

European housing markets

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Abstract

In Europe, rental housing is supplied by individuals buying additional properties as savings, not by the institutional landlords assumed in macro-housing models. We study an economy in which heterogeneous households supply rental housing by saving for lumpy whole-unit purchases. At the aggregate level, individual landlords replicate institutional-landlord models: wealth accumulation substitutes for deep pockets. Loan-to-value (LTV) constraints leave house prices unaffected; long-run income growth strongly raises price-to-rent ratios. Distributionally, relaxing LTV constraints raises homeownership and shifts rental supply toward small landlords, while faster growth reduces homeownership and concentrates supply among large landlords. Regulations affecting individual landlords are evaluated.

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1 Introduction

With house prices decoupling from incomes in many countries, and households finding it increasingly more difficult to become homeowners, governments on both sides of the Atlantic have moved to curb the role of landlords (buy-to-let investors) in housing markets. The premise behind these efforts is that landlords push up house prices, crowd out potential owner-occupiers and, ultimately, increase housing wealth inequality. For instance, Spain’s 2023 Housing Law designates ‘stressed market areas’ (*Zonas Tensionadas*) where ‘large landlords’ (*Grandes Tenedores*)—owners of more than five residential rental properties—face binding rent caps and regulations regarding rental property sales. These measures effectively impose an implicit tax on rental property investment.¹ In the United States, a January 2025 executive order announced immediate steps to ban large institutional investors from purchasing single-family homes and the Senate overwhelmingly passed the 21st Century ROAD to Housing Act in March 2026, which would prohibit any large institutional investor from purchasing single-family homes.² Alongside the measures by governments, central banks and financial regulators have moved to impose more stringent lending criteria on rental properties than owner-occupied properties, with the aim of containing house prices.³ As the sentiments in societies about housing affordability grow stronger, we are likely to see more such measures going forward.

Despite this symmetry of concerns, the underlying market structures on the two continents could hardly be more different. In most European countries, an overwhelming majority of *private rental units* are owned by individual households holding just one or a few apartments or family houses, often as a form of long-term saving, alongside an owner-occupied

¹An extreme example of policies targeting landlords is the 2021 non-binding referendum in Berlin, approved by 57.6% of voters, to socialize residential properties of large real estate companies. A second, legally binding, referendum on the same issue is being prepared to coincide with Berlin’s 2026 state election. A moderate example is a bill passed in the United Kingdom in 2026, introducing separate—higher—tax brackets on the part of personal income accruing from rental properties. Progressive property taxes, falling especially on those holding rental properties, exist in France (*Impt sur la Fortune Immobilière*) and Greece (*ENFIA*). Various cities around Europe recently introduced their own local policies targeting landlords.

²Parallel state-level initiatives have advanced in California, New York and Minnesota, among others.

³Among others, the Bank of England, the Central Bank of Ireland, the Finanstilsynet in Norway, and the Czech National Bank.

home. The presence of institutional landlords in private rental markets is negligible (Section 2).⁴ In the United States, by contrast, the picture is mixed but tilted toward institutional landlords. While individual investors own roughly 70% of all rental *properties*, concentrated in the single-family segment (family houses), various types of institutional entities own about 65% of all rental *units*, by dominating the segment of multi-unit properties (apartment blocks); Congressional Research Service (2022).

This empirical asymmetry is not reflected in the macro-housing literature. In fact, little is known about the properties of models with individual landlords and how the standard questions of housing economics answer themselves in such environments. Motivated by the US market, the practice is to assume institutional landlords, modeled either as a representative domestic real estate firm (eg, Gervais and Fisher, 2011) or as a representative foreign deep-pocketed investor (eg, Kaplan, Mitman and Violante, 2020). In the former case, the firm pools all households’ savings, so that every household is indirectly a landlord, while in the latter case the landlord lives outside of the model. Chambers, Garriga and Schlagenhauf (2009a) and Sommer, Sullivan and Verbrugge (2013) consider ‘fractional’ landlords, households who can rent out a fraction of the property they use for owner occupancy. In a follow-up paper, Chambers, Garriga and Schlagenhauf (2009b) place such fractional landlords alongside institutional landlords.⁵ None of these setups, however, speaks to most European countries, where landlords in private rental markets are overwhelmingly individual households—facing the same constraints as everyone else—but acquire rental properties as a form of saving for themselves, as well as for their children. In Europe, wealth accumulation at the level of individual households and the supply side of the rental market are tightly connected.

To fill the gap, we construct an İmrohoroglu–Bewley–Aiyagari–Huggett economy of wealth accumulation, in which heterogeneous households endogenously, and nonexclusively, choose to be owner-occupiers, renters or landlords, and may own one or more housing units. The

⁴Renting in the private rental market is in Europe significantly more common than renting from public authorities (Section 2).

⁵See also Kaas, Kocharkov, Preugschat and Siassi (2021).

model is standard but for its treatment of landlords. There are neither institutional nor fractional landlords. Rental units can be purchased only as whole units. To clear the rental market, enough households must find it optimal to save enough for lumpy rental property purchases (or downpayments). Two versions of the model are considered: a general equilibrium version with endogenous interest rate (a theoretical benchmark) and a small open economy with an exogenous interest rate. The latter provides a more appropriate representation of European economies, as well as a closer comparison with the literature, which often treats the interest rate as exogenous. The latter version is the main focus of our analysis. House prices and rental prices (and thus the return on rental properties) are, however, endogenous in both cases.

We use the model to quantitatively study the *long-run* effects on standard housing market variables, as well as on the distribution of rental properties across landlords, of the following primitives. *First*, we vary the maximum permissible loan-to-value (LTV) ratio. It had long been a consensus that relaxing LTV constraints inevitably raises house prices, until Greenwald and Guren (2025) reopened the debate, showing that in the presence of a representative foreign deep-pocketed landlord (eg, Kaplan et al., 2020), borrowing constraints faced by potential owner-occupiers have essentially no effect on house prices.⁶ We ask whether this conclusion survives when rental supply comes from individual landlords. *Second*, we vary the long-run aggregate income growth rate, a force broadly overlooked in the macro-housing literature. In contrast to most of the literature (a notable exception being, eg, Kiyotaki et al., 2011), we consider a balanced growth path equilibrium, instead of a steady state equilibrium with zero growth. The theoretical reason for this consideration is simple. On a balanced growth path, rent growth (of both market and imputed owner-occupiers' rents) is related to income growth. Invoking lessons from asset pricing theory, a faster rent growth, everything else constant, leads to a higher price-to-rent ratio, as growing future rents get priced in. Long-run growth shocks are common in finance and aggregate in-

⁶See also Kiyotaki, Michaelides and Nikolov (2011) for the same outcome in the context of a representative domestic real estate firm.

come growth offers itself as an alternative (or complementary) factor to financial constraints, affecting house prices.⁷ Indeed, some of the economies with the fastest income growth in the EU over the past decade have experienced some of the fastest-growing house prices and highest price-to-rent ratios, despite no apparent relaxation of lending standards.⁸ *Third*, we consider regulatory constraints targeting individual landlords advanced by policymakers in the name of curbing house prices and improving housing affordability.

The results have a clear two-part structure. *At the aggregate level*, the European setting of individual landlords approximately replicates the properties of US models with institutional landlords: *wealth accumulation by individual households substitutes for deep pockets* of institutional landlords in supplying rental properties. First, the point made by Greenwald and Guren (2025) in the presence of a representative foreign deep-pocketed landlord—that LTV borrowing constraints have essentially no effect on house prices—turns out to hold also in the presence of individual landlords. Second, in the presence of individual landlords, in a small open economy, there are large effects of long-run aggregate income growth on the price-to-rent ratio. These effects are similar to those under a representative domestic deep-pocketed landlord, although they are smaller than under a representative foreign deep-pocketed landlord.⁹

On the distribution of housing wealth across households, the two settings part company entirely. First, with deep-pocketed institutional landlords (domestic or foreign), distributional effects of aggregate factors on landlords cannot even be posed: by construction such models are silent on this dimension. With individual landlords, LTV ratios and long-run aggregate income growth redistribute housing wealth not only between landlords and non-landlords, but also among landlords. Broadly speaking, relaxing the LTV constraint increases the homeownership rate and the share of ‘small’ landlords, whereas higher aggregate income

⁷We view our experiments of comparing balanced growth path equilibria as computationally less demanding substitutes for studying equilibrium outcomes in the presence of long-run growth rate shocks.

⁸Examples include Hungary, Czechia, Lithuania, or Latvia.

⁹The two institutional landlords differ from each other in the model only in the extent to which their discount factors are exposed to the domestic economy. With endogenous interest rate, the interest rate soaks up all the effects of growth rates, leaving all other variables unaffected.

growth reduces the homeownership rate and increases the share of ‘large’ landlords. In this sense, the former effect reduces housing wealth inequality, whereas the latter effect increases it. Second, various policies operate at the level of individual landlords.¹⁰ They thus affect different landlords differently and their aggregate outcomes depend on the underlying landlord heterogeneity. We consider two examples. A tax on rental income of landlords owning more than a threshold number of rental properties and a tighter LTV constraint on rental properties than owner-occupied properties. Our findings suggest that the success of such regulations in combating high house prices and supporting homeownership is questionable. The largest effects are on the landlord-size distribution. In some cases, renters loose out by having to pay higher rental prices.

The most directly related studies have been noted above. The paper is also related to the literature on nonconvexities in quantitative macro models, starting with Hansen (1985), in the case of labor supply, Díaz-Giménez and Prescott (1997) in the case of financial assets, and Thomas (2002), in the case of physical capital. The results for house prices share with a part of this literature the property that lumpiness and heterogeneity at the micro-level substitute for a representative agent. The idea that long-run growth can have significant effects on asset prices goes as far back as to Gordon (1959). Modern incarnations of this idea, starting with Barsky and DeLong (1993) and Bansal and Lundblad (2002), led to the so-called long-run risk models in finance. Jones (2016), among others, documents time-variations in long-run economic growth in various countries. The concept of balanced growth is borrowed from the growth literature. Gomme and Rupert (2007) provide theoretical results in a class of models with housing. Empirically, the effects of rent growth on the price-to-rent ratio have been studied, for instance, by Campbell, Davis, Gallin and Martin (2009).

The paper proceeds as follows. Section 2 describes the supply side of European housing markets. Section 3 introduces the model. Section 4 describes its parameterization. Section 5 presents the findings. Section 6 contains concluding remarks.

