

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

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**Disclaimer:** The views expressed in this presentation are our own and do not necessarily reflect those of the ECB or the Eurosystem.

- Housing has a **dual role** . . .
  - \* As a *consumption good* → if households don't buy a house, they must rent it
  - \* As an *asset/investment* → 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**.

- 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

- Empirically:

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

- 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

## 1. Introduction

### 1.1 Related Literature

## 2. Model

### 2.1 Production

### 2.2 Households

### 2.3 Equilibrium

## 3. A macro-prudential reform: the case of Ireland

### 3.1 Empirical evidence

### 3.2 Model parametrization & fit

### 3.3 Model results

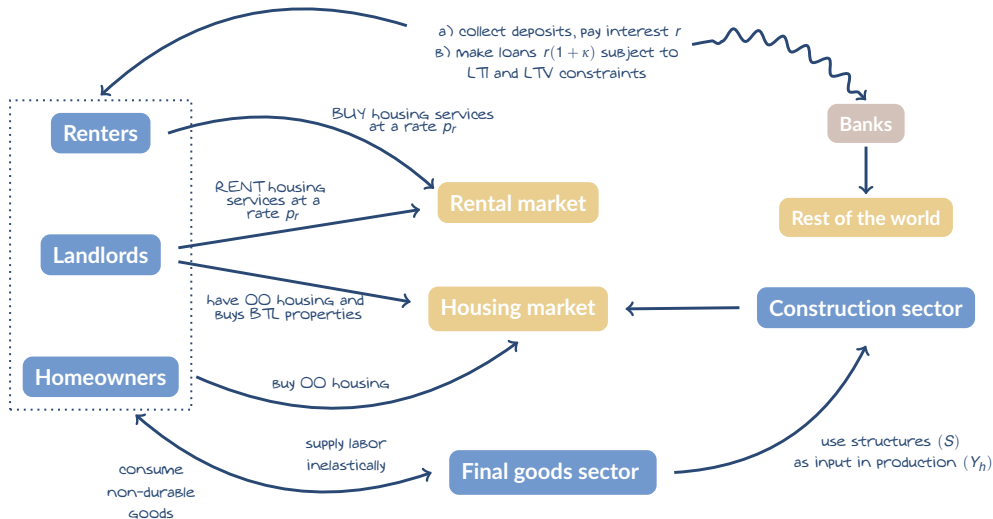
## 4. Other applications of the model: real interest shocks

# RELATED LITERATURE

- What explains the **housing boom and bust** that triggered the GFC?
  - \* Credit : Favilukis, Ludvigson, and Van Nieuwerburgh (2017, JPE); Greenwald (2018); Justiniano, Primiceri, and Tambalotti (2019, JPE)
  - \* Liquidity : Garriga and Hedlund (2020, AER)
  - \* Fluctuations in beliefs : Kaplan, Mitman and Violante (2020, JPE)
- Answer depends on the assumptions regarding the **rental market**
  - \* Typical assumptions : no rental markets or inelastic rents  $\rightarrow \text{cov}(p_h, p_r) > 0$
  - \* Endogenous house & rental prices to study mortgage tax deductions : Sommer and Sullivan (2018, AER)
  - \* If housing and rental markets are segmented, prices react to credit : Greenwald and Guren (2020)
  - \* This paper: house and rental prices are both endogenous and can move in opposite directions in response to shocks

# THE MODEL ECONOMY





## - 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:  $Y_h = A_h^{1/\alpha_L} ((1 - \alpha_L) p_h)^{(1-\alpha_L)/\alpha_L} \bar{L}$  (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
  - Conversion between types and aggregation is costless for the firm
  - Final transaction price depends on type:  $p(\tilde{h}_i)$
  - Households will need to buy and sell to adjust their stock

# HOUSEHOLDS

## - Life cycle model

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

## - Preferences

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

## - Assets and liabilities

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

- **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,  $\tau_h$ ) and **costly to maintain**,  $\delta_h$
- 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

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

s.t.

