# The aggregate and distributional implications of credit shocks on house and rental markets

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EUI Macro WG

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# Motivation

- Housing has a **dual role** . . .
  * As a *consumption good* $\rightarrow$ if households don't buy a house, they must rent it
  * As an *asset/investment* $\rightarrow$ capital gains + cash flows for landlords

- Housing and rental markets are economically and politically very relevant and thus **subject to regulation**, e.g. tax advantages, subsidies, borrower-based macroprudential policies, etc.

- Understanding the effects of these policies on household's welfare as well as on the dynamics of house prices and rents requires a **joint study of both markets**.

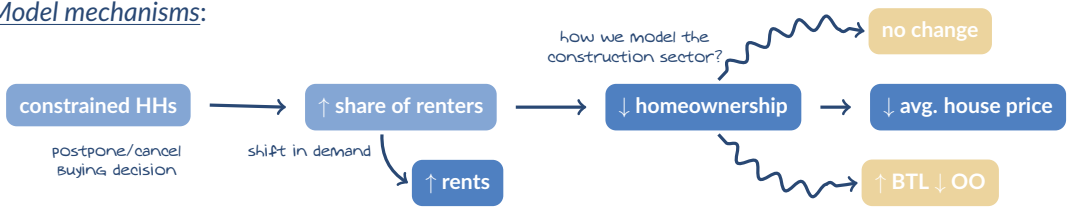
# What we do

- Build an equilibrium model of the **rental and housing markets** with the following key ingredients:
  * Heterogenous households (age, income and wealth)
  * Endogenous housing tenure choices (renters, homeowners or landlords)
  * Long-term mortgages with constraints that only bind at origination
- Use the model to study the effects of the **2015 macro-prudential intervention in Ireland** and its impact on:
  * House prices and rents
  * Homeownership rates
  * Welfare (losses)
- Possible to study empirically. Done already for its effects on house prices. We extend the analysis to rents.

# What we find

- *Empirically*: LTV & LTI limits $\Longrightarrow$ $\begin{cases} \downarrow \text{house price growth (Acharya et al., 2022)} \\ \uparrow \text{growth of rental prices} \end{cases}$

- *Model mechanisms*:




- *Welfare analysis*:
  - **At fixed prices**: losses concentrated among the young and the middle income households
  - **Movements in rents**: further harms the young and the middle income hh's, hurts the poor and slightly benefits the middle-age and the very rich
  - **Full transition**: quantitatively small role for the drop in house prices.

# Roadmap

# Related Literature

# Housing in macroeconomics: state-of-the-art models

- Mostly concerned with explaining **boom-bust cycles in house prices** with conflicting findings
  - Favilukis, Ludvigson, and Van Nieuwerburgh (2016, JPE) → looser credit conditions
  - Justiniano, Primiceri, and Tambalotti (2019, JPE) → increase in credit supply
  - Kaplan, Mitman, and Violante (2020, JPE) → fluctuations in beliefs
  - Garriga and Hedlund (2020, AER) → liquidity
  - Arslan, Guler and Kuruscu (2022) → bank lending channel

- **Assumptions about the rental market**
  - Traditionally: no renting or inelastic rents (deep-pocketed landlords)
  - *Greenwald and Guren (2021)* point to the degree of *market segmentation* to explain the distinct findings:
    - no segmentation → no house price changes
    - segmentation → rise in house prices if demand increases
  - *Sommer and Sullivan (2018, AER)*: study mortgage interest tax deduction through the lens of a model with endogenous house prices and rents.

# Macroprudential policy: what about the costs?

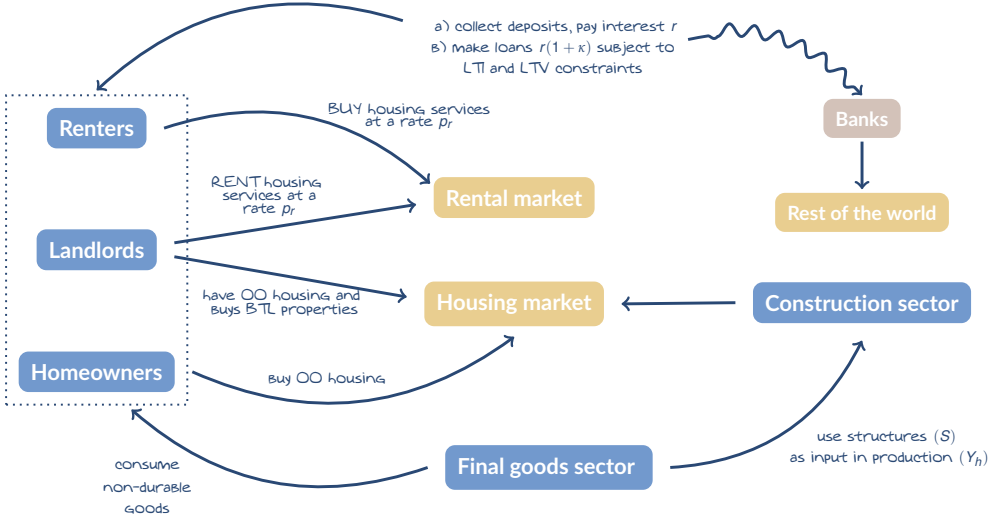
- A broad theoretical literature on the **benefits of macroprudential policies** in terms of *financial and macroeconomic stability*
  - Lambertini, Mendicino, and Punzi (2013, JEDC)
  - Farhi and Werning (2016, Ecta)
  - Ferrero, Harrison and Nelson (2023, ReStat)
  - Muñoz and Smets (2022)

