The aggregate and distributional implications of credit shocks on housing and rental markets

Juan Castellanos
European University Institute

Andrew Hannon
European Central Bank

Gonzalo Paz-Pardo
European Central Bank

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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**.

▷ Small landlords

What we do

- Build an equilibrium model of the **rental and housing markets**
  - 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 (distribution of losses)
- Model is also useful to understand other types of credit shocks such as a changes in the real interest rate

What we find: tighter LTV & LTI limits

- *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*:
  - Increased rental demand by constrained households
  - More rental properties need to be supplied: higher rental rates (key: **landlord heterogeneity**)
  - Lower house prices over the transition, persistently if rental $\neq$ owner-occupied properties
- *Implications*:
  - Along the transition, the reform **benefits the old** and **hurts the young**
  - Largest welfare losses for middle of income distribution
  - Drivers of welfare loss: credit constraint + increase in rents
  - Increase in wealth concentration

What we find: rising the real interest rate

- **Similar model mechanisms** that also lead to an increase in rental prices and a reduction of the average house price and the homeownership rate
- However, there are some interesting **differences**
  * Shock affects not only new buyers, but *current mortgagors* (**increase in mortgage payments**) and *savers* (**increase in the return on savings**)
  * Households react more by buying smaller houses and getting smaller mortgages

    more downsizing $\implies$ *bigger reaction of the average house price*
  * Because the rise in the return on savings, financial assets are comparatively more attractive for potential landlords

    $\uparrow r^s \implies$ *bigger reaction of rental prices*
- **Welfare** impact is also highly **heterogenous** with those at the *bottom* of the income distribution *losing* while those at the *top benefiting*

Roadmap

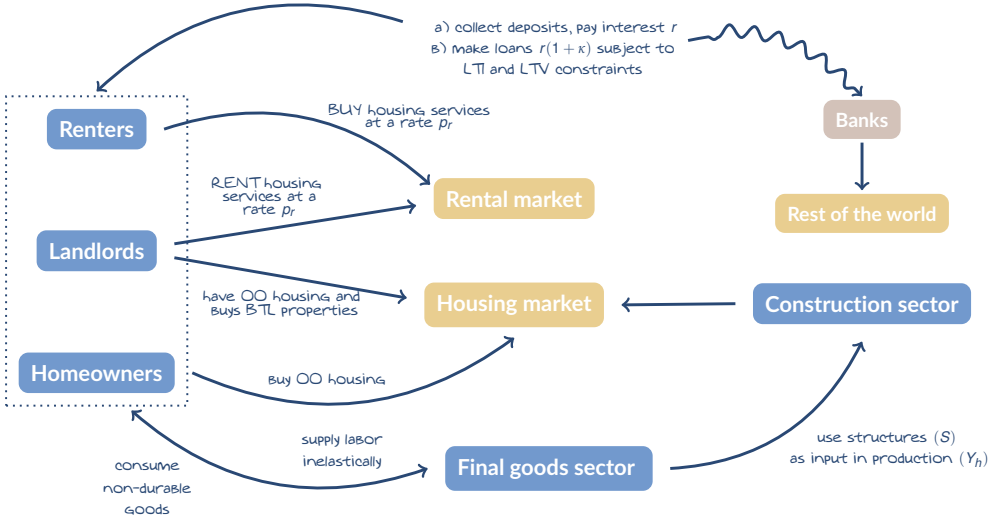
Related Literature

Literature

- What explains the **housing boom and bust** that triggered the GFC?
  - Credit: *Favilukis, Ludvigson, and Van Nieuwerburgh (2017)*; *Greenwald (2018)*; *Justiniano, Primiceri, and Tambalotti (2019)*
  - Liquidity: *Garriga and Hedlund (2020)*
  - Fluctuations in beliefs: *Kaplan, Mitman and Violante (2020)*
- **Rental market**
  - Traditional assumptions: no rental markets or inelastic rents $\rightarrow \text{cov}(p_h, p_r) > 0$
  - *Gete and Reher (2017)*: empirically shows that a **contraction in mortgage supply increases rents**
  - *Greenwald and Guren (2020)*: if housing and rental markets are **segmented, prices react to credit**
  - *Sommer and Sulivan (2018)*: **endogenous house & rental prices** to study mortgage taxation
  - *Rotberg and Steinberg (2024)*: highlight key role of **rental supply elasticity** for mortgage taxation
  - This paper: house and rental prices are both endogenous and can move in opposite directions in response to shocks