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

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

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

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

# MARKETS

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

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

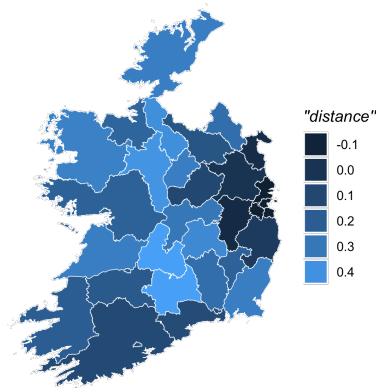


# THE IRISH MACROPRUDENTIAL REFORM

- 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

# EMPIRICAL EVIDENCE

- 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



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

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

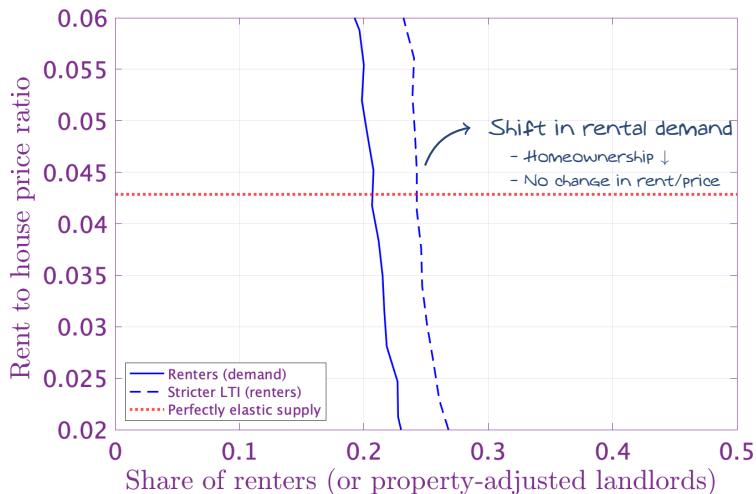
$$\Delta HR_i = \gamma_0 + \gamma_1 \text{Distance}_i + \nu_i \quad (7)$$

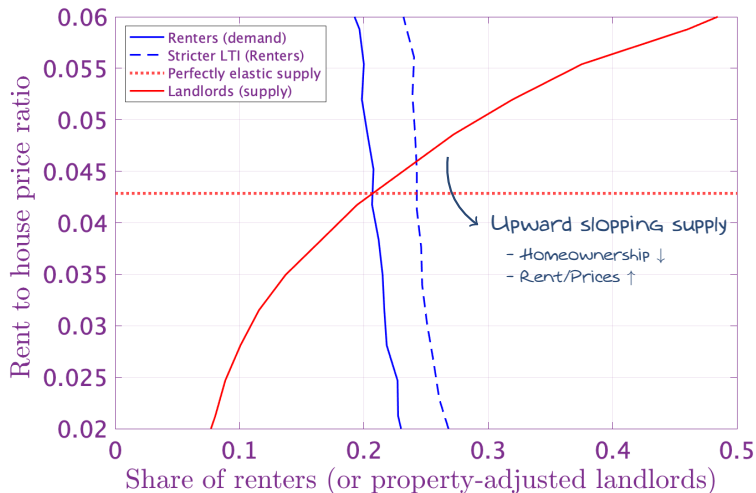
where  $i$  is county,  $\Delta$  is change between 2014Q3 and 2016Q4