- Fewer have studied their **negative consequences** for *household welfare* . . .
  - Queiró and Oliveira (2022) $\rightarrow$ focus on Portugal's reform using a model à la Kaplan et al. (2020)

- Some recent empirical contributions that study these reforms include:
  - Acharya, Bergant, Crosignani, Eisert and McCann (2022, J Finance)
  - Van Bekkum, Irani, Gabarro and Peydró (2019)

# The Model

# Model sketch



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# Production

# Final good & construction sectors

- **Final Good Producer**
  - $Y_c = A_c N$, where $A_c$ is constant and N are the unit of labor services.
  - Profit maximization $\implies$ wage $= A_c$
  - Consumption good is also input to housing production (structures)

- **Housing Good Producer**
  - Combines land permits $L$ (fixed) and structures $S$ through a Cobb-Douglas technology where $\alpha$ is the share of land in production.
  - Profit maximization implies the following *housing investment function*

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

# Aggregate housing stock

- In general, aggregate housing stock is given by

$$H = \int H_i dF(i) \tag{2}$$

where $H_i$ denotes the different types of houses in which HHs will live in

- We constrain $H_i$ to be **discrete**
  - There are only **two types**: owner-occupied (oo) and buy-to-let (btl)
  - They differ in their **quality/size**: $\tilde{h}_{oo} > \tilde{h}_{btl}$
  - Final transaction **price depends on type**: $p^h(\tilde{h}_j) = \tilde{h}_j p_h$ for $j = \{oo, btl\}$
- In practice, aggregate amount of housing is given by

$$H = \tilde{h}_{oo} H_{oo} + \tilde{h}_{btl}(1 - H_{oo}) \tag{3}$$

where $H_{oo}$ is the share of owner-occupied housing, which also coincides with the homeownership rate.

▷ Alternative housing supply assumptions

# Households

# Environment

- Economy is populated by OLG of households whose **life cycle** is divided between *working* ($j = 1, \ldots, J^{ret} - 1$) and *retirement* ($j = J^{ret}, \ldots, J$). After age $J$, they die with certainty.
- Households derive **utility** from *non-durable consumption* $c$ and *housing services* $s(\tilde{h})$

$$\mathbb{E}_0 \left\{ \sum_{j=1}^{J} \beta^{j-1} \frac{\left(c\, s(\tilde{h})\right)^{1-\gamma}}{1-\gamma} \right\} \tag{4}$$

  where $\beta \in (0, 1)$, $c > 0$ and $s(\tilde{h})$ varies depending on the quality of the house where the household resides.
- *Working age* households receive an **idiosyncratic labor income endowment**

$$\log y = \log A_c + f(j) + \eta \tag{5}$$

  where $A_c$ is an index of aggregate productivity, $f(j)$ is a polynomial in age and $\eta$ is the stochastic persistent component. *Retirees* receive a fixed fraction of their last period income.
- Households can **save in liquid assets**, whose return $r$ is fixed, or **in real estate**, whose prices are determined in equilibrium.

# Housing & mortgages

- **Housing state** is the number of houses owned (*renters*, *homeowners*, and *landlords*):

$$h \in \{0, 1, 2, 3\} \tag{6}$$

  * Owner-occupied has quality $\rightarrow \tilde{h}_{oo}$
  * Buy-to-let housing has lower quality $\rightarrow \tilde{h}_{btl} < \tilde{h}_{oo}$

- Houses are **illiquid** (proportional transaction costs, $\tau_h$) and **costly to maintain**, $\delta_h$.

- Households can **borrow** ($a < 0$) at a rate $r(1 + \kappa)$ with $\kappa > 0$

- The amount borrowed is limited by two **financial constraints** that can only *bind at origination*:

$$a' \geq -\lambda_{LTV}\, p^h(\tilde{h}) h' \tag{7}$$

$$a' \geq -\lambda_{LTI}\, y \tag{8}$$

- For the remaining life of the mortgage, households must at least pay interests and **amortize** a minimum amount per period, $m(j)$.

# Household's problem

$$V(a,h,y,j) = \max_{a',h'} \left\{ \frac{\left(c\, s(\tilde{h})\right)^{1-\gamma}}{1-\gamma} + \sigma_\varepsilon\, \varepsilon(h) + \beta \mathbb{E} V(a',h',y',j+1) \right\} \tag{9}$$

s.t.

$$\begin{aligned} c + a' + p^h(\tilde{h})h' + \tau^h p^h(\tilde{h})|h'-h| + \delta_h p^h(\tilde{h})h \;\leq \\ y + (1 + r\,(1 + \mathbb{I}_{a'<0}\,\kappa))\,a + p^h(\tilde{h})h + p_r(h-1) \end{aligned} \tag{10}$$

$$a' \geq \begin{cases} \max\{-\lambda_{LTV} p^h(\tilde{h})h', -\lambda_{LTI} y\} & \text{if } h' > h \\ a(1 + r(1+\kappa) - m(j)) & \text{if } h > 0 \text{ and } a < 0 \\ 0 & \text{otherwise} \end{cases} \tag{11}$$

$$\varepsilon(h) \sim F, \text{ extreme value type I dtb} \tag{12}$$

$$m(j) = \frac{r(1+\kappa)(1+r(1+\kappa))^{J-j}}{(1+r(1+\kappa))^{J-j} - 1} \tag{13}$$

