, and consumption inequality. Housing policy targeting supply, minimizing costs associated with new home building can work to improve outcomes for potential homeowners at the bottom of the distribution. The same cannot be said for demand-side policies which, in the face of limited supply response, will largely work to benefit the wealthy.

We further explore the effect of the introduction of institutional investors into the rental market, and find that they can decrease inequality by lowering equilibrium rental rates, at the cost of reduced homeownership. Taxation on rental income, targeting the incomes of the wealthiest, might actually harm renters the most by pushing up rental payments. Different policies can lead to different trade-offs between different types of inequality, as well as homeownership rates. An optimal policy mix can be achieved by combining these policies in an effective way; in this light, we note that supply policies aimed at improving the availability and reducing the cost of housing are essentially always positive.

We note that there are many unanswered questions remaining. In future research, we plan to expand our analysis to further experiment with different policy impacts, and to narrow down our focus on some of the policies we have already discussed here, but in more detail. The model setup outlined in this paper is very flexible and lends itself to further experimentation, with different calibrations and additional features; we plan to make use of this to explore further areas for investigation. For instance, while preliminary work suggests that help-to-buy schemes will not improve inequality, we plan to test this. Additionally we wish to better understand the degree to which various policies might work together.

Ultimately we emphasise that any study that wishes to understand the role of policy to affect inequality should take the housing market seriously. For better or worse it is an asset that makes up the majority of households' wealth and is therefore absolutely central to any serious attempt to understand and minimise such distortions.

References

Acharya, V. V., K. Bergant, M. Crosignani, T. Eisert, and F. J. McCann (2020). The anatomy of the transmission of macroprudential policies. Technical report, National Bureau of Economic Research.

Alpanda, S. and S. Zubairy (2016). Housing and tax policy. *Journal of Money, Credit and Banking 48*(2-3), 485–512.

Alpanda, S. and S. Zubairy (2017). Addressing household indebtedness: Monetary, fiscal or macroprudential policy? *European Economic Review 92*, 47–73.

Amberg, N., T. Jansson, M. Klein, and A. R. Picco (2022). Five facts about the distributional income effects of monetary policy shocks. *American Economic Review: Insights 4*(3), 289–304.

Bartels, C. and C. Schröder (2020). The role of rental income, real estate and rents for inequality in germany. Technical report, Working Papers.

Carozzi, F., C. A. Hilber, and X. Yu (2024). On the economic impacts of mortgage credit expansion policies: evidence from help to buy. *Journal of Urban Economics 139*, 103611.

Castellanos, J., G. Paz-Pardo, and A. Hannon (2024). The aggregate and distributional implications of credit shocks on housing and rental markets. *Available at SSRN 4889614*.

Causa, O., N. Woloszko, and D. Leite (2019). Housing, wealth accumulation and wealth distribution: Evidence and stylized facts.

Christophers, B. (2021). A tale of two inequalities: Housing-wealth inequality and tenure inequality. *Environment and planning A: economy and space 53*(3), 573–594.

Davtyan, K. (2017). The distributive effect of monetary policy: The top one percent makes the difference. *Economic modelling 65*, 106–118.

De Nardi, M. (2004). Wealth inequality and intergenerational links. *The Review of Economic Studies 71*(3), 743–768.

Doepke, M., M. Schneider, and V. Selezneva. Distributional effects of monetary policy.

Dustmann, C., B. Fitzenberger, and M. Zimmermann (2022). Housing expenditure and income inequality. *The Economic Journal 132*(645), 1709–1736.

Georgescu, O. M. and D. V. Martín (2021). Do macroprudential measures increase inequality? evidence from the euro area household survey.

Greenwald, D. L. and A. Guren (2021). Do credit conditions move house prices? Technical report, National Bureau of Economic Research.

Hohberger, S., R. Priftis, and L. Vogel (2020). The distributional effects of conventional monetary policy and quantitative easing: Evidence from an estimated dsge model. *Journal of Banking & Finance 113*, 105483.

Household Finance and Consumption Network (2022). Household Finance and Consumption Survey: Methodological report for the 2021 wave. *ECB Statistic Paper* (45).

Human Mortality Database. Human Mortality Database. *Max Planck Institute for Demographic Research (Germany), University of California, Berkeley (USA), and French Institute for Demographic Studies (France).*

Kaplan, G., K. Mitman, and G. L. Violante (2020). The housing boom and bust: Model meets evidence. *Journal of Political Economy 128*(9), 3285–3345.

Kaplan, G. and S. Schulhofer-Wohl (2017). Inflation at the household level. *Journal of Monetary Economics 91*, 19–38.