¹⁰For instance, they start to apply at a relatively small number of rental properties or, in the case of financial constraints, are more likely to bind for individual landlords than deep-pocketed institutional landlords.

2 European residential rental markets

Studies providing insights into the realities of European residential rental markets are less common than US studies. However, recent research by industry bodies (Accentro, 2020; Deloitte, 2024; JLL Research, 2024) offer a valuable overview of the key features of the markets and support earlier findings from the academic literature (London School of Economics, 2011; Scanlon and Whitehead, 2016). The studies show that in a vast majority of the countries covered, the presence of institutional landlords is negligible. Rental units are essentially owned by individuals.¹¹

Table 1 summarizes the ownership composition of the combined EU & UK housing stock, on the basis of JLL Research (2024). The combined figures are fairly representative of the composition in most of the individual countries. Where significant departures from the average arise, we note these departures in the text and refer the reader for details to JLL Research (2024).

There are about 226.4 million housing units (dwellings) in the EU & UK—more specifically, 194.5 million housing units in the 17 largest EU countries in 2023, according to Deloitte (2024), and 26.4 million units in the United Kingdom in 2021, according to the Office for National Statistics. The 17 EU countries cover 97% of the EU housing stock. Of the 226.4 million housing units, about 80 million are rental units, while 146.4 million units are owner-occupied. Rental units thus account for 35.3% while owner-occupied units make up 64.7% of the housing stock. While there are EU countries that do not quite fit this characterization (namely Germany and some Eastern European countries), the split of the combined housing stock between rental vs. owner-occupied dwellings more or less reflects the composition of the housing stock in most EU countries and the United Kingdom (JLL Research, 2024). In addition, as a ‘household’ is typically defined as a group of people sharing a given housing unit (subject to some minor conditions), the composition of the housing stock also closely

¹¹A note on terminology: a rental ‘unit’ corresponds to a dwelling (an apartment or a single-family house). A rental ‘property’ may consist of one or more rental units (an apartment building or a multi-family house). The statistics in this section refer to units.

reflects the composition of households in terms of renters and owner-occupiers. The homeownership rate in the EU is 68%, in the United Kingdom it is 64%. Among the original EU countries, the homeownership rate hovers between 60% and 70%, it is higher in Eastern European countries; see European Mortgage Federation (2021).¹²

Of the 80 million rental units, 53 million units are in the private rental market, making up 66.3% of all rental units. Publicly provided units constitute 25.9%, with the remaining 7.8% ascribed to student accommodation and care homes. Finally, of the 53 million units in the private rental market, 90% are owned by small nonprofessional landlords (individuals or couples), with institutional owners holding only 10% of the market. In comparison, in the United States, the share of residential rental units held by institutional landlords is 65% (Congressional Research Service, 2022). Private rental units owned by small nonprofessional landlords thus constitute the second largest category in the EU & UK housing market, after owner-occupied dwellings, making up 21.1% of the total housing stock.¹³ From some media headlines one would have the impression that institutional landlords are important players in the EU & UK market. This is because big investors are starting to enter the market, which seem to be catching the media attention.

The small role of institutional landlords is nearly uniform across the EU & UK. The only countries in which institutional landlords play an important role in the private rental market are Denmark, Finland, and Sweden, where institutional landlords account for 40% or more of a country's stock of private rental units. In Germany, which ranks fourth in the sample in the role of institutional landlords, the share is only 14%. In fact, in most countries the presence of institutional landlords is negligible, with their share of the private rental market being close to zero (for instance, in the United Kingdom the share is 2%).¹⁴

¹²Germany has the lowest homeownership rate, 52%, while Romania has the highest homeownership rate, 95%. Eastern European EU countries have a higher homeownership rate than the original EU members due to the mass privatization of public and company housing in the 1990s.

¹³For instance, in the United Kingdom, the share is 20%, with owner-occupied units making up 62% of the stock, on the basis of the 2021 Census.

¹⁴The 10% share of the combined EU & UK private rental market ascribed to institutional owners is largely accounted for by Germany, due to a low homeownership rate in Germany, the sheer size of the German population and the 14% share of institutional owners in the private rental market in Germany.

Further, JLL Research (2024) confirms earlier findings by London School of Economics (2011) that most small nonprofessional landlords in the EU & UK hold only up to five rental units. More details on the distribution of rental units across landlords are available for Germany and the United Kingdom. Research by Accentro (2020), which looks in more detail at the German market, implies that about 20% of landlords own one rental unit, 50% own up to three units, and nearly 90% own up to seven units. A survey carried out by Scanlon and Whitehead (2016) shows that 80% of UK landlords own one or two rental units and 93% own up to four units. A slightly wider distribution for the United Kingdom is suggested by the 2021 English Private Landlord Survey, according to which 82% of landlords own between one and four rental units and 93% own up to nine units. Further, the survey by Scanlon and Whitehead (2016) implies that the average number of rental units per landlord is equal to 2.23. This figure is broadly confirmed by aggregate data. According to the 2021 Census, there are about 5.28 million private rental dwellings in the UK. The Office for National Statistics reports that, on the basis of the 2024 self-assessment tax returns, there are about 2.82 million UK landlords. These figures then imply the average number of rental units per landlord equal to 1.87.

Finally, a related comparison between the US and the EU & UK markets concerns segmentation. In the United States, institutional landlords own large blocks of apartments, which are not available for sale to individual households. The US housing market is thus to a large extent segmented, with rental units being sold in a different market than units used for owner occupancy; see Garriga and Hedlund (2020) and the studies cited therein. In contrast, European housing markets are integrated, with units changing hands from landlords to owner-occupiers and back; see London School of Economics (2011).¹⁵ For instance, CBRE (2023) reports substantial flows of housing units between owner occupancy and the rental market in the United Kingdom: between 2022 and 2023, 2.4% of the stock of rental dwellings was sold to owner occupiers.

¹⁵One notable exception is Denmark, which to some extent resembles the US model.

3 The model

The model economy is an İmrohoroglu–Bewley–Aiyagari–Huggett dynastic economy of wealth accumulation in which heterogeneous households endogenously, and nonexclusively, choose to be owner-occupiers, renters, or landlords and may own one or more housing units. The model is standard but for its treatment of landlords. There are lumpy housing assets and perfectly divisible bonds. Financial markets are incomplete—in both the number of securities and the presence of a borrowing constraint—so becoming an owner-occupier or a landlord requires sufficient wealth to make a downpayment or to purchase a property outright. Households have two motives to save: precautionary savings and downpayments.¹⁶ The rent vs. own decision is modeled in a parsimonious way as a tradeoff between saving for a downpayment on a lumpy property purchase vs. higher utility from owning than renting. The decision to become a landlord is modeled as a tradeoff between saving for a downpayment on a lumpy property investment vs. higher equilibrium return on rental properties (the sum of rental yield and capital gain) than bonds. Neither fractional landlords—renting out a fraction of an owner-occupied property—nor institutional landlords are present in the model. The return on rental properties has to be sufficiently high to induce enough households to acquire a lumpy rental property to satisfy the demand by renters.¹⁷ Two versions of the model economy are considered: a general equilibrium version (a useful theoretical benchmark) and a small open economy (which more closely corresponds to the nature of European countries).

¹⁶In the absence of borrowing constraints, the housing effective lumpiness would be completely eliminated, as one could choose an arbitrarily small downpayment. The purchase would have to satisfy only a life-time budget constraint.

¹⁷In the context of the model, we use the terms ‘property’ and housing ‘unit’ interchangeably. They both refer to the same lumpy housing asset.

3.1 Environment

As in Greenwald and Guren (2025) households are infinitely lived and production takes the form of simple endowments. Preferences are characterized by the utility function

$$E_0 \sum_{t=0}^{\infty} \tilde{\beta}_t \frac{1}{1-\sigma} (c_t^\theta h_t^{1-\theta})^{1-\sigma}, \quad \theta \in (0, 1), \quad \sigma \geq 0, \quad (1)$$

where $\tilde{\beta}_t = \beta_t \tilde{\beta}_{t-1}$, with β_t following a three-state stationary Markov process. Shocks to the time preference parameter (Krusell and Smith, 1997) are one of the standard modeling choices used to generate a realistic wealth distribution, complementing idiosyncratic income shocks, introduced below. Further, c_t is consumption of a nonhousing good and h_t is consumption of housing services. Housing services may be bought in a spot rental market, h_{Rt} , and/or derived from the quantity of the housing asset owned, h_{Ot} , less the quantity of the housing asset supplied to the rental market, h_{Lt}

$$h_t = \psi_R h_{Rt} + \psi_O (h_{Ot} - h_{Lt}), \quad \psi_O > \psi_R > 0, \quad (2)$$

$$h_{Rt} \geq 0, \quad h_{Ot} \geq 0, \quad h_{Ot} \geq h_{Lt} \geq 0. \quad (3)$$

The restriction on the parameters ψ_0 and ψ_R means that people derive higher utility from the occupancy of the asset they own than from purchasing housing services in the rental market. This is one of the modeling assumptions in the literature used to generate an advantage of owning over renting; see, for instance, Ríos-Rull and Sanchez-Marcos (2008), Kiyotaki et al. (2011), and Bajari, Chan, Krueger and Miller (2013). We think of it as a reduced-form wedge capturing various homeownership benefits noted in the literature, the relevance of which likely differs across countries.¹⁸

¹⁸A nonexhaustive list of factors noted in the literature includes: mortgage interest tax deductibility, nontaxable capital gains on owner-occupied properties, greater control over the state of own property, and saving on renegotiation costs (both pecuniary and nonpecuniary) of rental contracts.

The quantities of the housing asset, h_{Ot} and h_{Lt} , are constrained to be on the grid

$$h_{Ot}, h_{Lt} \in \{0, \bar{h}, 2\bar{h}, \dots, \mathcal{H}\}. \quad (4)$$

For instance, a household can own $h_{Ot} = 2\bar{h}$ and rent out $h_{Lt} = \bar{h}$. (We use the term ‘to rent out’ in the context of landlords and the term ‘to rent’ in the context of renters.) The grid restriction, in conjunction with the borrowing constraint below, means that acquisitions of the housing asset, both for owner occupancy and as a rental property, are lumpy.