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

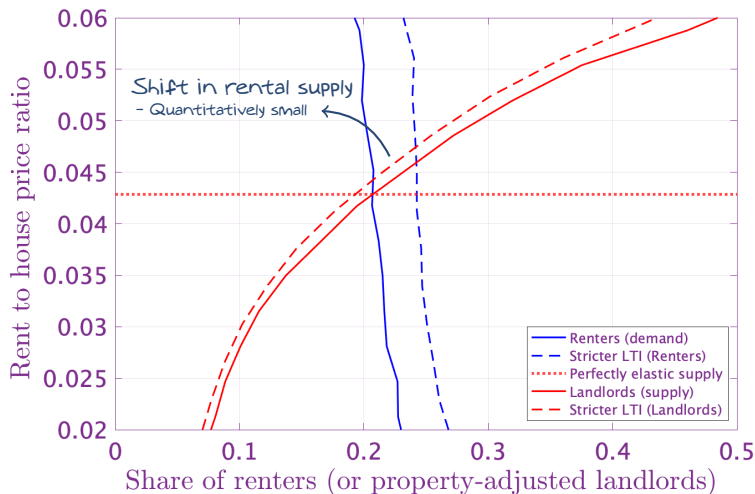
# INTUITION

# Model intuition: perfectly elastic supply









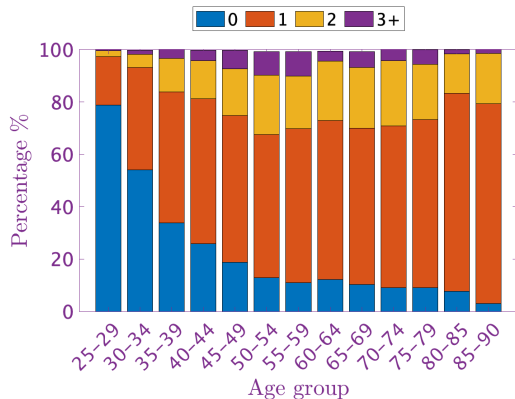
# CALIBRATION

Parameter	Interpretation	Value
$J^{ret}$	Working life (years)	41
$J$	Length of life (years)	71
$\gamma$	Risk aversion coefficient	2.0
$\sigma_\varepsilon$	Taste shock scale parameter	0.05
$\{\tilde{h}_1, \tilde{h}_2\}$	Housing qualities	$\{0.8061, 1.1044\}$
$\alpha^h$	Curvature in utility premium function	0.5
$\delta^h$	Housing depreciation rate	0.012
$\tau^h$	Proportional transaction cost	0.03
$\lambda_{LTV}$	Maximum loan-to-value ratio	1.0
$\lambda_{LTI}$	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
$\alpha_L$	Share of land in production	0.33

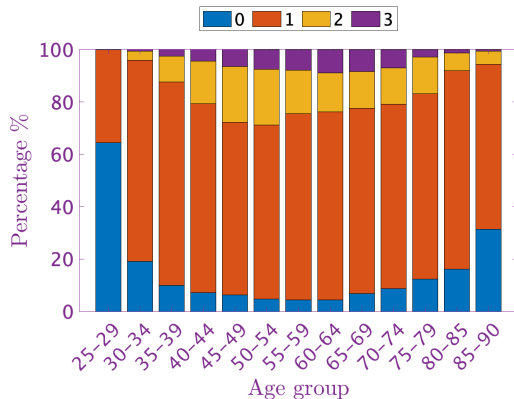
- The discount factor  $\beta = 0.9656$ , the ownership utility premium  $f(\tilde{h}_1) = 1.098$ , and the scaling factor in housing production  $A_h = 0.125$  are jointly chosen to match four moments of the data:

Moment	Model	Data	Source
<i>Targeted:</i>			
Wealth to income ratio	5.835	6.78	HFCS
Homeownership rate	80.24%	80%	EU-SILC
Avg. house price to income ratio	4.70	5.0	CSO
House price to rents ratio	24.07	22.58	RTB/CSO
<i>Untargeted:</i>			
Rents to avg. income ratio	0.158	0.2216	RTB/CSO
Share of households with 3+ properties	4.15%	5.11%	HFCS