# MARKETS

# Market clearing & equilibrium

- r is fixed $\rightarrow$ small open economy
- **Housing market**
  * houses bought = houses produced + houses sold - depreciation
- **Rental market**
  * Competitive: renters meet landlords
  * $p_r$ is determined using household's equilibrium distribution, $\mu$

$$\underbrace{\sum_{i_a=1}^{n_a}\sum_{i_y=1}^{n_y}\sum_{j=1}^{J}\mu(a,y,0,j)}_{\text{renters}} = \underbrace{\sum_{i_a=1}^{n_a}\sum_{i_y=1}^{n_y}\sum_{j=1}^{J}\mu(a,y,2,j)}_{\text{landlords w/ 1 btl property}} + 2\underbrace{\sum_{i_a=1}^{n_a}\sum_{i_y=1}^{n_y}\sum_{j=1}^{J}\mu(a,y,3,j)}_{\text{landlords w/ 2 btl properties}} \tag{14}$$

▷ Equilibrium definition

# A macro-prudential reform: the case of Ireland

# Institutional framework

- First discussed in October 2014
- Officially announced and directly implemented in **February 2015**
- **Loan-to-Value (LTV) requirements**:
  * In general, the limit was set to 80%
  * For *first time buyers* (FTB) can be 90% if the property value is below €220,000
  * For *buy-to-let* (BTL) properties the limit is even more stringent: 70%
  * 15% of new lending can be above limit
- **Loan-to-Income (LTI) requirements**:
  * 3.5 times household income for primary dwellings only
  * 20% of bank lending can be above limit

▷ Relaxation of the rules announced in October 2022 ▷ House prices and rents

# Empirical evidence

# Parametric Evidence

- We **replicate Acharya et al. (2020)** empirical strategy using also **data on rents**:

$$\Delta HP_i = \beta_0 + \beta_1 \text{Distance}_i + \epsilon_i \quad (15)$$

$$\Delta HR_i = \gamma_0 + \gamma_1 \text{Distance}_i + \nu_i \quad (16)$$

where $i$ is county, $\Delta$ is change between 2014Q3 and 2016Q4

| | $\Delta$ House prices | $\Delta$ Rents |
|---|---|---|
| Distance | 0.289 | -0.171 |
| | (0.068) | (0.039) |
| Obs. | 54 | 54 |
| $R^2$ | 0.34 | 0.31 |

▷ Data ▷ Pre-Trends

# Parametrizing the model

# Externally calibrated parameters

| Parameter | Interpretation | Value |
|---|---|---|
| $J^{ret}$ | Working life (years) | 41 |
| $J$ | Length of life (years) | 71 |
| $\gamma$ | Risk aversion coefficient | 2.0 |
| $\sigma_\varepsilon$ | Scale parameter (taste shock) | 0.05 |
| $\{\tilde{h}_{oo}, \tilde{h}_{btl}\}$ | Housing qualities | $\{1.036, 0.8562\}$ |
| $\delta_h$ | Housing depreciation rate | 0.012 |
| $\tau^h$ | Proportional transaction cost | 0.04 |
| $\lambda_{LTV}$ | Maximum loan-to-value ratio | 1.0 |
| $\lambda_{LTI}$ | Maximum loan-to-income ratio | 6.0 |
| $r$ | Risk-free rate | 0.02 |
| $\kappa$ | Intermediation wedge | 0.02 |
| $A_c$ | Aggregate labor productivity | 1.25 |
| $\bar{L}$ | Amount of land | 1.0 |
| $\alpha$ | Share of land in production | 0.33 |

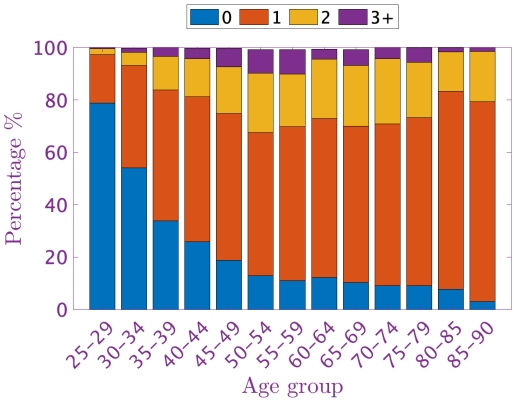
# Internally calibrated parameters, targets, & model fit

- The discount factor $\beta = 0.9375$, the utility premium from ownership $s(\tilde{h}_{oo}) = 1.6$, and the scaling factor in housing production $A_h = 0.12$ are jointly chosen to match four moments of the data:

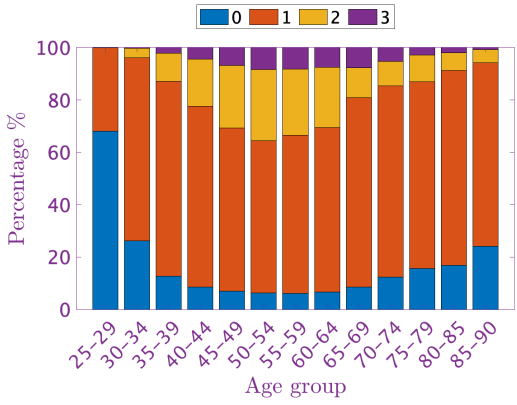
| Moment | Model | Data | Source |
|---|---|---|---|
| *Targeted:* | | | |
| Wealth to income ratio | 5.32 | 6.78 | HFCS |
| Homeownership rate | 79.13% | 80% | EU-SILC |
| Avg. house price to income ratio | 4.90 | 5.0 | CSO |
| House price to rents ratio | 23.00 | 22.58 | RTB/CSO |
| *Untargeted:* | | | |
| Rents to avg. income ratio | 0.2132 | 0.2216 | RTB/CSO |
| Share of households with 3+ properties | 3.97% | 5.11% | HFCS |

▷ Small landlords

# Life-cycle patterns: number of properties



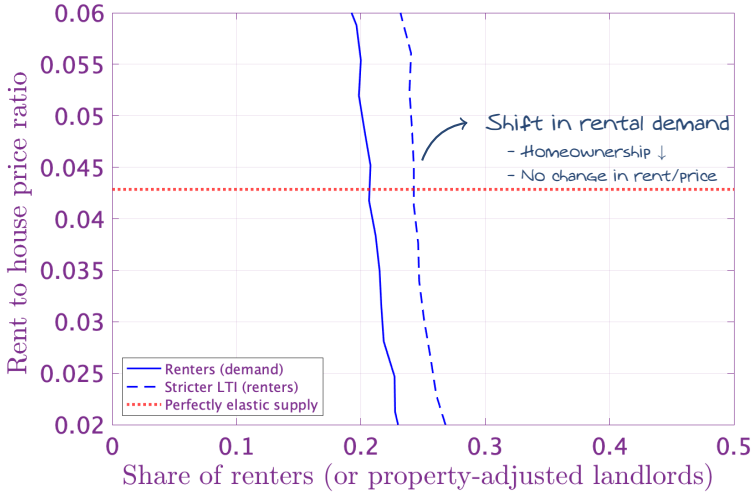

(a) Data



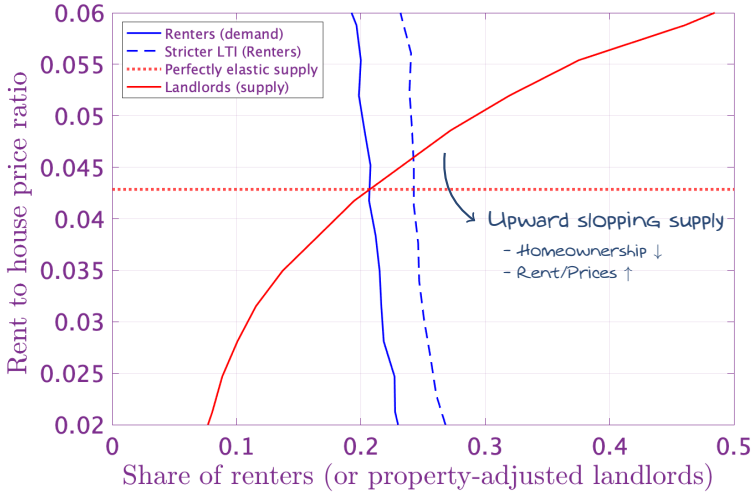

(b) Model

# Constraining credit:
## tighter LTI & LTV limits

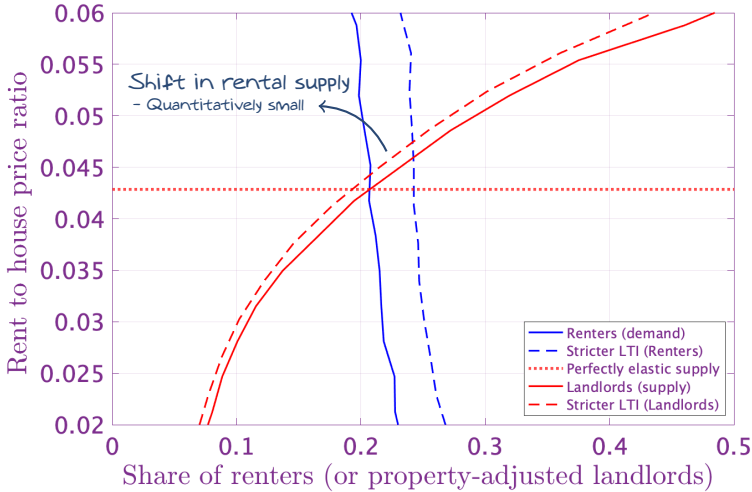
# Model intuition: perfectly elastic supply



# Model intuition: landlord heterogeneity



# Model intuition: mostly unconstrained landlords



# Steady State comparison

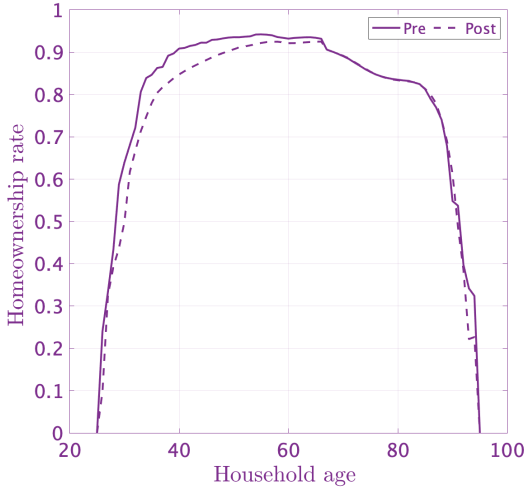
- First, study the effects of the reform in the long run. Later, we will look at the transition.