A few observations about the grid are appropriate. First, a minimum size constraint on a perfectly divisible housing stock would have the same effect on low income/wealth households as the grid. However, it would allow incremental adjustments once the minimum size requirement was met. An alternative strategy leading to lumpy housing investment would be to introduce a sufficiently high fixed cost of adjusting the housing stock at the individual level. Second, the model abstracts from the possibility that one could rent out a fraction of $\bar{h}$ that is used for owner occupancy (eg, a room in an owner-occupied house). Such an assumption is made, among others, by Chambers et al. (2009b), Sommer et al. (2013), and Kaas et al. (2021). Our focus is on landlords who purposefully acquire an entire property to rent it out. This is the key feature of European housing markets and such acquisitions require sufficient wealth. Abstracting from fractional landlords also isolates more clearly the mechanism in the model, which relates the supply of rental properties to wealth accumulation. Third, in principle, the multiples of $\bar{h}$ can be thought of as both different numbers of equally-sized housing units or a single housing unit of different sizes. We calibrate the model so that $\bar{h}$ corresponds to an average-priced property. The interpretation of the grid in terms of the number of units allows a more straightforward mapping into the available data, which are in terms of the number of rental units a landlord owns.

Renting is divisible, meaning that it is possible to rent a fraction of the housing asset (it is possible to share a rented house with other people but not to co-own it). It is also possible to rent an entire unit or even more than just one unit. That is, $h_{Rt} < \bar{h}$ is feasible, as is

$\bar{h} \leq h_{Rt} < 2\bar{h}$, and so on. In principle, a household can have all three tenure statuses at the same time: an owner-occupier, renter and landlord. For instance, by owning $2\bar{h}$, renting out $\bar{h}$ and renting a fraction of $\bar{h}$.¹⁹

The budget constraint is

$$c_t + q_t h_{Rt} + p_t h_{Ot} + v_t^i b_t = y_t + a_t + q_t h_{Lt} - \kappa_t, \quad (5)$$

$$a_{t+1} = p_{t+1} h_{Ot} + b_t. \quad (6)$$

Here, q_t is the rental price, p_t is the price of the housing asset, b_t is holdings of a one-period bond, $v_t^i = (1 + r_t^i)^{-1}$ is the bond price (with r_t^i being the interest rate), y_t is an endowment of the nonhousing good, a_t is net worth, and κ_t is a cost of managing rental properties, explained below. The interest rate r_t^i , $i \in \{S, B\}$, contains a spread τ , depending on the sign of the bond position: $r_t^S = r_t - \tau$ if $b_t > 0$ and $r_t^B = r_t + \tau$ if $b_t < 0$, where r_t is the mid-rate that clears the bond market. With this formulation, the borrowing interest rate is higher than the saving interest rate. The spread is an ‘intermediation cost’, a resource loss, measured in terms of the nonhousing good. The role of the spread is to ensure that for sufficiently wealthy households, for whom the lumpiness of housing is a small concern, saving in bonds and investment in rental properties are not close substitutes, which creates computational issues (in the extreme case of perfect substitutes, their portfolio is indeterminate).

As h_{Ot} represents a claim on all future housing services, whereas h_{Rt} represents the right to access the services only in the current period, $p_t > q_t$. Note the timing convention that housing services (regardless of whether in terms of utility or rent payments) are received in the current period t . We also abstract from any costs of adjusting h_{Ot} or h_{Lt} . These assumptions allow us to stack the housing asset and bonds into the net worth variable, a_t , reducing the state space (otherwise it would be necessary to keep track of h_{Ot} , h_{Lt} and b_t separately). Despite the absence of adjustment costs, the lumpiness of the housing asset

¹⁹In the computational experiments, households in equilibrium never choose to rent more than one unit or to be both owner-occupiers and renters. The measure of households who choose to be both landlords and renters (renting out all properties they own and consuming rental housing) is tiny.

means that when faced with a negative income shock, a household runs down its bond position first, before selling the housing asset. This is because otherwise there would be large changes in utility and rates of return on the overall asset position (the latter in the case of landlords). The housing asset is thus less liquid than bonds.²⁰

Households face a collateral constraint on their bond position

$$-b_t \leq \chi p_t h_{Ot}, \quad \chi \in [0, 1), \quad (7)$$

where χ is the maximum permissible LTV ratio. As we abstract from default or inflation (monetary policy), for which a long-term repayment schedule of mortgage contracts is important, debt is modeled as a simple one-period loan.²¹ An implicit assumption in the borrowing constraint is that the constraint does not discriminate between owner-occupied ($h_{Ot} - h_{Lt}$) and rental (h_{Lt}) properties. Only the overall position (h_{Ot}) in the housing asset matters. This will be relaxed later.

The endowment of the nonhousing good, which we will refer to as income, consists of a deterministic aggregate component $\bar{Z}_t$ and a stochastic individual component w_t

$$y_t = \bar{Z}_t w_t.$$

The individual component w_t follows a stationary stochastic process taken from the literature (described as a part of calibration below), while the aggregate component $\bar{Z}_t$ grows at a constant growth rate λ

$$\bar{Z}_t = (1 + \lambda) \bar{Z}_{t-1}.$$

This process captures in a simple way long-run aggregate productivity growth in a sector producing the nonhousing good.

²⁰The setup does not allow us to keep track of transitions of individual households across the different tenures over two consecutive periods (we only see the current tenure of each household). The transitions, however, are not the focus of the paper anyway and nothing in terms of the analysis is lost by ignoring them.

²¹See Garriga, Kydland and Šustek (2017) for an interaction between long-term mortgages and monetary policy and Garriga and Hedlund (2020) for an interaction between long-term mortgages and default.

Finally, the cost of managing rental properties κ_t is given by

$$\kappa_t = \kappa_{0j} \overline{Z}_t (h_{Lt})^{\kappa_1},$$

where $\kappa_{0j} \in \{\kappa_{0L}, \kappa_{0H}\} > 0$, $\kappa_1 > 1$ and $\overline{Z}_t$ is a scaling factor ensuring stationarity.²² Further, $\kappa_{0H} > \kappa_{0L}$. The parameter κ_{0j} introduces ex-ante heterogeneity into the model, splitting the population into households who can potentially become landlords (if they accumulate enough wealth) and households who will never become landlords. For the latter, κ_{0H} is set arbitrarily high so that $h_{Lt} = 0$ always holds. The parameter κ_{0j} captures unobserved heterogeneity in a cross-section of households. In the data, not all households who have enough wealth to own a rental property own one (for instance, due to high disutility of having to deal with tenants, legislation, maintenance or due to individual-specific returns on other investments). The ex-ante heterogeneity allows the model to be consistent with both (i) a reasonable wealth distribution and (ii) an observed fraction of households in the population who are landlords. Without the ex-ante heterogeneity, the model would produce either too large share of households in the population who are landlords or we would have to force the model to generate a wealth distribution that is significantly (and counterfactually) right-skewed. We denote by $\overline{\mu}_L$ the fraction of households for whom $\kappa_{0j} = \kappa_{0L}$. Within $\overline{\mu}_L$, the fraction of households who choose to become landlords is endogenous. The ex-ante heterogeneity is orthogonal to both the discount factor and income heterogeneity.²³

In their main model, Greenwald and Guren (2025) assume rich ex-ante heterogeneity in terms of a cost of owning a rental property. The distribution over the cost is exogenous and calibrated. In our model, the ex-ante heterogeneity has just two values. On the other hand, our model has endogenous wealth distribution, whereas their model is silent on this dimension. Our model thus complements their framework and focuses on saving behavior

²²An alternative assumption would be to specify the cost in terms of disutility, rather than placing it into the budget constraint. Either formulation is valid.

²³The convex shape of the cost function (the κ_1 parameter) is introduced for practical reasons. It helps keep wealth of the richest households below a pre-specified upper bound of the state space across different parameterizations of the model we explore in computational experiments.

and wealth heterogeneity as a mechanism determining the supply of rental properties, factors appearing to be important in European housing markets.

3.2 Balanced growth path equilibrium

There is no aggregate uncertainty and we focus on a steady-state (balanced growth path) equilibrium. Let $s_t \equiv [\kappa_{0j}, \beta_t, w_t, a_t]$ be a vector of individual characteristics, μ be the endogenous (stationary) measure of households with these characteristics and H be a constant aggregate *per-capita* housing stock.²⁴ In every s_t , households can choose the vector $[c_t, h_{Ot}, h_{Rt}, h_{Lt}, b_t, a_{t+1}]$ to maximize the utility function (1) subject to constraints (2)-(7). Define $c_t^* \equiv c_t/\bar{Z}_t$, $b_t^* \equiv b_t/\bar{Z}_t$, $a_t^* \equiv a_t/\bar{Z}_t$, $\kappa_t^* \equiv \kappa_t/\bar{Z}_t$, $p_t^* \equiv p_t/\bar{Z}_t$ and $q_t^* \equiv q_t/\bar{Z}_t$ to transform the growing economy into a stationary one.

In a balanced growth path equilibrium (a steady-state equilibrium of the transformed stationary economy), the price vector $[p^*, q^*, r]$ clears the market for the housing asset, the rental market and the bond market, respectively

$$\begin{aligned} \int h_O(s) \mu(ds) &= H, \\ \int h_L(s) \mu(ds) &= \int h_R(s) \mu(ds), \\ \int b^*(s) \mu(ds) &= 0, \end{aligned}$$

where $h_O(s)$, $h_L(s)$, $h_R(s)$, and $b^*(s)$ are the individually optimal decision rules. The market for the nonhousing good clears by Walras's Law. When the interest rate is exogenous, only the first two conditions apply. The bond market is not required to clear. This is the assumption of a small open economy.²⁵

In the rental market clearing condition, the left-hand side sums all housing units sup-

²⁴Constant per-capita housing stock captures the observation that, in the data (in countries for which sufficiently long housing stock estimates are available), the aggregate housing stock and population grow in the long run at similar rates, in the ballpark of 1%.

²⁵For given values of the time preference parameters, there is a lower bound on λ that can be considered, for a given exogenous interest rate. If λ is too low, wealth grows without bounds.

plied to the market. The right-hand side sums individual demand for the units by renters. Individual demand, however, can be fractional, while the supply is in terms of entire units.

For future reference, observe that the market clearing conditions for the housing asset and rental market can be combined and either of the two conditions can be replaced with

$$\int (h_O(s) - h_L(s))\mu(ds) + \int h_R(s)\mu(ds) = H. \quad (8)$$

Here, the first term is the demand for housing by owner-occupiers and the second term is the demand for housing by renters. Owner occupiers can demand only whole units, whereas renters can demand fractions of units.