# Life-cycle patterns: number of properties



(a) Data

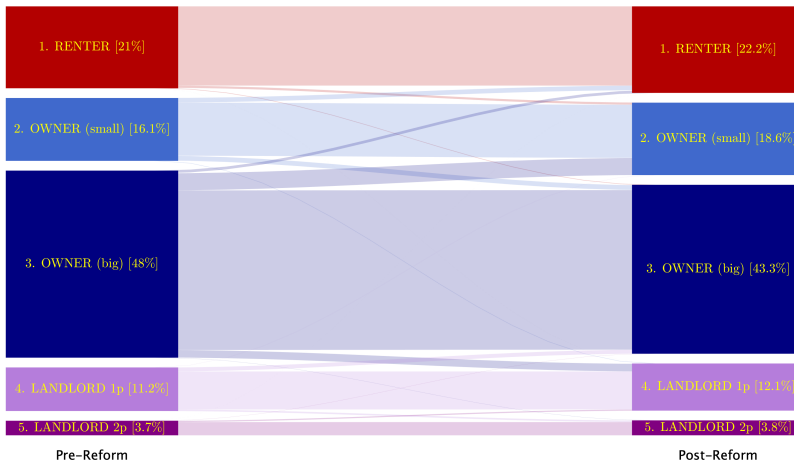


(b) Model

# STEADY STATE RESULTS

	Pre-Reform	Post-Reform
	LTV = 100%, LTI = 6	LTV = 80%, LTI = 3.5
Rent-to-Price	3.35 %	3.45 %
Average house price to income	4.70	4.65
Rent to Income	0.157	0.160
Homeownership rate	80.24 %	79.25 %
Share of HHs living in big house	64.74 %	61.27 %

- Rent/Price  $\rightarrow 3.1\% \uparrow = \begin{cases} \text{Prices} \rightarrow 1.25\% \downarrow \\ \text{Rents} \rightarrow 1.81\% \uparrow \end{cases}$ 
  - Homeownership rate  $\rightarrow 1\text{pp} \downarrow$
  - Share of HHs living in big  $\rightarrow 3.5\text{pp} \downarrow$
- LTI more effective in controlling house prices without increasing rents or reducing homeownership





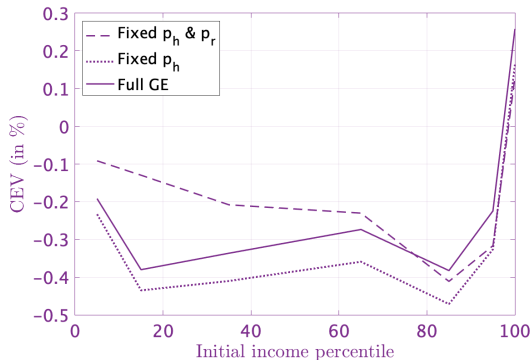
# WELFARE

## - Hypothetical question:

- \* How much consumption needs to change in the pre-reform economy such that a newly born household is indifferent between pre and post-economies?

## - Implications:

- \* The **increase in rental prices** mostly **harms** low and middle income households
- \* The **fall in house prices** **benefits** those in the middle of the income distribution



# OTHER APPLICATIONS: RAISING REAL INTEREST RATES

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

	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	3.45 %	3.88 %	3.96 %
Average house price to income	4.65	4.61	4.59
Rent to Income	0.160	0.179	0.182
Homeownership rate	79.25 %	78.85 %	77.52 %
Share of HHs living in big house	61.27 %	59.08 %	57.89 %

- $\uparrow r^s$  (SE > IE)  $\rightarrow$  homeownership  $\downarrow 0.39p.p.$ ,  $p_r \uparrow 11.38\%$ ,  $p_h^{avg} \downarrow 0.80\%$
- $\uparrow r^b \rightarrow$  homeownership  $\downarrow 1.33p.p.$ ,  $p_r \uparrow 1.59\%$ ,  $p_h^{avg} \downarrow 0.43\%$
- $\uparrow r \rightarrow$  homeownership  $\downarrow 1.73p.p.$ ,  $p_r \uparrow 13.16\%$ ,  $p_h^{avg} \downarrow 1.23\%$