Kindermann, F. and S. Kohls (2018). Rental markets and wealth inequality in the euro-area. *University of Regensburg, unpublished. https://economics. unihohenheim. de/fileadmin/einrichtungen/economics/Lecture_Series_Abstracts/Kin dermann_rental_markets. pdf*.

Kinghan, C., Y. McCarthy, and C. O'Toole (2019). How do macroprudential loan-to-value restrictions impact first time home buyers? a quasi-experimental approach. *Journal of Banking & Finance*, 105678.

La Cava, G. and C. He (2021). The distributional effects of monetary policy: Evidence from local housing markets in australia. *Australian Economic Review 54*(3), 387–397.

Mavropoulos, A. and Q. Xiong (2019). Housing consumption and macroprudential policies in europe: An ex ante evaluation. Technical report, IWH Discussion Papers.

Rubio, M. and J. A. Carrasco-Gallego (2014). Macroprudential and monetary policies: Implications for financial stability and welfare. *Journal of Banking & Finance 49*, 326–336.

Tarne, R., D. Bezemer, and T. Theobald (2022). The effect of borrower-specific loan-to-value policies on household debt, wealth inequality and consumption volatility: An agent-based analysis. *Journal of Economic Dynamics and Control 144*, 104526.

Tauchen, G. (1986). Finite state Markov-chain approximations to univariate and vector autoregressions. *Economics Letters 20*(2), 177–181.

A. Comparison of the various simulations

Throughout the paper, we have discussed the outcomes of different variants and simulations of the model, in terms of the distributional consequences of each policy considered. In Table 2, we summarise the most relevant distributional statistics for each of the simulations discussed above, for a quick comparison among them. We are interested in the outcomes of policies in terms of inequality (measured by Gini coefficients) in wealth, housing wealth, income and consumption, as well other as overall welfare considerations, such as the distribution of utility.

We note that the variation of housing wealth inequality across simulations is the largest, while that of overall wealth is the lowest. This suggests that increasing housing inequality is often largely compensated by lower inequality in financial wealth: the households who do not have housing save more in financial wealth instead. Income inequality (where income here is net income, i.e. after taxes and after rental income or rental payments) also has a large variation, comparable to that of housing wealth; this is in line with the fact that the variation in income across simulations is given by the different numbers and compositions of renters and landlords - indeed, housing policies have no bearing on labour income.

Speaking of rental income - another thing to note is that while (net) rental yields are what matter most for landlord households (and institutional investors) when making investment decisions, this is different for renters. Renters could be better off in an economy with a high r_h but low p_h compared to the opposite situation, if that means that the actual rental payment they make is a lower proportion of their wage in the former case. For instance, in the simulation with higher construction sector productivity and tight LTI limits, r_h is higher than under the baseline scenario (3.25% vs 3.15%); however, renters are still better off, because thanks to the significantly lower house prices (5.20 vs 5.80), their rent payments are actually lower relative to aggregate income (15.6% vs 18.3%).

In terms of utility, the largest movements across different simulations come from the poorest households, who have typically low consumption and no owned housing, and thus have very low levels of utility. Welfare considerations based on utility are tricky due to the merely ordinal nature of this measure; however, due to higher marginal utility for poorer households, 'transferring' a unit of consumption from a high-wealth, high-consumption household to a low-consumption household would increase overall welfare (when seen as the sum of individual utilities). It is therefore consumption inequality, together with the homeownership rate, what matters most for the distribution of utility and welfare.[29]

Homeownership rates move across simulations around the 60-70% range, with the highest actually being obtained in the baseline scenario. Because however the movements in this measure are all the result of households' optimisation,[30] we do not necessarily see homeownership as an

[29]Recall that because households only gain utility from their first house, what matters is the proportion of households with at least one house, rather than the number of houses each of them owns.

[30]Contrast this instead with a situation in which, for instance, institutional investors are allowed to bid against households, as we briefly discussed in Section 4.3.