In a balanced growth path equilibrium, p_t and q_t grow at the growth rate λ , reflecting the fact that the quantity of the nonhousing good per capita grows at the rate λ , whereas the quantity of housing per capita (regardless of whether owned or rented) is constant. This captures in a simple way differences in long-run productivity growth in the sectors producing nonhousing goods and housing (Davis and Heathcote, 2005; Davis and Van Nieuwerburgh, 2015). The experiments in which we vary λ should thus be interpreted as comparisons across different, relative, productivity paths in the sector producing nonhousing goods.

3.3 Various housing market statistics

We close this section by setting up some definitions and notation that we use later to summarize the equilibrium outcomes. We refer to the p_t/q_t ratio as the *price-to-rent ratio* and use the notation $r_{h,t+1}$ for *housing return* (return on rental properties). Housing return is defined as the sum of *rental yield* (r_{yt}) and *capital gain* ($r_{g,t+1}$), where rental yield is the inverse of the price-to-rent ratio (q_t/p_t) and capital gain is the change in the house price ($p_{t+1}/p_t - 1$). A *housing premium* ($prem_{t+1}$) is defined as the difference between the housing return and the interest rate (the mid-rate). In sum, the following accounting identity holds

$$r_{h,t+1} \equiv r_{yt} + r_{g,t+1} \equiv r_t + prem_{t+1},$$

where the time subscripts reflect the timing of payoffs. To be more precise, the above equation should be written as $r_{h,t+1} \equiv (1 + r_t)r_{yt} + r_{g,t+1}$, given that rents are obtained in the current period. For easier exposition, we proceed with the simpler expression (a common convention in the asset pricing literature for a small r_t). The results reported in the tables in the next sections follow, however, the latter relationship. As there is no aggregate uncertainty, the relations hold both ex-ante and ex-post (ie, expected returns are equal to realized returns).²⁶

Using the above relations, the price-to-rent ratio can be written as

$$\frac{p_t}{q_t} = \frac{1}{r_{h,t+1} - r_{g,t+1}} \quad \text{or} \quad \frac{p_t}{q_t} = \frac{1}{r_t + prem_{t+1} - r_{g,t+1}}. \quad (9)$$

In a balanced growth path equilibrium, $r_{g,t+1} = \lambda$, the interest rate is constant and p_t and q_t grow at the same rate λ (the price-to-rent ratio is constant). Consequently, $r_{h,t+1}$ and $prem_{t+1}$ are constant. From now on, for variables that are constant, time subscripts are dropped. The steady-state level of house prices satisfies the relation

$$p^* = \frac{1}{r + prem - \lambda} q^*. \quad (10)$$

Only three of the four variables in (10) are independent, clearing the three markets.

At times, it is more instructive to explain the results in terms of $[p^*, r_h, r]$ or $[q^*, r_h, r]$, where $r_h = r + prem$, rather than $[p^*, q^*, r]$. In particular, we will use r_h as the price clearing the rental market and either p^* or q^* as the price making equation (8) to hold.

We report various cross-sectional variables, based on the endogenous stationary distribution μ . The *homeownership rate* (*O-rate*) is defined as the fraction of households owning at

²⁶For a household with characteristics s_t , purchasing the housing asset in the current period for rental purposes, the following condition holds at the marginal rental unit: $r_{yt} - \delta(h_L(s_t)) + (1 + r_{g,t+1})E[m(s_{t+1}, s_t)|s_t] \geq 1$, where $m(s_{t+1}, s_t)$ is the investor's stochastic discount factor, $\delta(\cdot)$ is the marginal management cost, as a fraction of p_t , and $E[\cdot|s_t]$ is the expectation operator about next period's individual state, conditional on the current state. If the housing asset was perfectly divisible, the condition would hold with equality. Note that, the interest rate spread aside, $E[m(s_{t+1}, s_t)|s_t]$ is not necessarily equal to $(1 + r_t)^{-1}$ due to the borrowing constraint. The lumpiness of the housing asset (downpayment) affects $m(s_{t+1}, s_t)$ by making consumption less smooth than if housing was perfectly divisible ($m(\cdot, \cdot)$ depends on h_L). If $E[m(s_{t+1}, s_t)|s_t] = (1 + r_t)^{-1}$ and the above condition for housing holds with equality, household s_t satisfies the Poterba (1984) user cost theory.

least one property (owner-occupied or rental) and the *landlord rate* (L -rate) as the fraction of households owning at least one rental property.²⁷ The notation $\mu_L(h_L = 1)$, $\mu_L(h_L = 2)$, etc., is used to denote the fraction of landlords, conditional on the landlord rate, with one, two, etc. rental properties. The average number of rental properties per landlord is denoted by $E(h_L)$. For future reference we note here that the endogenous distribution is sometimes characterized by bunching around the discrete number of the housing units on the grid. Consequently, the moments $\mu_L(h_L = 1)$, $\mu_L(h_L = 2)$, etc. appear to contain discrete jumps as we vary the values of the model parameters.

Finally, using the stationary distribution μ , we report statistics commonly used to gauge housing affordability: the *price-to-income ratio*, $p/E(y)$, where $E(y)$ is the average income in the population, and the average share of renters' income spent on rent, $qE[h_R/y_R]$, where h_R is given by the optimal decision rule $h_R(s)$ and y_R is income of the renter with the characteristics s .²⁸

4 Parameterization

The parameterization is meant to be illustrative, not tied to any specific country. We are simply interested in the quantitative properties of an economy with individual landlords, rather than trying to explain a specific period in a specific country. The baseline values are reported in Table 2.

4.1 Parameter values

The model period corresponds to a year. There are two normalizations: $\bar{h} = 1.0$ and $\psi_O = 1.0$. The first normalization means that if $p/E(y)$ is equal to the average price-to-income ratio, then $\bar{h}$ has the interpretation of an average-size dwelling. This is the interpretation of

²⁷The equilibrium measure of households who choose to be both landlords and renters (renting out all properties they own and consuming rental housing) is tiny. The homeownership rate and owner-occupancy rate are thus essentially the same thing.

²⁸Both the average income $E(y)$ and the average renters' income $E(y_R)$ grow at the rate λ .

$\bar{h}$ we have in mind. The normalization of ψ_O means that the parameter ψ_R is a measure of relative utility of renting $\bar{h}$, instead of owner-occupying it.

A number of parameters are set equal to relatively standard benchmark values in the literature. The parameter of the curvature of the utility function, σ , is set equal to one and the growth rate of aggregate income, λ , is set equal to 2%, a long-run average in developed countries. The maximum permissible LTV ratio, χ , is set equal to 0.7 and the interest rate spread parameter, τ , is set equal to 0.005, which makes the spread between the borrowing and saving rates equal to 1.0%. The process for the individual component of income is AR(1) with autocorrelation equal to 0.97 and the standard deviation of innovations equal to 0.2. Such parameterization is used, for instance, by Kaplan et al. (2020). The parameters of the transition matrix of the β_t shocks are the same as in Krusell and Smith (1997), who motivate them as capturing elements of altruism (parents caring about the utility of their children) and less than perfect correlation in genes between parents and children. The cost function for managing rental properties is assumed to be quadratic and κ_{0L} is set to a modest value of 0.001.

The remaining six parameters are chosen jointly to match six moments. This strategy concerns the relative weight on nonhousing consumption in the utility function, θ , the relative utility from renting, ψ_R , the ex-ante heterogeneity measure, $\bar{\mu}_L$, and the three values of the time preference parameter, denoted by β_L , β_M and β_H . The six moments consist of: the rental yield equal to 4.4%, the price-to-income ratio equal to 8.2, the homeownership rate equal to 0.65, the landlord rate equal to 0.056, the average number of rental properties per landlord equal to 1.87, and the share of hand-to-mouth households equal to 0.25 (ie, those with zero wealth). This strategy yields $\theta = 0.79$, $\psi_R = 0.8$, $\bar{\mu}_L = 0.065$, $\beta_L = 0.920$, $\beta_M = 0.955$, and $\beta_H = 0.966$. The three values of the time preference parameter help pin down the rental yield (and thus, for a given λ , the housing return) and two distributional moments, the share of hand-to-mouth households and the average number of rental properties per landlord.²⁹

²⁹The rental yield is the average from the Numbeo Cost of Living Database (Europe, 2025). This is a

4.2 Equilibrium implications

The values of the model’s endogenous variables in the balanced growth path equilibrium are reported in Table 3. Six of the variables in the table have already been used as targets in the aforementioned parameterization. The values of the equilibrium house and rental prices are reported for completeness, but they are only meaningful in relation to each other or to income. The housing return is equal to 6.4%, the sum of the rental yield of 4.4% and the long-run growth rate of 2%. Such a return is within the long-run cross-country estimates reported by Jordà, Knoll, Kuvshinov, Schularick and Taylor (2019). The housing premium resulting from housing lumpiness is 0.53%. The price-to-rent ratio is equal to 24.07, which is the inverse of the rental yield, adjusted for the timing of rent payments being received in the current period, as discussed in Section 3.3. In the model, the average fraction of income renters spend on rent is 0.28. According to Eurostat, the share of rent related to occupied dwelling in disposable household income hovered in the EU around 0.23 between 2018 and 2025 (Eurostat database, online data code: ilc mded02). JLL Research (2024) report a higher estimate, 0.33 of disposable income. Finally, the model has implications for the distribution of rental properties across landlords. Using the notation introduced in Section 3.3: $\mu_L(h_L = 1) = 0.46$, $\mu_L(h_L = 2) = 0.35$, $\mu_L(h_L = 3) = 0.10$, $\mu_L(h_L = 4) = 0.04$, and $\mu_L(h_L \geq 5) = 0.05$. Thus, 81% of landlords own up to two and 95% own up to four rental properties. This is broadly consistent with the UK evidence discussed in Section 2.³⁰

database for selected European cities. The OECD database provides at the level of countries only an index, but not the actual yield (or the price-to-rent ratio). The price-to-income ratio is also from the Numbeo database and corresponds to the locations with the average rental yield. The homeownership rate more or less corresponds to the EU & UK average, discussed in Section 2. The landlord rate is for the UK, given the available data. It corresponds to the fraction of landlord individuals (on the basis of 2024 self-assessment tax returns) in the population 18+. The figure for the average number of rental properties is also for the UK and is discussed in Section 2. The share of hand-to-mouth households is relatively standard.