# CONCLUDING REMARKS

- 
- 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 ↓ 1 pp, rents ↑ 1.81%, house prices ↓ 1.25%
  - \* ☹️ poor and middle income → higher rents + postpone/cancel buying
  - \* 😊 top-earners → not constrained, higher returns at lower costs

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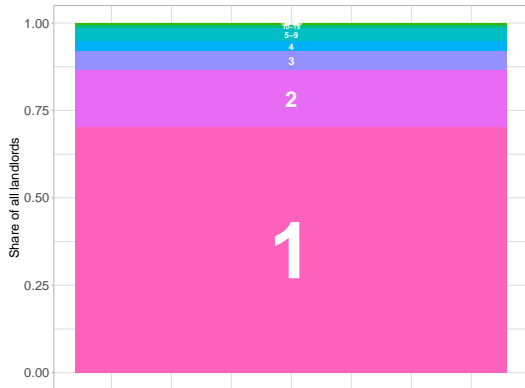
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THANK YOU!

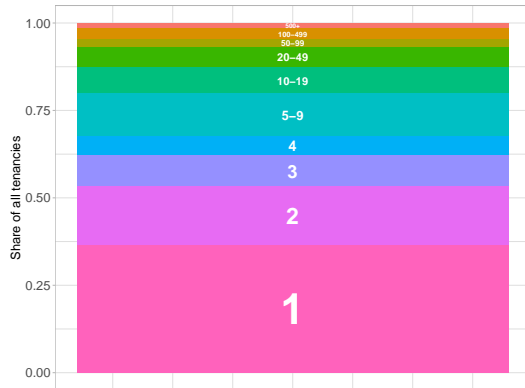
# APPENDIX

# Why we only model small landlords?

Share of landlords by number of registered tenancies (RTB)

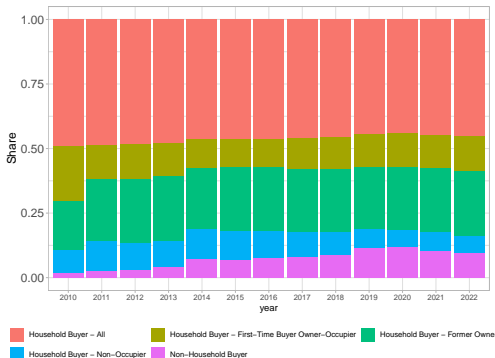


Share of tenancies by number of registered tenancies (RTB)

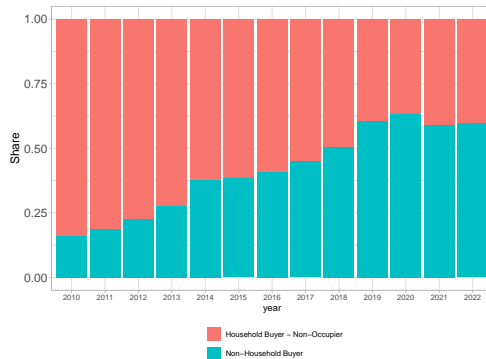


# Who is the marginal investor?

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.



# THE MODEL ECONOMY

## 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:

$$\sum_{j=1}^J \int \int \mathcal{D}(a, 0, y, j) da dy = \sum_{j=1}^J \int \int \mathcal{D}(a, 4, y, j) da dy + 2 \sum_{j=1}^J \int \int \mathcal{D}(a, 5, y, j) da dy \quad (8)$$