The Model Economy

Model sketch



Production

- **Final Good Producer**
  - Linear technology: $Y_c = A_c N$, where A_c is a parameter and N is labor
  - Profit maximization: wage $= A_c$
- **Housing Good Producer**
  - Cobb-Douglas technology: $Y_h = A_h \bar{L}^{\alpha_L} S^{1-\alpha_L}$ where $\{A_h, \alpha_L\}$ are parameters, $\bar{L}$ land permits and S structures
  - Profit maximization: $Y_h = A_h^{1/\alpha_L} \left((1-\alpha_L)\, p_h \right)^{(1-\alpha_L)/\alpha_L} \bar{L}$ (housing investment function)
  - *Housing stock* is composed by houses of *two different qualities*: $H = \tilde{h}_1 H_1^{sh} + \tilde{h}_2 H_2^{sh}$ where $\tilde{h}_i$ denotes quality and H_i^{sh} is its share in the aggregate stock
    - Final transaction price depends on type: $p(\tilde{h}_i)$
    - Conversion between types is costly for the firm
    - Households will need to buy and sell to adjust their stock

Households: environment

- **Life cycle model**
  * Working age from $j = 1, \cdots, J^{ret} \rightarrow$ supply labor inelastically and receive idiosyncratic income
  * Retirement age from $j = J^{ret} + 1, \cdots, J \rightarrow$ receive fix fraction of their last period income
  * After age $J \rightarrow$ they die with certainty
- **Preferences**

$$u(c, \tilde{h}) = \frac{\left(c\, f(\tilde{h}_i)\right)^{1-\gamma}}{1-\gamma} \quad \text{where} \quad f'(\cdot) > 0, f''(\cdot) < 0$$

- **Assets and liabilities**
  * Financial assets $\rightarrow r$
  * Real estate $\rightarrow p_r / p(\tilde{h})$
  * Mortgages $\rightarrow r(1 + \kappa)$

Households: housing & mortgages

- **Housing state**: quantity and quality of housing $s := \{h, \tilde{h}\} \in \mathcal{H}, \dim(\mathcal{H}) = 5$
  - *Renter*: doesn't own $(h = 0)$, lives in a small rented house $\{\tilde{h}_1\}$, and pays rent p_r
  - *Homeowner*: owns $(h = 1)$ and lives in a house of either quality $\{\tilde{h}_1, \tilde{h}_2\}$
  - *Landlord*: owns multiple houses $(1 < h \leq 3)$, lives in the best quality $\{\tilde{h}_2\}$ and rents the remaining low quality $\{\tilde{h}_1\}$ at a rate p_r each
- Houses are **illiquid** (proportional transaction costs, τ_h) and **costly to maintain**, δ_h
- Mortgages ($a < 0$) are limited by two **financial constraints** that can only *bind at origination*:

$$a' \geq -\lambda_{LTV}\, p_h(\tilde{h}')h'$$
$$a' \geq -\lambda_{LTI}\, y$$

- Households must at least **pay interests** and **amortize** a minimum amount per period for the remaining life of the mortgage

Household's problem

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

s.t.

$$\begin{aligned} c + a' + p(\tilde{h}')h' + \mathbb{1}_{sell}\tau^h p(\tilde{h})h + \mathbb{1}_{buy}\tau^h p(\tilde{h}')h' + \delta^h p(\tilde{h})h \leq \\ y + (1 + r(1 + \mathbb{1}_{a'<0}\kappa))\, a + p(\tilde{h})h + p_r(h-1) \end{aligned} \tag{2}$$

$$a' \geq \begin{cases} \max\left\{-\lambda_{LTV}\, p(\tilde{h}')\, h', -\lambda_{LTI}\, y\right\} & \text{if } h' > h \\ a(1 + r(1+\kappa) - m(j)) & \text{if } h > 0 \text{ and } a < 0 \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

$$\varepsilon(s) \sim F, \text{ extreme value type I dtb} \tag{4}$$

$$m(j) = \frac{r(1+\kappa)(1 + r(1+\kappa))^{J-j}}{(1 + r(1+\kappa))^{J-j} - 1} \tag{5}$$

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, $\mathcal{D}(a, s, y, j)$

$$\underbrace{\sum_{j=1}^{J} \int \int \mathcal{D}(a, s_1, y, j) da\, dy}_{\text{renters}} = \underbrace{\sum_{j=1}^{J} \int \int \mathcal{D}(a, s_4, y, j) da\, dy}_{\text{landlords w/ 1 btl property}} + 2 \underbrace{\sum_{j=1}^{J} \int \int \mathcal{D}(a, s_5, y, j) da\, dy}_{\text{landlords w/ 2 btl properties}}$$

▷ Equilibrium Definition

The Irish Macroprudential Reform

Institutional framework

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

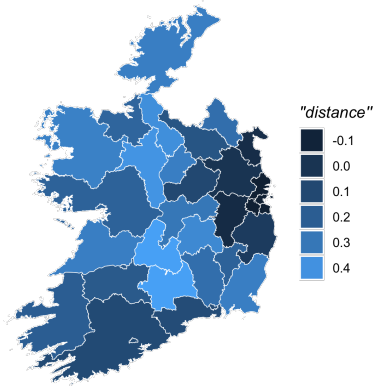
▷ Relaxation of the rules announced in October 2022

Empirical Evidence

Intended effect on house prices

- Acharya, Bergant, Crosignani, Eisert, McCann (2022) study the effect of the reform on house prices

- What do they do?
  * Use data on newly originated mortgages before the reform
  * Construct a `Distance` measure that captures the exposure to lending limits (LTI & LTV) across counties and the income distribution
  * Regress house price changes on the `Distance` measure
  * Main finding: house prices increased more in more distant counties



What about rents?