Table 2: *Model outcomes, various model specifications*

Simulation	Baseline	4.2	4.3	4.3.1	4.4	4.2	4.5	4.5	4.5	4.6
LTI	6	3.5	6	3.5	6	6	6	6	3.5	3.5
LTV	90%	90%	90%	90%	90%	75%	90%	90%	90%	90%
τ_{rh}	40%	40%	40%	40%	20%	40%	40%	40%	40%	45%
Inst. inv.?	NO	NO	YES	YES	NO	NO	NO	NO	NO	YES
r^{ii}	-	-	1/3%	1/3%	-	-	-	-	-	1%
L	L	L	L	L	L	L	L*1.2	L	L	L*0.8
A_h	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4	1.3
Housing Gini	45.2%	49.2%	44.3%	48.9%	46.5%	46.1%	46.9%	47.3%	50.7%	51.1%
Wealth Gini	44.1%	44.3%	44.8%	44.8%	44.8%	44.3%	44.9%	45.0%	45.1%	46.0%
Income Gini	35.1%	36.6%	32.0%	32.5%	34.0%	35.1%	34.3%	34.1%	35.9%	39.8%
Cons. Gini	38.3%	39.2%	35.4%	35.2%	37.0%	38.3%	36.8%	36.8%	37.6%	41.1%
Median utility	-1.134	-1.136	-1.117	-1.131	-1.134	-1.132	-1.113	-1.118	-1.125	-1.097
Avg. utility	-1.371	-1.417	-1.275	-1.278	-1.324	-1.371	-1.326	-1.329	-1.357	-1.467
Homeownership	70.0%	66.2%	67.0%	61.9%	69.1%	69.4%	68.5%	68.0%	64.6%	62.9%
p_h	5.80	5.80	5.80	5.80	5.80	5.80	5.30	5.20	5.20	6.55
r_h	3.15%	3.40%	2.40%	2.40%	2.60%	3.15%	2.95%	3.00%	3.25%	3.82%
r_h % avg. wage	18.3%	19.7%	13.9%	13.9%	15.1%	18.3%	15.6%	15.6%	16.9%	25.0%

inherently positive measure that should be pursued by policy, unless movements in homeownership also come together with movements in inequality and/or households' welfare. While owning a house improves utility (all else equal) from an individual household's perspective, a lower homeownership rate in the economy is in fact not necessarily bad in terms of welfare and equality. For example, under the scenario with a higher rate of land permits, the homeownership rate declines to 68.5% from the baseline's 70%; nevertheless, because of the lower house prices and rental yields, renting is much more affordable: this leads to reductions in income and consumption inequality, and better utility outcomes compared to baseline.

B. Changes in interest rates

Due to computational challenges, interest rates in our model are set exogenously and do not originate from household maximisation and a need to balance savings and investment. Indeed, there is no capital in the model economy. Interest rates are also not a policy tool that is or should be used to influence the housing market; and finally as our model better describes the longer term, the interest rates within it can be characterised as 'natural' rates rather than arising from monetary policy.

However, as they still do play a very important role in the results we derive from our model, we describe here how some results may change based on their level. Indeed, the level of interest rates (note that there is a fixed wedge between the rate on deposits and the rate on loans) determines how attractive the return on housing is relative to the return on deposits.

As second and further houses do not provide additional utility to the owners, the rental yield (minus property tax, rental income tax and depreciation costs) needs to be at least as high as the return on deposits (net of capital gain taxes) for it to make it an attractive investment for landlords who have the necessary cash. The prospective landlords who would need to borrow in order to purchase additional housing would demand an even higher rate of return.[31] As a result, we can expect equilibrium housing demand to decline as deposit interest rates rise while (given any level of p_h determined by the construction sector) the equilibrium rental yield would rise with interest rates.

Assume now that r_b rises to 1% from the baseline 0%. After capital gain taxes of 34%, this corresponds to a net return of 0.66%. With δ_h and τ_h totalling 1.1% between them, and a rental income tax rate of 40%, housing provides a better investment when $(1-\tau_{rh})r_h - \delta_h - \tau_h > (1-\tau_k)r_b$, i.e. if $r_h > 2.93\%$. This appears evident in Figure 11, with housing demand jumping significantly as r_h surpasses 2.93%. Interestingly however, the equilibrium rental yield does not rise by as much as the increase in the deposit rate, increasing to 3.80% from 3.15% in the baseline model. Lowering the interest rate on deposits would likewise result in a lower equilibrium rental return.

The effects on inequality are similar to those seen in a number of experiments above: because the equilibrium r_h increases, renters end up paying higher rents, leading to higher income and

[31]Some households will still demand owner-occupied housing even if deposits are more attractive financially, due to the utility gain from owner-occupied housing.

consumption Gini coefficients. Landlords, however, do not really enjoy the benefits of a higher rental yield, because the mortgage interest rate r_l actually increases by more than r_h (i.e., only landlords who buy investment properties out of pocket stand to gain).

Note finally how a change in the property tax rate would lead to very similar results to a change in interest rates as described here. Indeed, a higher property tax rate decreases the attractiveness of housing as an asset by reducing one-for-one the (net) differential in returns between housing and deposits. It therefore leads to a decrease in demand for housing at any price and to an eventual increase in the equilibrium rental yield.

Figure 11: *Surface area representation of demand for housing as a percentage of population, when r_b is increased to 1%, all else equal, by p_h and r_h.*