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

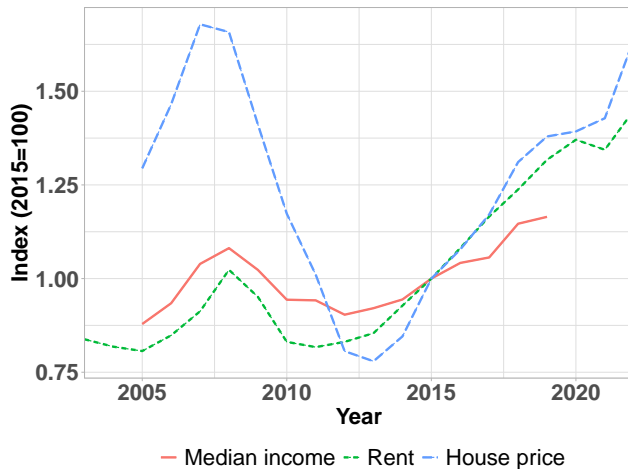
$$Y_c = C + S \quad (10)$$

# THE IRISH MACRO-PRUDENTIAL FRAMEWORK

- 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

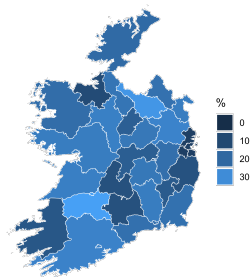


# Cyclical evolution of house prices and rents in Ireland

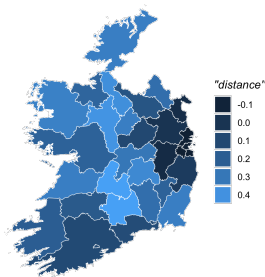


# EMPIRICAL EVIDENCE

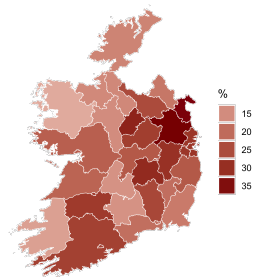
- Data on **house prices and rents** obtained from **daft.ie** property website (Lyons, 2022)
  - \* 54 housing markets (26 counties + cities + all postcodes in Dublin)
- **Distance measure** computed at borrower level (Acharya et al., 2022)
  - \* Look at households who obtain a mortgage in year 2014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



(a) House price growth



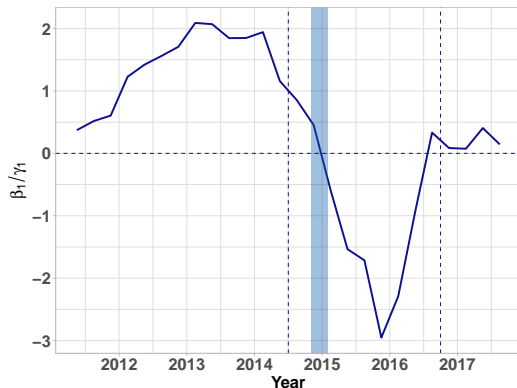
(b) Distance measure



(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).

- Run placebo regressions (6) - (7) using 9-quarter rolling windows to compute growth rates
- Plot ratio of regression coefficients
  - \*  $\beta_1/\gamma_1 > 0 \implies \text{cov}(\Delta HP, \Delta HR) > 0$
  - \*  $\beta_1/\gamma_1 < 0 \implies \text{cov}(\Delta HP, \Delta HR) < 0$
- Sign changes around the reform ...
  - \* Rents do not longer co-move with house prices as a result of the credit shock



# CALIBRATION

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

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

where  $g(\cdot)$  is a polynomial in age and  $\eta$  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