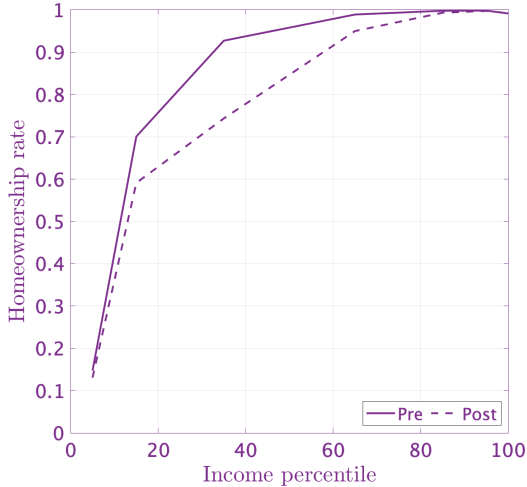
| | Pre-Reform | Post-Reform | Only LTI |
|---|---|---|---|
| | LTV = 100%, LTI = 6 | LTV = 80%, LTI = 3.5 | LTV = 100%, LTI = 3.5 |
| Rent-to-Price | 4.38% | 4.73% | 4.73% |
| Average house price to income | 4.90 | 4.87 | 4.87 |
| Rent to Income | 0.21 | 0.23 | 0.23 |
| Homeownership rate | 79.13% | 76.34% | 76.36% |
| Share of households with 3 properties | 3.97% | 4.65% | 4.66% |
| Share of houses in hands of 3-property landlords | 38.06% | 39.29% | 39.47% |

- Rent/Price $\rightarrow 8.76\% \uparrow =$ $\begin{cases} \text{Prices} & \rightarrow 0.65\% \downarrow \\ \text{Rents} & \rightarrow 8.06\% \uparrow \end{cases}$ Homeownership rate $\rightarrow 2.79\text{pp} \downarrow$
- Most of the effects are originated by the tighter LTI limit

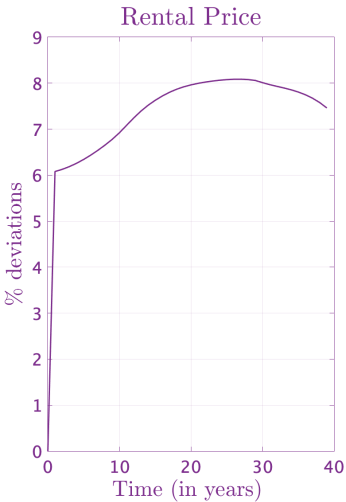
▷ Housing supply assumptions ▷ Housing supply elasticity