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

$$\Delta HP_i = \beta_0 + \beta_1 \texttt{Distance}_i + \epsilon_i \quad (6)$$

$$\Delta HR_i = \gamma_0 + \gamma_1 \texttt{Distance}_i + \nu_i \quad (7)$$

where i is county, Δ is change between 2014Q3 and 2016Q4

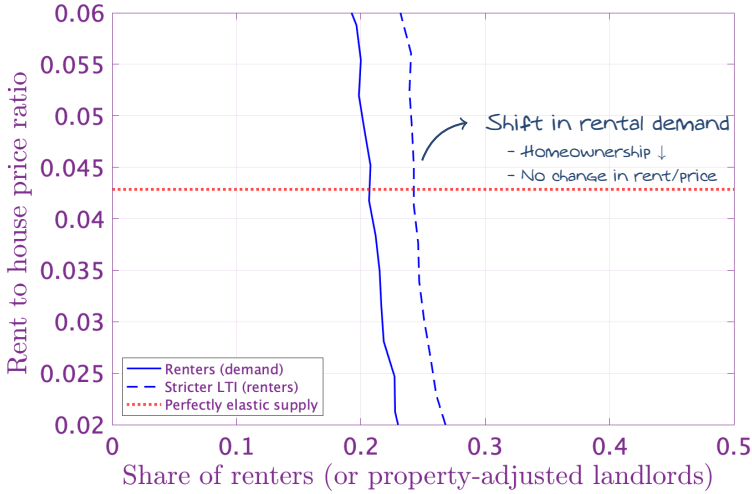
	Δ House prices	Δ Rents
Distance	0.289	-0.171
	(0.068)	(0.039)
Obs.	54	54
R^2	0.34	0.31

▷ Data ▷ Non-parameteric ▷ Pre-Trends

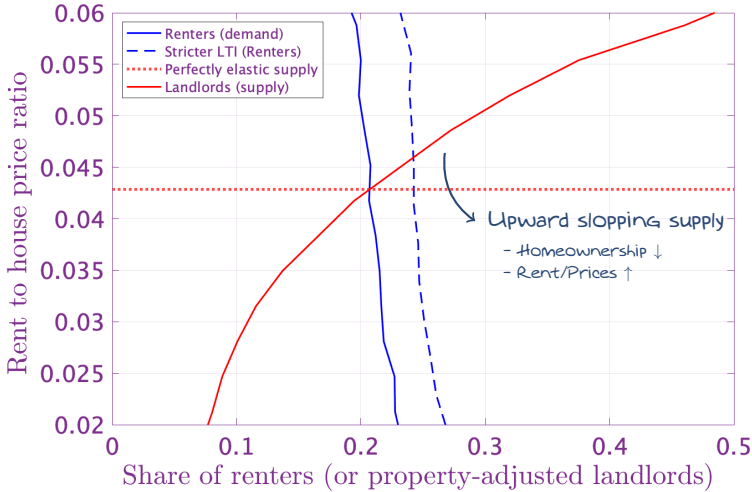
Model's Intuition

(A Credit Crunch)

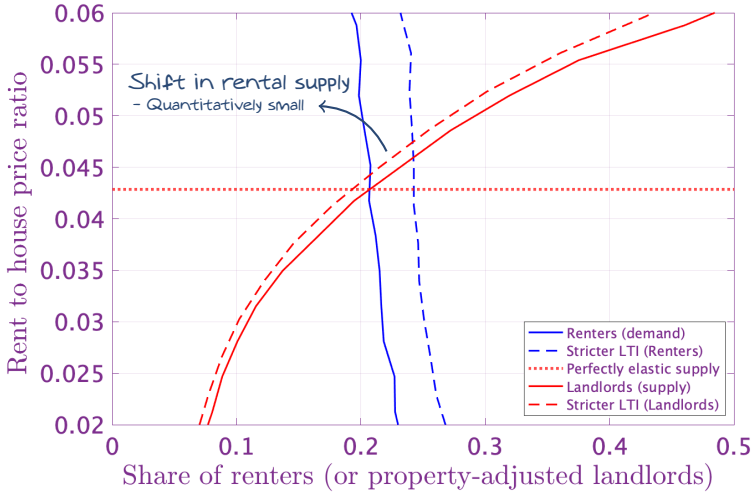
Model intuition: perfectly elastic supply