³⁰To put housing wealth in the model in a broader context of wealth distribution, the wealthiest households in the model own ten properties and own them outright. If one was to use the average UK house price of £226,756 (ONS UK House Price Index, December 2017), this would place these households, on the basis of the housing wealth alone, in the 97th to 98th percentile of the UK wealth distribution (ONS, 2017).

5 Findings

This section presents the results of our computational experiments: the effects of LTV borrowing constraints, long-run aggregate income growth, and regulations affecting landlords.

5.1 LTV borrowing constraints

For a while there has been a consensus in the literature that relaxing LTV borrowing constraints inevitably increases house prices. Greenwald and Guren (2025) have, however, reopened the debate. They have made the important point that in the presence of a representative foreign deep-pocketed landlord and integrated housing markets (assumptions made by, for instance, Kaplan et al., 2020), LTV borrowing constraints have no effect on house prices.³¹ The only equilibrium effects of different LTV ratios in such an environment are on the homeownership rate, with a higher LTV ratio leading to a higher homeownership rate. This is because in the presence of a representative foreign deep-pocketed landlord, the supply of rental properties is perfectly elastic and accommodates any number of rental properties—and thus, by the flip-side, also owner-occupied properties—demanded at any LTV ratio. Housing units in such an environment effectively change tenure along with households.³² We revisit this question in our environment in which the supply of rental properties is tied to household wealth accumulation. The findings are reported in Table 4, for the general equilibrium case, and in Table 5, for the small economy case.

5.1.1 General equilibrium

Table 4 reports the results for the general equilibrium case (endogenous interest rate). Varying the maximum permissible LTV ratio (χ) has no effect on the house price, the housing return or the price-to-rent ratio.³³ Increasing the LTV ratio, however, increases the interest

³¹The term ‘deep-pocketed’ means that the landlord faces no budget constraint. The term ‘foreign’ means that the landlord’s discount factor is exogenous and the resources used to purchase rental properties do not need to satisfy the model’s feasibility constraints.

³²The same is true also in the representative real estate firm setting (Kiyotaki et al., 2011).

³³The small variations in the values of these variables in the table are indistinguishable from a numerical error, resulting from the solution method used, based on standard approximation of continuous variables

rate, reduces the housing premium, increases the homeownership rate, and (at sufficiently high LTV ratios) increases the share of very small landlords, holding one or two rental properties.

The results in Table 4 extend the point made by Greenwald and Guren (2025) to an environment with heterogeneous domestic individual landlords, who do not have deep pockets and have to give up consumption to accumulate wealth for a downpayment on a lumpy rental property. Such landlords effectively replicate the equilibrium outcome of a perfectly elastic supply curve of rental properties present in an environment with a representative foreign deep-pocketed landlord.

On the supply side of the rental market, when the LTV constraint is tight, demand for credit by landlords is low, the interest rate (the price of credit) is low and the housing premium (reflecting a shadow price of lumpiness) is high, as households need to be compensated for the extra saving required to obtain a lumpy investment property. A high housing premium makes rental properties relatively attractive for wealthy households, who are less concerned about the lumpiness of such investment than less wealthy households. Consequently, the fraction of very small landlords is low and rental properties are concentrated in the hands of larger landlords, holding three or more rental properties.

On the demand side of the rental market, rental demand is strong at low maximum permissible LTV ratios, as the attractiveness of owner occupancy is low, due to the high foregone consumption required to save for the lumpy downpayment. Demand for credit by owner-occupiers is thus low, contributing further to the low interest rate.

As the LTV constraint gets relaxed, the housing asset becomes effectively less lumpy and accessible to more households for both owner occupancy and as a rental property. Demand for credit increases by both owner-occupiers and landlords. The interest rate rises, while the housing premium (reflecting a shadow price of lumpiness) falls, leaving the rate of return on housing constant. Consequently, in line with equation (9), the price-to-rent ratio remains constant. Easier access to credit increases the share of very small landlords, while a

(a, b, h_R, c, w) with a grid.

lower housing premium reduces the attractiveness of rental properties to wealthy households. Higher maximum permissible LTV ratios thus change the landlord composition of the supply of rental properties, tilting it towards very small landlords. At the constant rate of return on housing, this supply accommodates the lower demand in the rental market, which falls as owner occupancy increases with higher LTV ratios.³⁴

The rental market pins down r_h and thus the price-to-rent ratio. To understand the effect on the equilibrium level of house prices, p^* , it is instructive to think in terms of equation (8). An increase in owner occupancy at higher LTV ratios comes from a decline in renters renting the entire housing unit. The decline in the demand for rental properties thus translates one-for-one to an increase in the demand for owner-occupied properties, leaving total demand in equation (8) unaffected. Consequently, the homeownership rate increases while the house price remains unchanged. Finally, as both the price-to-rent ratio and the house price are constant, the rental price is also constant.

5.1.2 Small open economy

In Greenwald and Guren (2025) the representative foreign deep-pocketed landlord discounts investment in rental properties at a constant exogenous interest rate. The previous experiment in which the interest rate is endogenous, while theoretically appealing, is thus perhaps not the appropriate case for comparison. In addition, it does not reflect the small open economy nature of European countries. For this reason, we repeat the experiment under an exogenous interest rate, kept at the value resulting in general equilibrium under the baseline LTV ratio of 0.7. The results are contained in Table 5.

In this case, the effect of relaxing the LTV borrowing constraint is not accompanied by the equilibrium increase in the interest rate seen in Table 4. Higher maximum permissible LTV

³⁴The effect of relaxing the LTV borrowing constraint on the share of very small landlords is somewhat nonmonotone. At first, as the LTV ratio increases from 0.35 to 0.55, the share declines. At these values, the effect of relaxing the LTV borrowing constraint is taken advantage of by larger landlords, who increase the number of their rental properties (but not the largest landlords, as the average number of rental properties per landlord declines). The share of very small landlords increases significantly at the LTV ratio of 0.65 and higher.

ratios reduce the effective lumpiness of investment in rental properties. The housing premium and the housing return therefore decline and, in line with equation (9), the price-to-rent ratio increases. The resulting changes in the price-to-rent ratio are, however, small. An increase in the ratio by 4.8% (from 23.0 to 24.1) accommodates a change in the homeownership rate from 0.58 to 0.66, as the LTV ratio increases from 0.25 to 0.85. The change in the homeownership rate is comparable to the general equilibrium case. The equilibrium outcome in Greenwald and Guren (2025) under a representative foreign deep-pocketed landlord is thus *approximately* replicated by individual landlords in a small open economy. The changes in the landlord structure of the rental supply are similar to the general equilibrium case.

5.1.3 Discussion

Greenwald and Guren (2025) make the point about LTV constraints in the context of a representative foreign deep-pocketed landlord. Quantitatively negligible effects of LTV constraints on house prices, alongside large effects on the homeownership rate, have been previously obtained by Sommer et al. (2013). Both setups—like ours in the above experiment—assume a constant exogenous interest rate. In the model of Sommer et al. (2013), households are fractional landlords, renting out a fraction of a housing unit used for owner occupancy. Wealth accumulation in their model is thus less of an issue to become a landlord than in our model. Nonetheless, all three environments—a representative foreign deep-pocketed landlord, heterogeneous fractional landlords and our environment—lead to a roughly the same equilibrium outcome.

In order to reduce the elasticity of the supply of rental properties, Greenwald and Guren (2025) amend their framework by introducing rich ex-ante heterogeneity in the foreign landlord sector. In their main model, landlords are still deep-pocketed, and therefore identical in wealth, but differ in the cost of owning rental properties. When the exogenous distribution is appropriately calibrated, the authors find that changes in LTV borrowing constraints play a larger role, explaining from a third to a half of the boom-bust cycle in US house prices in the 2000s. The results of this section demonstrate that investment lumpiness and endogenous

wealth distribution are not a substitute for such a cost function and that, on their own, come close to replicating the perfectly elastic supply behavior of a representative foreign deep-pocketed landlord.³⁵

In Kaplan et al. (2020), where the supply curve is perfectly elastic, house price expectations do the heavy lifting. This is closer to the effects of long-run aggregate income growth in our model, studied below, as both mechanisms rely on expectations. In Kaplan et al. (2020), the expectations are about future preferences for housing. In our model, the expectations are about the long-run growth rate of the economy.

5.2 Long-run aggregate income growth

In a balanced growth path equilibrium, p_t and q_t grow at the growth rate λ (see Section 3.2). The effects of λ on other variables are reported in Table 6, for the general equilibrium case, and in Table 7, for the small economy case. As pointed out in Section 3.2, the experiments should be interpreted as comparisons across different relative productivity paths in the production of nonhousing goods.

5.2.1 General equilibrium

Table 6 reports the results for the general equilibrium case, which is again taken as a theoretical benchmark. As is clear from the table, the interest rate carries essentially all the burden of equilibrium adjustments to different long-run income growth paths. With the housing premium remaining roughly constant, the housing return adjusts nearly one-for-one with the interest rate. There are no clear effects on any other variables.³⁶

³⁵While our model contains a cost of managing rental properties, it is specified in the intensive margin (ie, the cost function is the same for all landlords and increases with the number of rental properties a landlord owns). As noted earlier, its role is to keep the state space in check across different calibrations, by limiting the number of properties the wealthiest households would like to own.

³⁶The small variations in the values of some of the other variables in the table are indistinguishable from a numerical error, resulting from the solution method used, based on standard approximation of continuous variables (a, b, h_R, c, w) with a grid.

5.2.2 Small open economy

Table 7 reports the results for the small open economy. The interest rate is exogenous, kept constant at the value resulting in general equilibrium under the baseline $\lambda = 0.02$, and the bond market clearing condition is not applicable.

Compared with Table 6, the results in Table 7 are markedly different. Different values of λ have large effects on housing market outcomes. Generally speaking, higher values of λ lead to higher house prices, higher housing returns and housing premia, and greater price-to-rent and price-to-income ratios. At the same time, they reduce the homeownership rate, increase the average number of rental properties per landlord, and reduce the fraction of very small landlords, owning only one or two rental properties. There are, however, certain nonlinearities and nonmonotonicities in these effects. Changes in the price-to-rent ratio are larger at higher income growth rates than lower income growth rates and the price-to-income ratio tends to decline first, before increasing as the income growth rate gets higher (Figure 1).