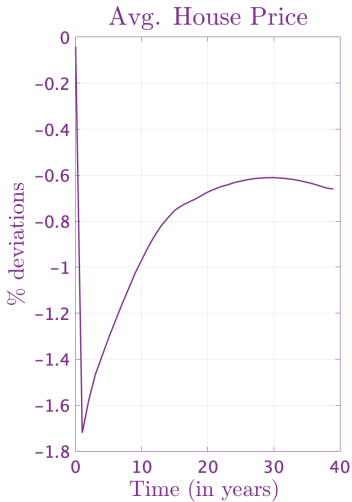
# Homeownership rate by age and income

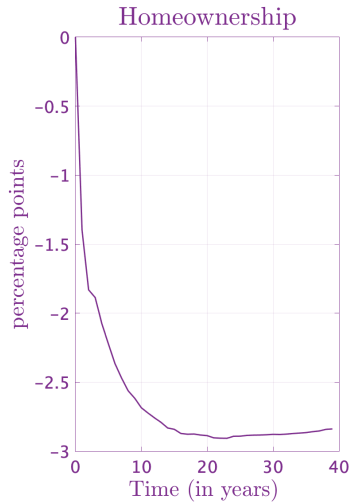


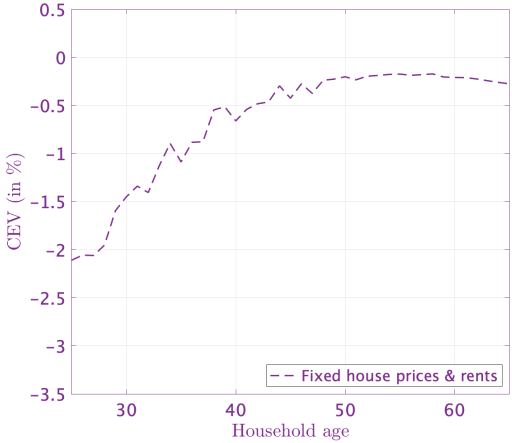
# Transition paths

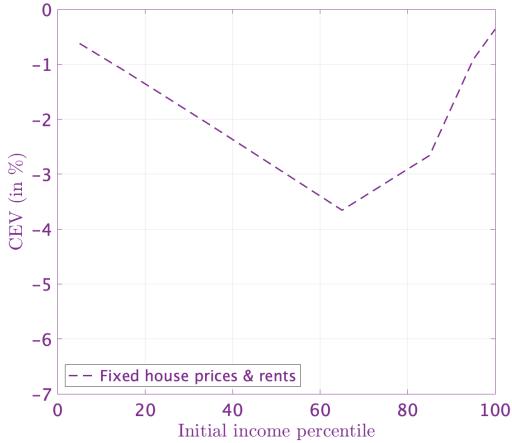


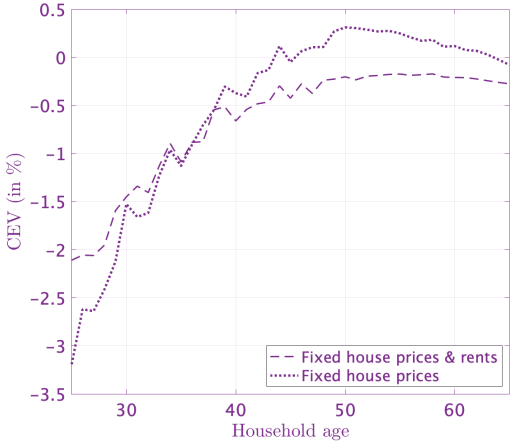



# Lifetime CEV: fixed house prices & rents

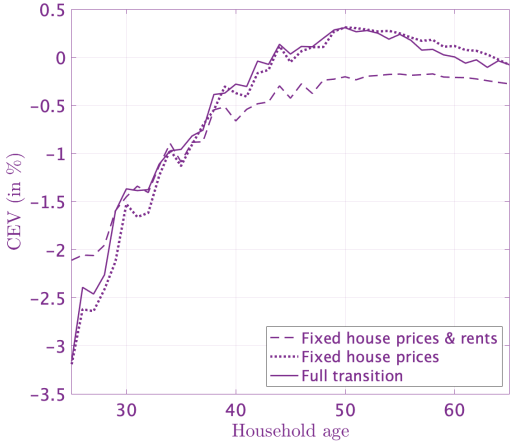


# Lifetime CEV: movements in rents




# Lifetime CEV: full transition




# Concluding remarks

# Main Takeaways

- We have **empirically** shown that the Irish macroprudential reform had **opposite effects on house prices and rents**.

- We build an **equilibrium model with landlord heterogeneity** that is able to rationalize this finding.

- We use it to evaluate the **aggregate** and **distributional** effects of the reform:
  * upon impact: rent/price $\uparrow$ 7.8% $\rightarrow$ house prices $\downarrow$ 1.7% & rents $\uparrow$ 6.1%
  * across steady states: homeownership $\downarrow$ 2.79 pp & market concentration $\uparrow$1.2 pp
  * ☹ Young, poor, middle-income and renters $\rightarrow$ postpone/cancel buying + higher rents
  * ☺ Middle-aged, top-earners, landlords $\rightarrow$ not constrained, higher returns at lower costs

# Next steps

- Introduce **additional details of the reform** such as the distinct LTV limits for owner-occupied (80%) and buy to let properties (70%)
  * It will most likely magnify the effect on prices as landlords will be more constrained
- Replicate *distance* regression with model simulated data
  * In the model, we could generate different synthetic counties by modifying the housing supply elasticity ($1/\alpha$)
- Study the interaction between macro-pru and monetary policy
  * **Interest rate hikes** put pressure on housing markets
  * The **relaxation of the macro-prudential measures** implemented in January 2023 probably related to it
  * Can we look at it within our framework?

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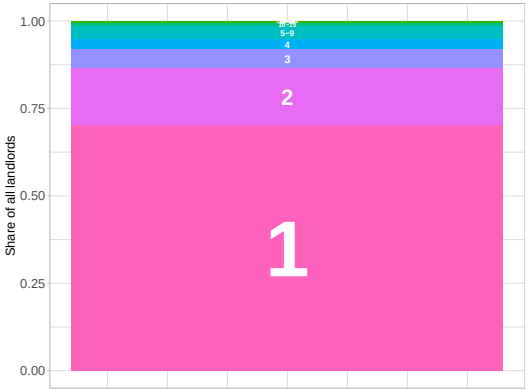
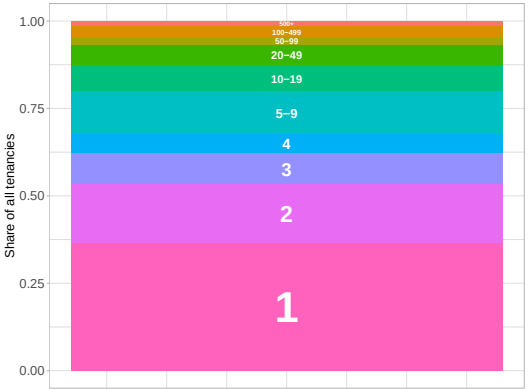
# THANK YOU!