Model intuition: landlord heterogeneity



Model intuition: mostly unconstrained landlords



Model Calibration

Externally calibrated parameters

Parameter	Interpretation	Value
J^{ret}	Working life (years)	41
J	Length of life (years)	71
γ	Risk aversion coefficient	2.0
σ_ε	Taste shock scale parameter	0.05
$\{\tilde{h}_1, \tilde{h}_2\}$	Housing qualities	$\{0.905, 1.1095\}$
α^h	Curvature in utility premium function	0.5
δ^h	Housing depreciation rate	0.012
τ^h	Proportional transaction cost	0.03
λ_{LTV}	Maximum loan-to-value ratio	1.0
λ_{LTI}	Maximum loan-to-income ratio	6.0
r_s	Risk-free rate	0.02
r_b	Mortgage rate	0.04
A_c	Aggregate labor productivity	1.2055
$\bar{L}$	Amount of buildable land	1.0
α_L	Share of land in production	0.33
ξ	Adjustment cost scale in housing production	0.16

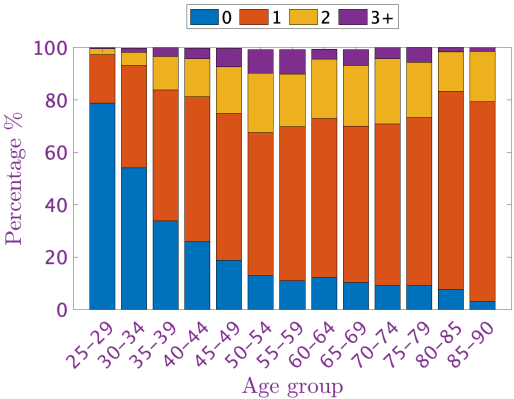
▷ Income process

Internally calibrated parameters, targets & model fit

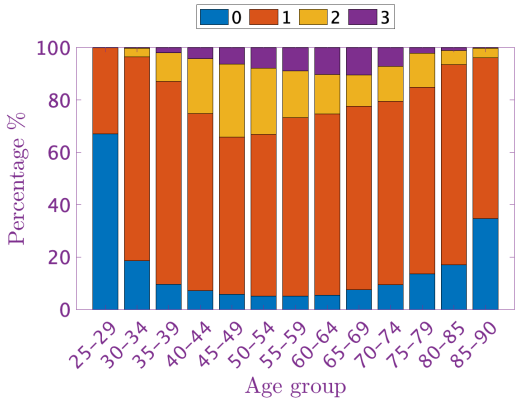
- The discount factor $\beta = 0.9656$, the ownership utility premium $f(\tilde{h}_1) = 1.3378$, and the scaling factor in housing production $A_h = 0.121$ are jointly chosen to match four moments of the data:

Moment	Model	Data	Source
Targeted:			
Wealth to income ratio	5.89	6.78	HFCS
Homeownership rate	79.42%	80%	EU-SILC
Avg. house price to income ratio	4.93	5.0	CSO
House price to rents ratio	22.73	22.58	RTB/CSO
Untargeted:			
Rents to avg. income ratio	0.196	0.2216	RTB/CSO
Share of households with 3+ properties	4.29%	5.11%	HFCS

Life-cycle patterns: number of properties



(a) Data



(b) Model

Aggregate & Distributional Effects

(Steady states, Transition & Welfare)

Long-term aggregate effects

	Pre-Reform	Post-Reform
	LTV = 100%, LTI = 6	LTV = 80%, LTI = 3.5
Rent-to-Price	3.98 %	4.09 %
Average house price to income	4.930	4.925
Rent to Income	0.196	0.201
Homeownership rate	79.42 %	77.59 %
Share of HHs living in big house	50.41 %	50.03 %
Share of households with 3 properties	4.29 %	4.51 %

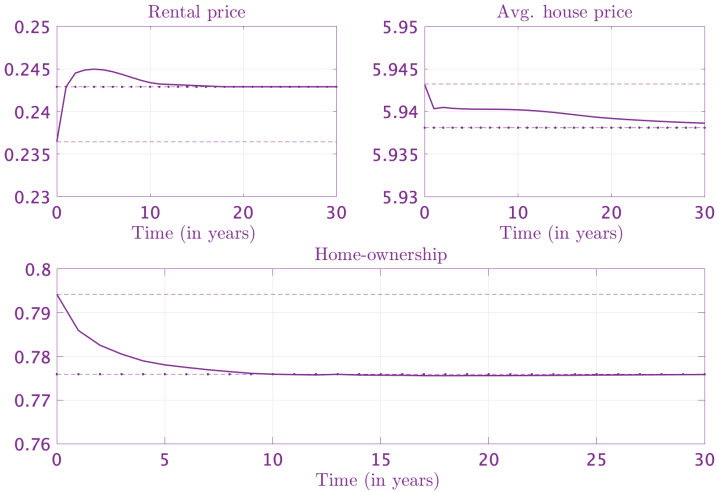
- Rent/Price $\rightarrow 2.82\% \uparrow = \begin{cases} \text{Prices} \rightarrow 0.01\% \downarrow \\ \text{Rents} \rightarrow 2.73\% \uparrow \end{cases}$