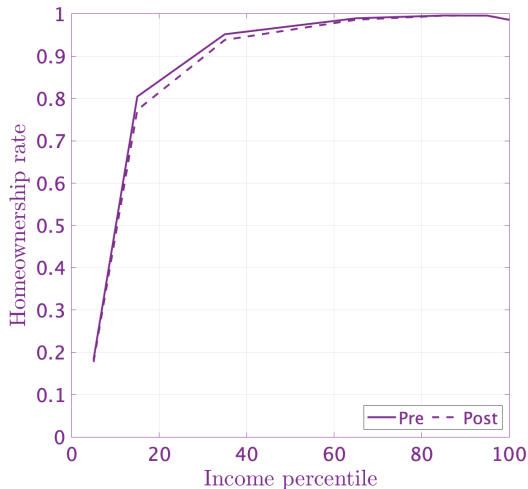
# TIGHTER LTV & LTI LIMITS



	Full-Reform	Only LTI	Only LTV
$\Delta\%$ Rent-to-Price	<b>+3.10 %</b>	+1.76 %	+1.72 %
$\Delta\%$ Average house price to income	-1.25 %	<b>-1.11 %</b>	- 0.78 %
$\Delta\%$ Rent to Income	+1.81 %	<b>+0.63 %</b>	+0.93 %
$\Delta$ Homeownership rate	-0.99 p.p	<b>-0.57 p.p.</b>	-0.63 p.p.
$\Delta$ Share of HHs living in big houses	-3.47 p.p.	-3.07 p.p.	<b>-2.15 p.p.</b>

- Non-linear interactions between the two constraints amplify the response of prices
  - \* Similar to the constraint switching effect of Greenwald (2018)
- LTI limit seems more effective in controlling house prices without: (i) distorting as much the homeownership rate, and (ii) pushing rental prices upwards

# Homeownership rate by age and income



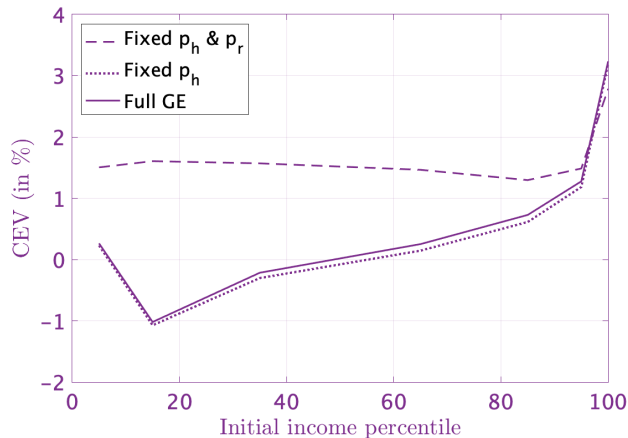
# RAISING THE REAL INTEREST RATE

- The effect of the shock is amplified when looser LTV and LTI limits are in place

	Low Int. Rate	Decomposition	High Int. Rate
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Rent-to-Price	3.35 %	3.81 %	3.93 %
Average house price to income	4.70	4.65	4.59
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Homeownership rate	80.24 %	79.75 %	77.77 %
Share of HHs living in big houses	64.74 %	61.76 %	58.39 %

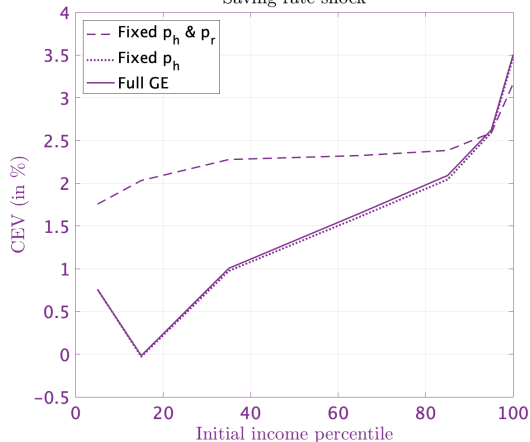
- $\uparrow r^s$  (SE > IE)  $\rightarrow$  homeownership  $\downarrow 0.49p.p.$ ,  $p_r \uparrow 12.54\%$ ,  $p_h^{avg} \downarrow 1.08\%$
- $\uparrow r^b \rightarrow$  homeownership  $\downarrow 1.98p.p.$ ,  $p_r \uparrow 1.82\%$ ,  $p_h^{avg} \downarrow 1.23\%$
- $\uparrow r \rightarrow$  homeownership  $\downarrow 2.47p.p.$ ,  $p_r \uparrow 14.59\%$ ,  $p_h^{avg} \downarrow 2.30\%$

# CEV (across SS) from a real rate shock



# CEV (across SS) from savings and mortgage rate shocks

Saving rate shock



Mortgage rate shock