The effects are quantitatively interesting. As an example, a change in λ from 0.02 (baseline calibration) to 0.04 increases the level of house prices by about 31%. The price-to-rent ratio rises by 42%, from about 24 to 34, while the commonly used measure of homeownership affordability, the price-to-income ratio, increases by 31%, from about 8 to 11. Rental prices, however, remain relatively stable, declining by 5%. The homeownership rate declines from 0.65% to 0.53%, as does the number of very small landlords (from 81% to 45%), while the average number of properties per landlord increases from 1.87 to 2.93. At the same time, landlords enjoy a higher rate of return on housing, with the housing premium increasing from 0.53% to 1.22%. A comparison of the equilibrium outcomes under the two values of λ is meaningful. The two growth rates are well within the variation in long-run growth rates, over the period 2015-2025, between the fastest-growing and slowest-growing economies in the EU in terms of wage growth.³⁷

³⁷Hungary, Czechia, Lithuania, or Latvia experienced over the period 2015-2025 both some of the highest long-run growth rates of real wages (around 4% per annum on average) and strongest real house price

It is again instructive to think about r_h (or the housing premium) as the price in the rental market. The housing return has a lower bound given by the exogenous r , less the spread τ . For returns higher than r , the following holds. When λ increases, the cost of financing housing investment increases, as the cost is a weighted average of the costs of credit (the constant interest rate) and the cost of internal finance, which (in the cross-section of households) is related to λ and the time preference parameter. Without the lumpiness of investment in rental properties, arbitrage would drive the rate of return on housing to be equal to this weighted average. As the weighted average exceeds the interest rate, it mechanically creates a positive housing premium, which increases with λ . With lumpiness the premium reflects also compensation for the extra foregone consumption required to save enough for the lumpy downpayment. Table 7 shows that the housing premium increases, but by less than λ . In line with equation (9), the price-to-rent ratio thus increases with a higher λ . Figure (1) provides a plot of the price-to-rent ratio against λ . The difference between r_h and λ gets smaller at higher values of λ , creating the observed nonlinearity.

The premium required to compensate less wealthy households to undergo the lumpy investment into rental properties makes rental properties relatively attractive for wealthy households, who are less concerned about the lumpiness. Consequently, the fraction of very small landlords in Table 7 generally declines, and the average number of properties per landlord increases, as the housing premium and the housing return increase. Rental demand requiring a higher housing return for the rental market to clear is thus accommodated by supply that is tilted towards larger landlords.³⁸

To understand the level of house prices, p^* , we turn again to equation (8). At $\lambda = 0.01$

appreciations (5.6% per annum on average) in the EU. This has been accompanied by large increases in price-to-rent ratios. At the other end of the spectrum are, for instance, Italy or Finland, with zero long-run growth of real wages and small negative growth of real house prices. (Based on OECD and national statistics data.)

³⁸This description applies at $\lambda = 0.02$ and higher. Recall that the housing premium is defined with respect to the mid-interest rate. The negative premium of -0.24% at $\lambda = 0.01$ means that the housing return is higher than the saving rate, but lower than the mid-rate and the borrowing rate (the spread is 0.5% in either direction from the mid-rate). The positive premium of 0.19% at $\lambda = 0.015$ means that the housing return is higher than the saving rate and the mid-rate but smaller than the borrowing rate. At these housing returns, most landlords hold only one rental property, as credit is relatively expensive, and the purchase is almost entirely financed with their own funds.

and $\lambda = 0.015$, households have a strong incentive to save, as the values of λ are below the baseline $\lambda = 0.02$ consistent with the exogenous interest rate in general equilibrium. Consequently, a large number of households reach the point of having sufficient savings for a downpayment, leading to a high homeownership rate (0.70 and 0.67, respectively). And as owner-occupiers have to purchase an entire housing unit, whereas renters can share a unit, total demand for the housing asset in equation (8) is high. The house price is therefore high (5.81 and 5.16, respectively), despite a low price-to-rent ratio (22.9 and 23.2, respectively). As λ increases, the incentive to save falls and, thus, the demand for owner-occupied housing and the homeownership rate fall. More housing units are available for renters, who generally demand less housing. Total demand in equation (8) thus falls. This effect has a negative effect on the rental price, q^* . At the same time, however, (as explained above) the price-to-rent ratio increases with higher values of λ . At $\lambda = 0.025$, the second effect starts to dominate the first effect and, in line with equation (10), the house price starts to increase as λ increases. Due to this nonmonotonicity in the house price, the price-to-income ratio in Figure 1 is also nonmonotone.

5.2.3 Discussion

Different landlord structures are associated with different supply curves in the rental market and thus different returns on housing (or price-to-rent ratios for a given λ) at which they accommodate the demand for rental properties. Table 8 compares the price-to-rent ratio in our model, for different values of λ , with price-to-rent ratios under the two common specifications of institutional landlords: a representative foreign deep-pocketed landlord and a representative domestic real estate firm. The distinction from individual landlords lies in two key properties of the specifications, which are related to the size of institutional landlords: (i) institutional landlords do not require compensation for the lumpiness of individual housing units and (ii) they satisfy any rental demand at a constant rate of return on housing. Both types of institutional landlords behave competitively, making zero profits. The distinction between the two types rests on the exposure of their costs of funds to the domestic economy.

We compare environments in which only one type of landlord structure is present. To make the two alternatives as closely comparable with our model as possible, we impose the assumption that both institutional landlords finance the fraction $\chi = 0.7$ of their assets with credit, with the remaining fraction coming from perfectly divisible deposits by households.³⁹ Further, as in our model, the deposit interest rate is subject to a negative spread, while the credit rate is subject to a positive spread. The value $\tau = 0.005$ is used as in our model. Credit comes from the world bond market, where the mid-interest rate is $r = 5.89\%$, the same as in Table 7. In the case of the foreign landlord, deposits come from the world market. In the case of the real estate firm, deposits come from domestic households. The source of the deposits is thus the only difference between the two institutional landlords.

In the case of the foreign landlord, the price-to-rent ratio is given by $p_t/q_t = 1/(r^s - \lambda)$, where $r^s = (1 - \chi)(r - \tau) + \chi(r + \tau)$. The expression for r^s reflects the assumptions that the fraction χ of assets is financed with credit, while the fraction $(1 - \chi)$ is financed with deposits. Here, the split between credit and deposits is somewhat artificial and only comes down to the spread.

In the case of the domestic real estate firm, the price-to-rent ratio is given by $p_t/q_t = 1/(r^* - \lambda)$, where $1 + r^* = (1 - \chi)[(m^*)^{-1} - \tau] + \chi(1 + r + \tau)$ and $m^* = \bar{\beta}u_{c,t+1}/u_{c,t}$. Here, $\bar{\beta}$ is the unconditional mean of β_t and $u_{c,t+1}/u_{c,t} = (1 + \lambda)^{-1}$ is the marginal rate of intertemporal substitution for the utility function used in our model (with the calibrated $\sigma = 1.0$), evaluated at the growth rate of the per-capita endowment of the nonhousing good.⁴⁰

Table 8 delivers two messages.⁴¹ One concerns the level of the price-to-rent ratio, the other its volatility. To focus on the level, consider the baseline value $\lambda = 0.02$. This is the growth

³⁹In our model, however, the LTV constraint does not need to bind.

⁴⁰This specification could be justified, for instance, by assuming that the domestic real estate firm pools endowments from a representative sample of households, thus discounting the payoffs from deposits at the discount factor of a representative household. A lottery determines which individual households are included in the sample. At all values of λ in the table, $(m^*)^{-1}$ exceeds the interest rate, providing an incentive for the households to participate in the real estate firm, if selected by the lottery.

⁴¹For both types of landlords, the reported values of the price-to-rent ratio are adjusted for the timing of the rental payment, as per the discussion in Section 3.3.

rate consistent in general equilibrium with the interest rate used in the present experiments, $r = 5.87\%$. The table shows that the price-to-rent ratio is higher in the case of the foreign landlord than in our model. This is because the required return on downpayments on rental properties in our model exceeds $r - \tau$, the return on deposits offered by the institutional landlord.

In the case of the domestic real estate firm, the price-to-rent ratio is slightly lower than in our model. Two effects are at play. First, using m^* of the representative household removes precautionary saving motive from the discount factor, which increases $(m^*)^{-1} - 1$ above $r = 5.87\%$, which is the equilibrium interest rate in the presence of individual uncertainty. Second, as the housing asset is divisible from the perspective of the real estate firm, compensation for lumpiness is not required. It turns out that the first effect is somewhat stronger, making $(m^*)^{-1} - 1 - \tau$ slightly higher than the required rate of return on downpayments on rental properties in our model.

The last column in Table 8 concerns the volatility of the price-to-rent ratio, in relation to the different values of λ . It is clear that under the foreign landlord, the ratio is much more volatile than in our model. In the case of the domestic real estate firm, the volatility is only slightly higher than in our model.

We need to stress that these comparisons rest on the simplifying nature of the models of institutional landlords. Nonetheless, these simplifications are currently standard in the literature. Further confidence in the conclusions likely requires more detailed models of institutional landlords, including their choice of the capital structure (debt vs. equity) and pooling of individual property risk, which is absent in our model. Such endeavors are, however, beyond the scope of this paper.

5.3 Regulations targeting landlords

Some regulations considered by policymakers with the aim of curbing house prices and increasing homeownership operate at the level of individual landlords. We consider, in the

case of the small open economy, two such regulations as examples: (i) taxes that bind above a property threshold and (ii) tighter LTV constraints on rental properties than owner-occupied properties.⁴² These examples are particularly relevant for individual landlords because the threshold, if set at a small number of properties, is irrelevant for portfolio adjustments of institutional landlords with large portfolios and institutional landlords can work around LTV constraints by accessing capital through other channels than the credit market.

The results are contained in Table 9. We use long-run aggregate income growth as the force behind high house prices and ask the following question. Suppose that the growth rate increases from 0.02 to 0.04, resulting in an increase in house prices by 31% (the equilibrium implications of the two growth rates are repeated, for convenience, in columns (1) and (2) of Table 9, respectively). Suppose the government decides to combat the resulting increase in house prices, and the decline in the homeownership rate, with the two policies. The effects of the exact implementation of the policies are presented in columns (3)-(7).

The findings suggest that the effects of the regulations are questionable. The main impact is on the landlord-size distribution, with limited effects on house prices and the homeownership rate. In some cases, renters loose out by having to pay higher rental prices.