- Homeownership rate $\rightarrow 1.83\text{pp} \downarrow$
- Share of HHs living in big $\rightarrow 0.38\text{pp} \downarrow$

- Increased rental demand is met by owners starting the landlord business (1.39pp) rather than by landlords purchasing extra units ($0.22 \times 2 = 0.44$pp)

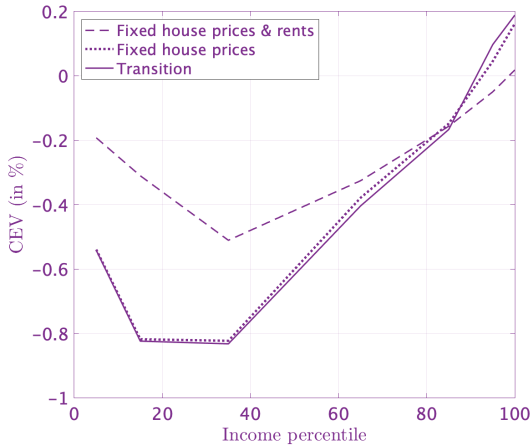
▷ LTV vs. LTI experiments ▷ Housing Tenure Flows

Transition dynamics: short-term effects

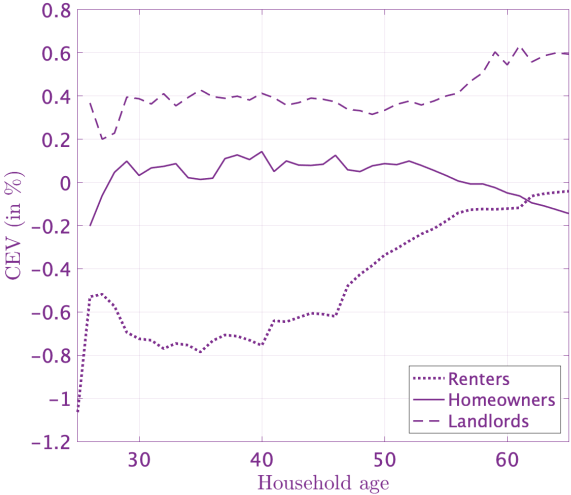


Welfare: Consumption Equivalent Variation

- **Tighter LTV & LTI** limits affects primarily potential (constrained) homebuyers who are in the **middle** of the income distribution
- The **increase in rental prices** hurts the **very poor** (as they have to still pay more rent) and those at **bottom-mid** of the income distribution (as it is more difficult to save for downpayment)
- Limited role for house prices



Heterogenous effects: the housing tenure status



- **Renters are the biggest losers** from the reform as it is more difficult to access homeownership and they pay higher rental prices
- **Homeowners are indifferent** because they have already purchased their homes
- **Landlords benefit** from the higher cash flows from their housing portfolio

Rising The Real Interest Rate

Long-term effects

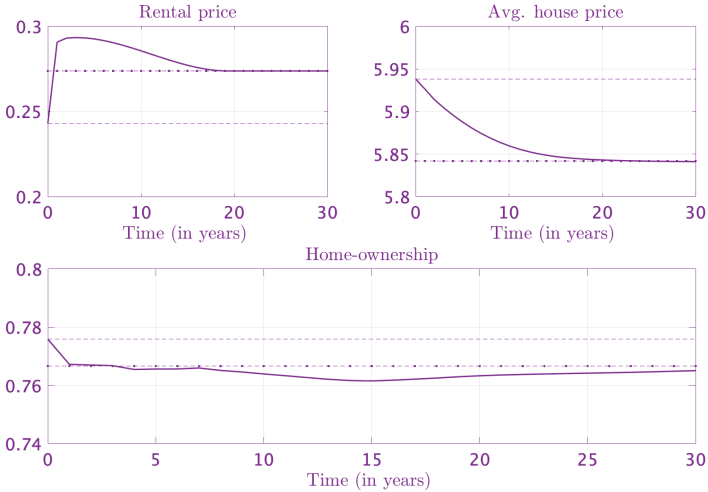
- $\uparrow r = \begin{cases} \uparrow r^s \rightarrow \text{substitution effect (financial assets)} + \text{positive income effect (downpayment)} \\ \uparrow r^b \rightarrow \text{negative income effect (mortgage payments)} \end{cases}$