# Why we only model small landlords?

**Share of landlords** by number of registered tenancies (RTB)



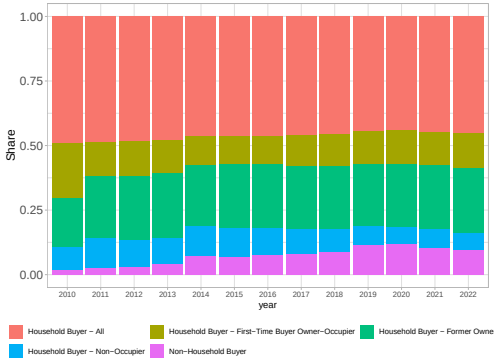

**Share of tenancies** by number of registered tenancies (RTB)



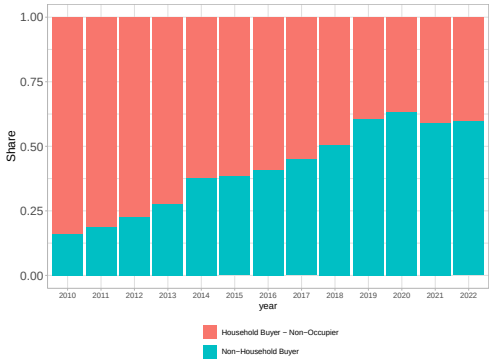

▷ Back

# Who is the marginal investor?

Share of all property transactions, by type of buyer and year (CSO data)




Share of all property transactions, by type of buyer and year (CSO data), **excluding owner-occupiers**.

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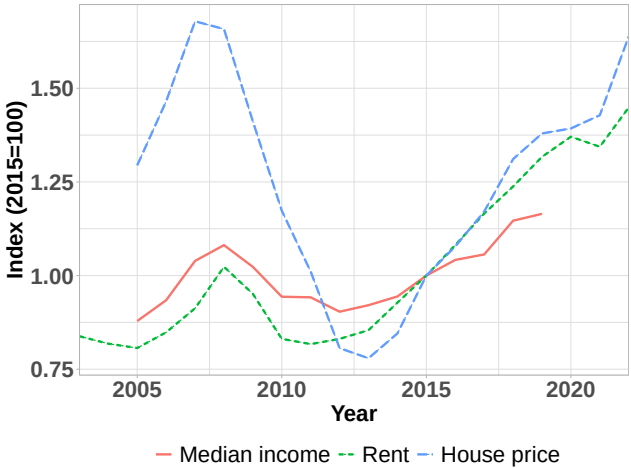
# Cyclical evolution of house prices and rents in Ireland




**Source**: Daft.ie property website based on Keely and Lyons (2020, JREFE)

▷ Back

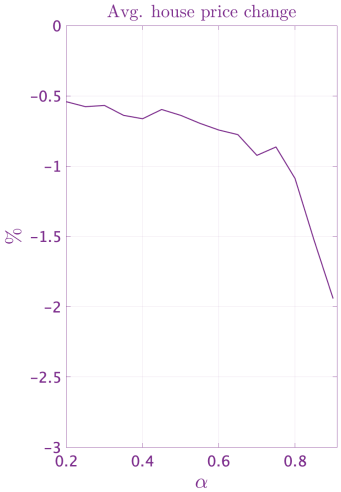
# Aggregate housing supply elasticity

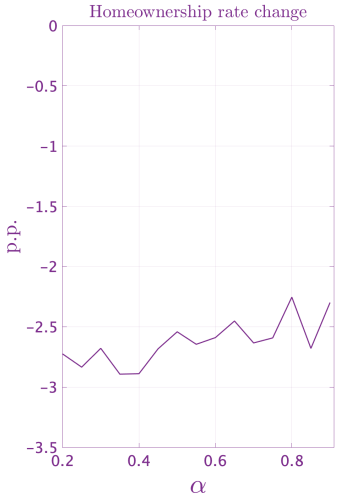
- Using the housing investment function one can derive the housing supply elasticity:

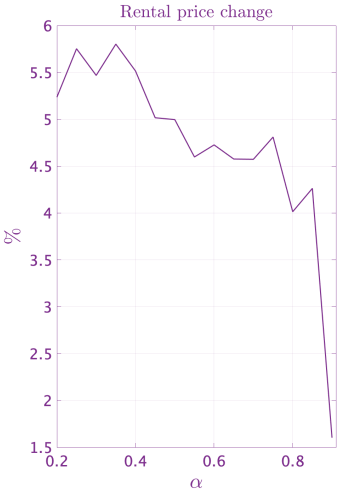
$$\begin{aligned}\frac{\partial Y_h}{\partial p_h}\frac{p_h}{Y_h} &= A_h^{1/\alpha}\bar{L}\frac{1-\alpha}{\alpha}\left((1-\alpha)\,p_h\right)^{\frac{1-\alpha}{\alpha}-1}\frac{p_h}{Y_h} \\ &= \frac{1-\alpha}{\alpha}\left((1-\alpha)\,p_h\right)^{-1}p_h \\ &= \frac{1}{\alpha}\end{aligned}$$

- We solve for the pre and post reform steady state under different values of the housing supply elasticity (high $\alpha$, low elasticity)
  - To isolate its effect, we find the corresponding $A_h$ that keeps prices unchanged
- We also look at CEV across steady states.