5.3.1 Taxes binding above a property threshold

Under this policy landlords have to pay a tax on rental income once the number of their rental units exceeds a given threshold. That is, rental income in the budget constraint is $(1 - \delta)q_t h_{Lt}$, where $\delta > 0$ if $h_{Lt} \geq h_\delta$ and $\delta = 0$ otherwise. Here, δ is the tax rate and h_δ is the threshold (tax collections are spent on government consumption of the nonhousing good, without providing any utility to anyone). We set δ equal to 0.15 and consider, separately, three thresholds: $h_\delta = 6$, $h_\delta = 3$ and $h_\delta = 1$. In the second case, the tax applies to all landlords but, using our earlier terminology, very small landlords. In the third case, the tax

⁴²The first example is inspired by the new housing law in Spain noted in the Introduction. Although the law does not impose additional statutory taxes for landlords with the number of properties above a certain threshold, the regulatory constraints impose additional burdens that can be thought of as implicit taxes. The second example corresponds to the regulations introduced in the UK, Ireland, Norway, and Czechia.

applies to all landlords. To give a better sense of the magnitude of the assumed tax rate, it corresponds to 6.4% tax rate on both rental yield and capital gain and 0.44% property tax. This magnitude falls roughly into the mid-range of property taxes in most EU countries (www.globalpropertyguide.com).⁴³

The results are reported in columns (3)-(5) of Table 9. In all three cases, the effects on the house price and the homeownership rate are small, the largest impact falls on the landlord size distribution, as landlords re-adjust the number of rental units under ownership, in response to the tax thresholds and the changes in the equilibrium housing premium and house price. Relative to column (2), the house price varies by up to $+/- 2\%$, while the homeownership rate increases by, at the most, 3 percentage points. This leaves the homeownership rate still far below the rate in the baseline case, column (1). For two of the three thresholds, columns (4) and (5), the rental price increases and the increase is substantial, 21% and 16%, respectively. As the rental market is a smaller share of the aggregate housing stock than the owner-occupied market, a small gain in the homeownership rate comes at the price of a (relatively) larger loss in units available for rental.

5.3.2 Discriminatory LTV ratios

In this case, two values replace the single value of the maximum permissible LTV ratio χ . The LTV ratio for rental properties is denoted by χ_L and the LTV ratio for owner-occupied properties is denoted by χ_C . The borrowing constraint (7) is replaced with

$$-b_t \leq \chi_C p_t (h_{Ot} - h_{Lt}) + \chi_L p_t h_{Lt}.$$

We consider two cases. In the first case, the LTV ratio on rental properties is reduced, while the LTV ratio on owner-occupied properties remains at the baseline value. That is, $\chi_L = 0.5$ and $\chi_C = 0.7$. In the second case, the LTV ratio on rental properties remains at the baseline value, while the LTV ratio on owner-occupied properties is increased: $\chi_L = 0.7$

⁴³The calculations are as follows: $\delta[(r_y)/(r_y + \lambda)]$ for the former and $(\delta q)/p$ for the latter.

and $\chi_C = 0.9$. The results are reported in columns (6) and (7), respectively. The effects on the house price and the homeownership rate, relative to column (2), are again modest, similar to the effects of the tax thresholds. These small effects are again accompanied by significant swings in the landlord size distribution. Between the two LTV policies, the policy of relaxing the LTV constraint on owner-occupied properties increases the homeownership rate marginally more and at the same time reduces the rental price. In this sense, it is the preferred option.

6 Conclusion

In most European countries, the supply side of the private rental market consists of individual households who accumulate wealth to purchase rental units, alongside an owner-occupied home, as a form of saving for themselves and their children. Standard US-based housing market models avoid this complication by assuming institutional, deep-pocketed, landlords, whose rental supply is divorced from household wealth accumulation. We provide a quantitative examination of housing market issues in a European setting, where rental supply comes from the savings of heterogeneous households.

The findings are split along two dimensions. At the aggregate level, wealth accumulation by individual households substitutes for the deep pockets of institutional landlords. The point made by Greenwald and Guren (2025) that, under a representative deep-pocketed landlord, LTV borrowing constraints have essentially no effect on house prices (but large effects on the homeownership rate) survives when rental supply must come from saving for lumpy property purchases by budget- and credit-constrained households. Long-run aggregate income growth, in contrast, has large effects on the price-to-rent ratio in a small open economy, and, through offsetting movements in rental prices, potentially nonmonotone effects on the level of house prices and price-to-income ratios. The effects on the price-to-rent ratio are comparable to the effects under a representative domestic deep-pocketed landlord, but smaller than under a representative foreign deep-pocketed landlord. From these per-

spectives, the exact structure of the supply side of the rental market, whether in terms of individual or institutional landlords, has little consequences.

The importance of the distinction between individual and institutional landlords, however, emerges at the distributional level. Aggregate factors reshape the landlord-size distribution in ways institutional-landlord models cannot speak to. Looser LTV constraints increase the homeownership rate and, at the same time, tilt rental supply toward very small landlords, reducing housing wealth inequality. In contrast, faster aggregate income growth reduces the homeownership rate and, at the same time, tilts rental supply toward larger landlords, increasing housing wealth inequality. Policies targeting landlords—taxes that bind above a property threshold and tighter LTV constraints on rental properties than owner-occupied properties—operate precisely at the individual level. Such measures have been proposed, or even implemented, to combat high house prices. The results from our experiments suggest that the effects of such regulations are questionable. The main effect is on the landlord-size distribution, with limited impact on house prices and the homeownership rate. In some implementations of these policies renters lose out by having to pay higher rental prices.

There are obvious limitations of our analysis. The comparisons are across balanced growth path equilibria, thus speaking to long-run effects. Short-run adjustments to changes in the long-run growth rate of aggregate income, as well as transitional dynamics in response to LTV changes and landlord-targeting policies, are not captured by such comparisons. We have also considered only a limited number of regulations in the housing market as illustrations. The model, when appropriately extended, could be used to evaluate a broader set of housing market policies targeting individual landlords. Various extensions could take into account richer heterogeneity and exposure to individual property risk, as well as more detailed models of institutional landlords and their interaction with individual landlords. More work remains to be done on the empirical front, both in terms of data collection and characterization of landlord dynamics. All these considerations are left for future research.

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Table 1: Composition of the housing stock in the EU & UK

	millions of units	% of category	% of total
Total	226.4	100.0	100.0
Rental	80.0	35.3	
Owner-occupied	146.4	64.7	64.7
Rental	80.0	100.0	
Private	53.0	66.3	
Public	20.7	25.9	9.1
Other	6.3	7.8	2.8
Private	53.0	100.0	
Small nonprofessional	47.7	90.0	21.1
Institutional	5.3	10.0	2.3

Source: JLL Research (2024). Combined figures for the EU & UK. ‘Other’ includes student accommodation and care homes.

Table 2: Baseline parameter values

Parameter	Value	Description
Period	annual	
$\bar{h}$	1.00	Individual house size (normalization)
σ	1.00	Curvature of the utility function
θ	0.79	Weight on nonhousing consumption
ψ_O	1.00	Weight on owner-occupied housing (normalization)
ψ_R	0.80	Weight on rental housing
χ	0.70	Maximum permissible LTV ratio
τ	0.005	+/- spread over r
$\bar{\mu}_L$	0.065	Measure of potential landlords in the population
λ	0.02	Growth rate of aggregate income
ρ_z	0.97	Persistence of income shocks (AR(1) process)
σ_ε	0.20	Std of innovations in the AR(1) process
β_H	0.966	Time preference - high
β_M	0.955	Time preference - medium
β_L	0.920	Time preference - low
P_{hh}	0.98	Transition high to high
P_{mh}	0.02	Transition high to medium
P_{lh}	0.00	Transition high to low
P_{hm}	0.0025	Transition medium to high
P_{mm}	0.995	Transition medium to medium
P_{lm}	0.0025	Transition medium to low
P_{hl}	0.00	Transition low to high
P_{ml}	0.02	Transition low to medium
P_{ll}	0.98	Transition low to low
κ_{0L}	0.001	Level parameter in the cost function of landlords
κ_1	2.0	Curvature parameter in the cost function

Table 3: General equilibrium, results for baseline parameter values

Variable	Value	Description
p^*	4.90	House price
q^*	0.20	Rental price
r	5.87	Interest rate (%)
r_h	6.40	Housing return (%)
r_y	4.40	Rental yield (%)
r_g	2.00	Capital gain (%)
$prem$	0.53	Housing return over the interest rate (%)
p/q	24.07	Price-to-rent ratio
$p/E(y)$	8.22	Price-to-(average) income ratio
$qE[(h_R)/y_R]$	0.28	Average share of renters' income spent on rent
O -rate	0.650	Homeownership rate
L -rate	0.056	Landlord rate
$E(h_L)$	1.87	Average number of rental units per landlord
$\mu_L(h_L = 1)$	0.46	Fraction of landlords with one rental unit
$\mu_L(h_L = 2)$	0.35	Fraction of landlords with two rental units
$\mu_L(h_L = 3)$	0.10	Fraction of landlords with three rental units
$\mu_L(h_L = 4)$	0.04	Fraction of landlords with four rental units
$\mu_L(h_L \geq 5)$	0.05	Fraction of landlords with five or more rental units

Notes: The figures in the table have been rounded up. The interest rate is the mid-rate. An asterix denotes that the variable is detrended with the balanced growth path. The rental yield is adjusted for the timing of rents being received in the current period (ie, the figure in the Table is the current rental yield multiplied by the interest rate $(1 + r)$).

Table 4: The effects of the maximum LTV ratio (χ): general equilibrium

LTV	p^*	r (%)	r_h (%)	$prem$ (%)	p/q	O -rate	$E(h_L)$	$\mu_L(h_L \leq 2)$
0.25	5.03	5.47	6.45	0.98	23.7	0.56	2.86	0.46
0.35	5.01	5.62	6.43	0.81	23.9	0.59	2.83	0.51
0.45	4.90	5.76	6.40	0.64	24.1	0.61	2.68	0.42
0.55	4.90	5.85	6.43	0.58	23.9	0.62	2.57	0.36
0.65	4.89	5.86	6.41	0.55	24.0	0.64	1.91	0.81
0.70	4.90	5.87	6.40	0.53	24.1	0.65	1.87	0.81
0.75	4.90	5.90	6.40	0.50	24.1	0.65	1.94	0.80
0.85	4.91	5.95	6.44	0.49	23.9	0.66	2.02	0.79

Notes: All other parameters are set at the baseline values. The figures in the table have been rounded up. The interest rate is the mid-rate. p^* = house price (detrended with the balanced growth path), r = interest rate, r_h = housing return, $prem$ = housing return over the interest rate, p/q = price-to-rent ratio, O -rate = homeownership rate, $E(h_L)$ = the average number of rental units per landlord, $\mu_L(h_L \leq 2)$ = fraction of landlords with one or two rental units.