	Low Int. Rate	Decomposition	High Int. Rate
	$r^s = 0.02, r^b = 0.04$	$r^s = 0.03, r^b = 0.04$	$r^s = 0.03, r^b = 0.05$
Rent-to-Price	4.09 %	4.58 %	4.69 %
Average house price to income	4.925	4.899	4.846
Rent to Income	0.201	0.224	0.227
Homeownership rate	77.59 %	76.99 %	76.67 %
Share of HHs living in big houses	50.03 %	47.74 %	43.02 %

- $\uparrow r^s$ (SE $>$ IE) $\rightarrow$ homowership $\downarrow 0.6 p.p.$, $p_r \uparrow 11.38\%$, $p_h^{avg} \downarrow 0.50\%$
- $\uparrow r^b \rightarrow$ homowership $\downarrow 0.33 p.p.$, $p_r \uparrow 1.22\%$, $p_h^{avg} \downarrow 1.1\%$
- $\uparrow r \rightarrow$ homowership $\downarrow 0.92 p.p.$, $p_r \uparrow 12.70\%$, $p_h^{avg} \downarrow 1.62\%$

▷ Loose Credit Conditions

Transition dynamics: short-term effects



Welfare: Consumption Equivalent Variation

- The increase in the **return on savings** is welfare improving and **gains** are (monotonically) **increasing on income**
- The higher **borrowing rates** negatively impact welfare. **Losses** are larger for those at the **middle** of the income distribution (potential home-buyers)
- Adjustments in the **rental market** (higher rents) lead to **winners (top half) and losers (bottom half)** from the overall increase in real rates
- Limited role for house prices

Concluding remarks

Main Takeaways

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

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- We build an **equilibrium model with landlord heterogeneity** and use it to evaluate the *aggregate* and *distributional* effects of the reform:
  * across steady states: homeownership $\downarrow$ 1.83 pp, rents $\uparrow$ 2.73%, house prices $\downarrow$ 0.01%
  * ☹ poor and middle income $\rightarrow$ higher rents + postpone/cancel buying
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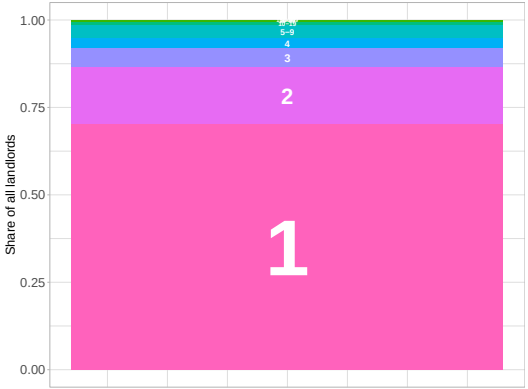
THANK YOU!

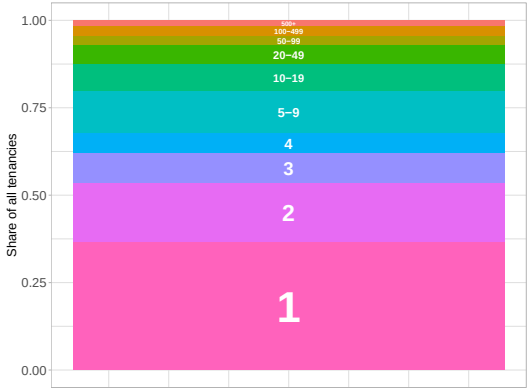
Appendix

Why we only model small landlords?

Share of landlords by number of registered tenancies (RTB)



Share of tenancies owned by landlords



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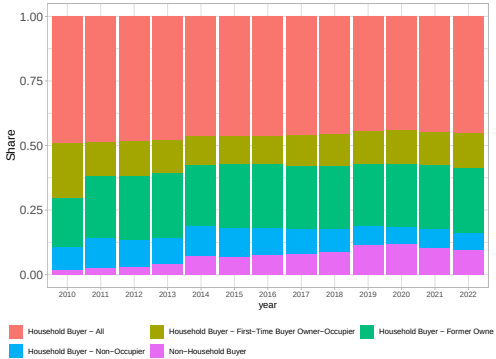
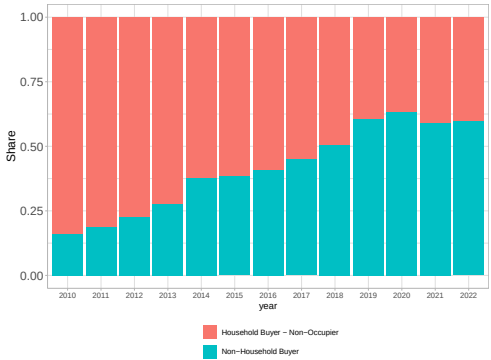
Who is the marginal investor?