# Steady state changes for different values of $\alpha$



# Construction firms

- *Baseline*: one product, different aggregations

$$Y_h = A_h L^{\alpha} S^{1-\alpha}$$

  * Two quality/sizes: $\tilde{h}_{oo}$ and $\tilde{h}_{btl}$
  * Two different prices: $p^h(\tilde{h}_{oo}) = \tilde{h}_{oo} p_h$ and $p^h(\tilde{h}_{btl}) = \tilde{h}_{btl} p_h$
  * Choose $\tilde{h}_{oo}$ and $\tilde{h}_{blt}$ such that we replicate the owner-occupied to buy-to-let price ratio

- *No segmentation*: single type of house: $\tilde{h}_{oo} = \tilde{h}_{btl} = 1$

- *Full segmentation*: two products, two supply functions

$$Y_h = A_h^j L^{\alpha} S_j^{1-\alpha} \quad \text{for} \quad j = \{oo, btl\}$$

  * Choose $A_h^j$ to match the owner-occupied to buy-to-let price ratio
  * Owner occupied more expensive implies $A_h^{oo} < A_h^{btl}$

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# Steady states under alternative assumptions

- We **recalibrate** each model version before solving for the two steady state equilibria

| | Single quality | Quality Ladder | Two Techn. |
|---|---|---|---|
| Δ Rent-to-Price | 5.98 % | 8.76 % | **23.58 %** |
| Δ Average house price to income | **0.0 %** | -0.65 % | -0.58 % |
| Δ Owner-occupied house price to income | · | · | **-2.14 %** |
| Δ Buy-to-let house price to income | · | · | **8.11 %** |
| Δ Rent to Income | 5.98 % | 8.06 % | 22.86 % |
| Δ Homeownership rate | -2.34 p.p | -2.79 p.p | -2.88 p.p. |
| Δ Share of households with 3 properties | 0.58 p.p. | 0.68 p.p. | 1.01 p.p. |
| Δ Share of houses in hands of 3-property landlords | 0.81 p.p | 1.24 p.p. | -4.42 p.p. |

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# Equilibrium Definition

**Definition 1: Competitive Equilibrium**

A competitive equilibrium is a value function $\{V\}$ and policy functions for the **households** $\{c, h', a'\}$, policy functions for the **firms** $\{N, L, S\}$, **prices** $\{w, p_h, p_r, p_l\}$ and a **stationary distribution** $\mu$ that jointly solve the household, final-good firm and construction firm problems, as well as the **market clearing** conditions

$$\begin{aligned}
\text{Housing:} \quad & Y_h = (\delta_h + 1/T)H \\
\text{Aggregate Housing:} \quad & H = \sum_{n=1}^{N} \tilde{h}_n H_n \quad \text{where} \quad \sum_{n=1}^{N} H_n = 1 \\
\text{Housing Permits:} \quad & L = \bar{L} \\
\text{Resources:} \quad & Y = C + S
\end{aligned}$$

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# Mortgage Measures Framework Review

- Relaxation of the rules were announced in October 2022
- These measures will come into effect in **January 2023**
- *First-Time-Buyers (FTB)*
  * The **LTI limit** increases from 3.5 to **4 times household's income**
  * No changes in the LTV limit
- *Second and Subsequent Buyers (SSB)*
  * The **LTV limit** increases from 80% to **90%**
  * No changes in the LTI limit
- The proportion of lending above limits applies at the level of borrower type
  * 15% of FTB and SSB can be above limit
  * 10% of BTL lending can be above limit

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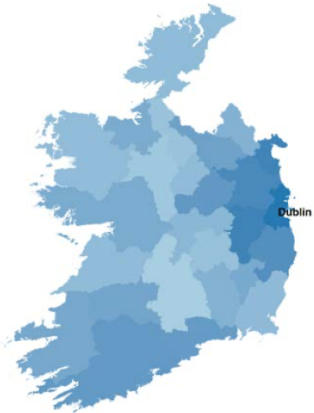
# Data Sources

- Data on **house prices and rents** obtained from **daft.ie** property website (Lyons, 2022)
  * 54 housing markets (26 counties + cities + all postcodes in Dublin)
- **Distance measure** computed at borrower level (Acharya et al., 2022)
  * Look at households who obtain a mortgage in year 2014
  * Compute the distance of their mortgage from the new limits
  * Group over 26 counties and over the income distribution
  * Take averages




**Note**: darker means less distance from limits

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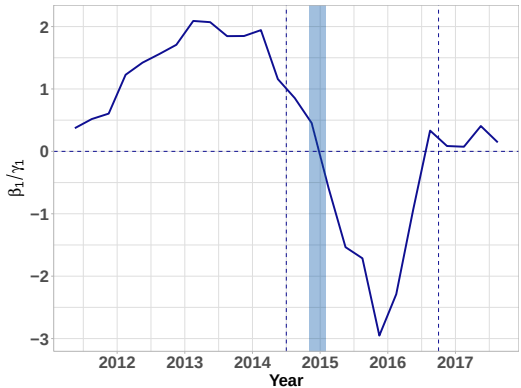
# Robustness: Pre-Trends?

- Run placebo regressions (15) - (16) using 9-quarter rolling windows to compute growth rates

- Plot ratio of regression coefficients
  - $\beta_1/\gamma_1 > 0 \implies cov(\Delta HP, \Delta HR) > 0$
  - $\beta_1/\gamma_1 < 0 \implies cov(\Delta HP, \Delta HR) < 0$

- Sign changes around the reform . . .
  - Rents do not longer co-move with house prices as a result of the credit shock

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# Lifetime CEV: the role of housing tenure