Table 5: The effects of the maximum LTV ratio (χ): small open economy

LTV	p^*	r (%)	r_h (%)	$prem$ (%)	p/q	O -rate	$E(h_L)$	$\mu_L(h_L \leq 2)$
0.25	4.92	5.87	6.57	0.70	23.0	0.58	2.83	0.55
0.35	4.90	5.87	6.51	0.64	23.5	0.60	2.74	0.46
0.45	4.93	5.87	6.47	0.60	23.7	0.61	2.58	0.38
0.55	4.89	5.87	6.45	0.58	23.8	0.62	2.24	0.72
0.65	4.89	5.87	6.42	0.55	24.0	0.64	1.92	0.81
0.70	4.90	5.87	6.40	0.53	24.1	0.65	1.87	0.81
0.75	4.90	5.87	6.40	0.53	24.1	0.66	1.83	0.81
0.85	4.91	5.87	6.40	0.53	24.1	0.66	1.91	0.81

Notes: All other parameters are set at the baseline values. The figures in the table have been rounded up. The interest rate is exogenous and set to the mid-rate resulting under the baseline calibration. p^* = house price (detrended with the balanced growth path), r = interest rate, r_h = housing return, $prem$ = housing return over the interest rate, p/q = price-to-rent ratio, O -rate = homeownership rate, $E(h_L)$ = the average number of rental units per landlord, $\mu_L(h_L \leq 2)$ = fraction of landlords with one or two rental units.

Table 6: The effects of aggregate income growth (λ): general equilibrium

λ	p^*	q^*	r (%)	r_h (%)	$prem$ (%)	p/q	$p/E(y)$	O -rate	$E(h_L)$	$\mu_L(h_L \leq 2)$
0.01	4.89	0.20	4.85	5.37	0.52	24.0	8.2	0.65	1.89	0.81
0.015	4.89	0.20	5.36	5.89	0.53	24.0	8.2	0.65	1.89	0.81
0.02	4.90	0.20	5.87	6.40	0.53	24.1	8.2	0.65	1.87	0.81
0.025	4.92	0.21	6.39	6.93	0.54	24.0	8.3	0.65	1.91	0.82
0.03	4.91	0.20	6.91	7.45	0.54	24.0	8.2	0.65	1.90	0.82
0.035	4.92	0.20	7.42	7.96	0.54	24.1	8.3	0.65	1.88	0.81
0.04	4.91	0.20	7.94	8.49	0.55	24.1	8.2	0.65	1.87	0.82

Notes: All other parameters are set at the baseline values. The figures in the table have been rounded up. The interest rate is the mid-rate. p^* = house price (detrended with the balanced growth path), q^* = rental price (detrended with the balanced growth path), r = interest rate, r_h = housing return, $prem$ = housing return over the interest rate, p/q = price-to-rent ratio, $p/E(y)$ = price-to-(average) income ratio, O -rate = homeownership rate, $E(h_L)$ = the average number of rental units per landlord, $\mu_L(h_L \leq 2)$ = fraction of landlords with one or two rental units.

Table 7: The effects of aggregate income growth (λ): small open economy

λ	p^*	q^*	r (%)	r_h (%)	$prem$ (%)	p/q	$p/E(y)$	O -rate	$E(h_L)$	$\mu_L(h_L \leq 2)$
0.01	5.81	0.25	5.87	5.63	-0.24	22.9	9.7	0.70	2.27	0.71
0.015	5.16	0.22	5.87	6.06	0.19	23.2	8.7	0.67	1.91	0.79
0.02	4.90	0.20	5.87	6.40	0.53	24.1	8.2	0.65	1.87	0.81
0.025	4.84	0.18	5.87	6.51	0.64	26.4	8.1	0.62	2.22	0.48
0.03	5.01	0.17	5.87	6.67	0.80	28.6	8.4	0.59	2.57	0.48
0.035	5.62	0.18	5.87	6.92	1.05	31.0	9.4	0.55	2.95	0.45
0.04	6.41	0.19	5.87	7.09	1.22	34.3	10.7	0.53	2.93	0.45
0.045	7.32	0.19	5.87	7.21	1.34	39.1	12.3	0.52	2.96	0.36
0.05	8.33	0.19	5.87	7.39	1.52	44.3	14.0	0.52	3.13	0.36

Notes: All other parameters are set at the baseline values. The figures in the table have been rounded up. The interest rate is exogenous and set to the mid-rate resulting under the baseline calibration. p^* = house price (detrended with the balanced growth path), q^* = rental price (detrended with the balanced growth path), r = interest rate, r_h = housing return, $prem$ = housing return over the interest rate, p/q = price-to-rent ratio, $p/E(y)$ = price-to-(average) income ratio, O -rate = homeownership rate, $E(h_L)$ = the average number of rental units per landlord, $\mu_L(h_L \leq 2)$ = fraction of landlords with one or two rental units.

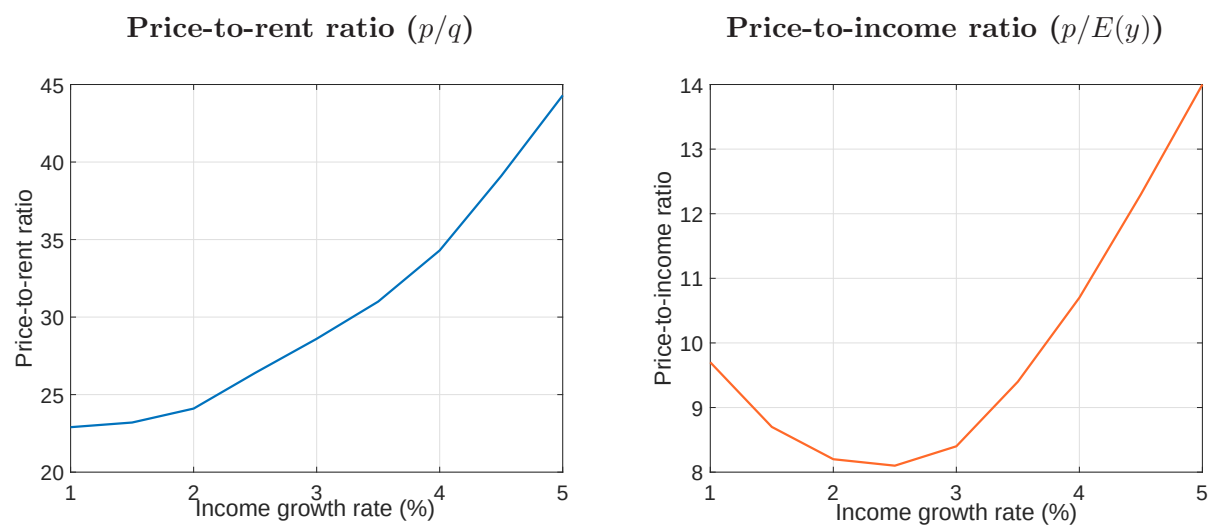


Figure 1: Nonlinearities in the price-to-rent and price-to-income ratios in relation to aggregate income growth rate.

Table 8: The effects of λ on the p/q ratio: comparison across landlord structures

λ	0.01	0.015	0.02	0.025	0.03	0.035	0.04	0.045	0.05	STD
Individual households	22.9	23.2	24.1	26.4	28.6	31.0	34.3	39.1	44.3	7.5
Institutional foreign	20.9	23.2	26.0	29.7	34.5	41.2	51.2	67.4	98.9	25.5
Institutional domestic	20.7	22.2	23.9	25.9	28.3	31.1	34.6	38.9	44.6	8.1

Notes: In the case of institutional landlords, the LTV ratio of 0.7 is imposed. In the case of individual households, this is the maximum permissible ratio. The same spread on deposits and credit, $\tau = 0.005$, applies across the specifications. The interest rate is exogenous and set to the mid-rate resulting under the baseline calibration.

Table 9: Regulations targeting landlords in response to high house prices

	NO ACTION			REGULATIONS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
λ	0.02	0.04	0.04	0.04	0.04	0.04	0.04
$\delta = 0.15$ applies to			$h_L \geq 6$	$h_L \geq 3$	$h_L \geq 1$		
χ_L, χ_C						0.5, 0.7	
χ_L, χ_C							0.7, 0.9
p^*	4.90	6.41	6.35	6.56	6.32	6.48	6.49
q^*	0.20	0.19	0.18	0.23	0.22	0.21	0.18
p/q	24.1	34.3	34.3	28.1	29.3	30.5	35.2
$prem(\%)$	0.53	1.22	1.22	1.89	1.73	1.60	1.13
$p/E(y)$	8.22	10.7	10.6	11.0	10.6	10.9	10.9
O -rate	0.65	0.53	0.53	0.56	0.54	0.54	0.55
L -rate	0.056	0.057	0.058	0.065	0.053	0.055	0.041
$E(h_L)$	1.87	2.93	3.38	1.99	2.73	2.77	2.94
$\mu_L(h_L \leq 2)$	0.81	0.45	0.15	0.99	0.43	0.53	0.38
$\mu_L(h_L = 3 \text{ or } 4)$	0.14	0.42	0.75	0.00	0.44	0.38	0.48
$\mu_L(h_L \geq 5)$	0.05	0.13	0.10	0.01	0.13	0.09	0.14

Notes: If not specified in the panel, the baseline parameterization in Table 2 applies. The figures in the table have been rounded up. The interest rate is exogenous and set to the mid-rate resulting under the baseline calibration. δ is the tax rate on rental income that applies to landlords with the specified number of rental units, χ_L is the maximum permissible LTV ratio on rental units, χ_C is the maximum permissible LTV ratio on owner-occupied units. p^* = house price (detrended with the balanced growth path), q^* = rental price (detrended with the balanced growth path), $prem$ = housing return over the interest rate, p/q = price-to-rent ratio, $p/E(y)$ = price-to-(average) income ratio, O -rate = homeownership rate, L -rate = landlord rate, $E(h_L)$ = the average number of rental units per landlord, $\mu_L(h_L = x)$ = fraction of landlords with x rental units.