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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The Model Economy

Equilibrium Definition

Definition 1: Competitive Equilibrium

For a given risk free rate r, a competitive equilibrium in this economy consists of: *(i)* a value function, a housing choice probability, and a consumption and asset policy function for the **households**: $\{V, \mathbb{P}(s), c, a'\}$, *(ii)* a **stationary distribution** over households' state: $\{\mathcal{D}\}$, *(iii)* policy functions for the **firms**: $\{N, L, S\}$, and *(iv)* **prices**: $\{w, p_L, p_h, p_r\}$ such that they jointly solve the household, final-good firm and construction firm problems, as well as satisfy the following **market clearing** conditions:

$$\sum_{j=1}^{J} \int \int \mathcal{D}(a, s_1, y, j) da\, dy = \sum_{j=1}^{J} \int \int \mathcal{D}(a, s_4, y, j) da\, dy + 2 \sum_{j=1}^{J} \int \int \mathcal{D}(a, s_5, y, j) da\, dy \tag{8}$$

$$Y_h = \left(\delta_h + \frac{1}{J}\right) H \tag{9}$$

$$Y_c = C + S \tag{10}$$

▷ Back

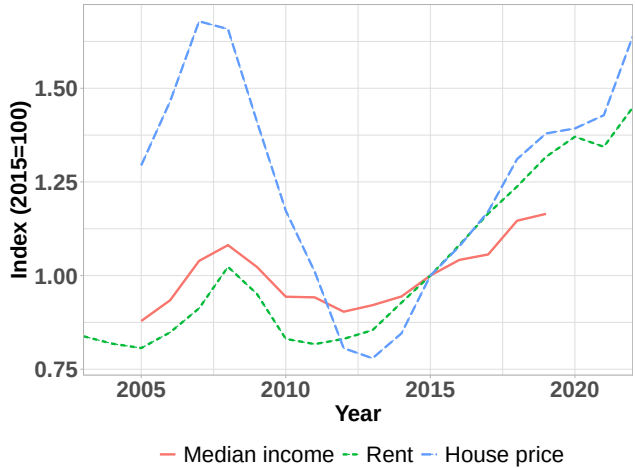
The Irish Macro-Prudential Framework

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

▷ Back

Cyclical evolution of house prices and rents in Ireland



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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

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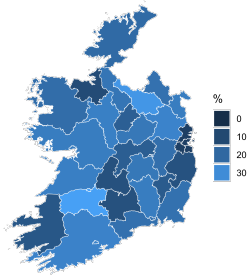
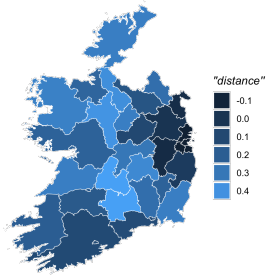
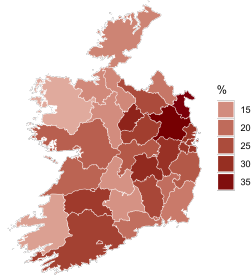
Non-parametric evidence



(a) House price growth



(b) Distance measure



(c) Rental price growth

- Counties where borrowers are close to the borrowing limits (low distance), e.g. around Dublin, experience *lower house price growth* (positive correlation) and *higher rental growth* (negative correlation).

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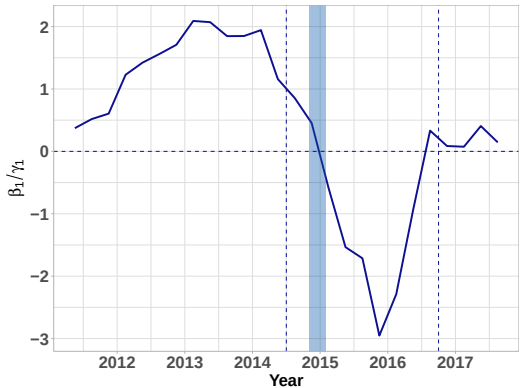
Robustness: Pre-Trends?

- Run placebo regressions (6) - (7) 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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Calibration

Income Process

- We assume that the idiosyncratic labor income endowment has a *deterministic* age component $g(j)$ and a *stochastic-persistent* component η

$$\log y = \log A_c + g(j) + \eta$$

  where $g(\cdot)$ is a polynomial in age and η is estimated non-linearly

- Income is measured after taxes and transfers
- HFCS and EU-SILC are used to extract the average age profile and the aggregate component of income, respectively
- Persistent and transitory component of the unexplained part of income are isolated using the methodology of Arellano, Blundell and Bonhomme (2017)
  * Flexible assumptions: age-dependence, non-normalities, non-linearities
  * We keep only the persistent component

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TIGHTER LTV & LTI LIMITS

Isolating the effects of each limit

	Full-Reform	Only LTI	Only LTV
Δ% Rent-to-Price	+2.82 %	+1.71 %	+0.73 %
Δ Homeownership rate	-1.83 p.p	-1.13 p.p.	-0.53 p.p.

- Non-linear interactions between the two borrowing constraints amplify the response of the rent to price ratio
  - Similar to the constraint switching effect of Greenwald (2018)
- LTI constraint is the most impactful if imposed in isolation

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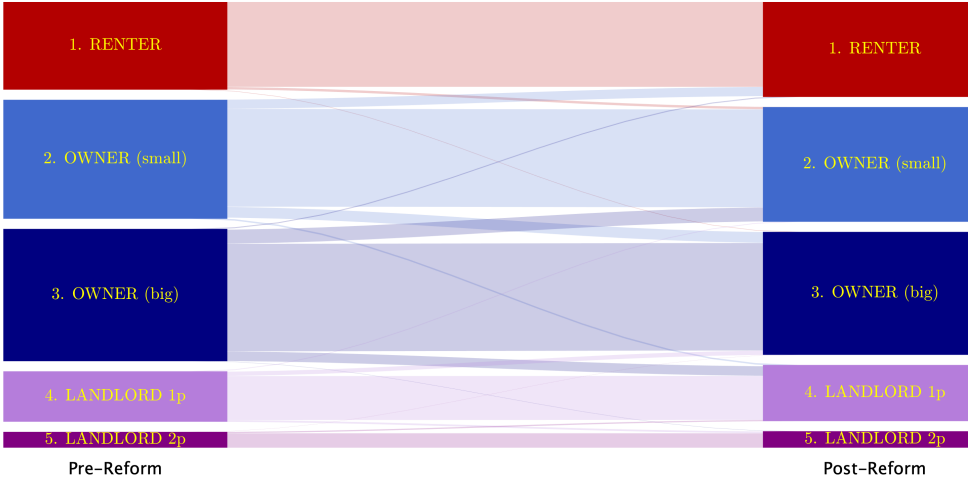
Housing tenure flows



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A Rise in the Real Interest Rate

Long-term effects with loose credit conditions

- Larger fall in the home-ownership rate and the average house price
- Similar rise in the rental price
- Macro-prudential policies help cushion the effects of other shocks

	Low Int. Rate	Decomposition	High Int. Rate
	$r^s = 0.02, r^b = 0.04$	$r^s = 0.03, r^b = 0.04$	$r^s = 0.03, r^b = 0.05$
Rent-to-Price	3.98 %	4.48 %	4.57 %
Average house price to income	4.930	4.880	4.835
Rent to Income	0.196	0.219	0.221
Homeownership rate	79.42 %	78.93 %	78.35 %
Share of HHs living in big houses	50.41 %	46.01 %	42.02 %

- $\uparrow r^s$ (SE $>$ IE) $\rightarrow$ homowership $\downarrow 0.49 p.p.$, $p_r \uparrow 11.57\%$, $p_h^{avg} \downarrow 1.01\%$
- $\uparrow r^b \rightarrow$ homowership $\downarrow 0.58 p.p.$, $p_r \uparrow 1.13\%$, $p_h^{avg} \downarrow 0.93\%$
- $\uparrow r \rightarrow$ homowership $\downarrow 1.07 p.p.$, $p_r \uparrow 12.84\%$, $p_h^{avg} \downarrow 1.93\%$

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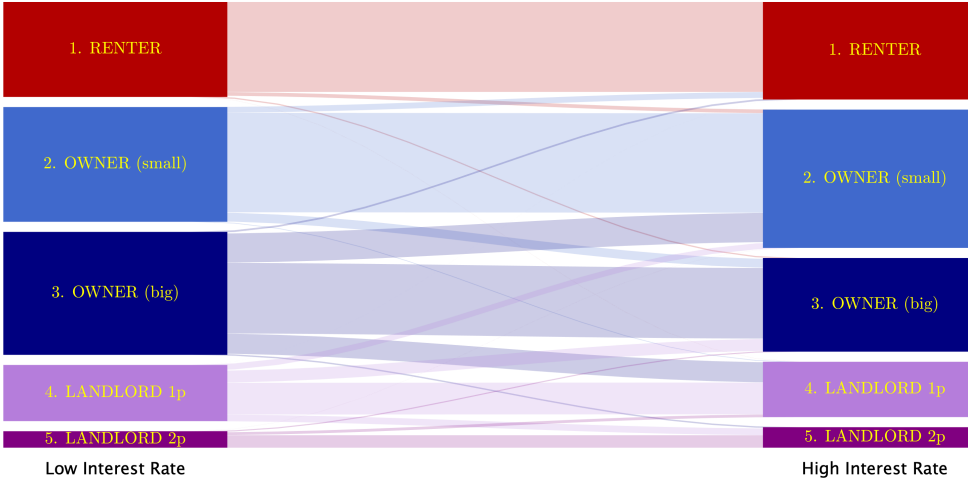
Housing tenure flows



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