

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

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Global Housing Markets and the Macroeconomy

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Disclaimer: The views expressed in this presentation are our own and do not necessarily reflect those of the Bank of England, its committees, the ECB nor the Eurosystem.

Motivation

- Housing ...
 - * most important **asset** for the majority of households
 - * large share of household **consumption** baskets (non-homeowners must rent)
- After the GFC, increasing focus on housing and the macroeconomy
 - * Link between credit, house prices and the business cycle
 - * Policy interventions related to mortgage credit
- But welfare effects on households depend also on rental markets
 - * Credit shocks → house prices and **rents** → household's decisions and welfare

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 at origination
- Use the model to study the effects of credit shocks on:
 - * House prices and rents
 - * Homeownership rates
 - * Welfare
- Two experiments:
 - * **Mortgage credit limits**: 2015 macro-prudential intervention in Ireland
 - * A permanent rise in the real interest rate

What we find: tighter LTV & LTI limits

- Empirically:

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

- Model mechanisms:

- * Increased rental demand by constrained households
- * More rental properties need to be supplied: higher rental rates in the short run and persistently
- * Lower house prices in the short run

- 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

Contribution

- Link credit shocks with **rental market outcomes**
 - * Using **standard forces** in life-cycle consumption-savings models
 - * Key: **housing lumpiness + landlord heterogeneity**
- Our framework rationalizes how credit shocks may feed in to **rental inflation**
 - * Including monetary policy shocks
 - * Standard implication: rent-to-price ratios move with interest rates
 - * We use distributions to separate both
- Study transitional dynamics
 - * House prices drop quickly, but in the long run they go back up
 - * Rental rates stay elevated permanently (constraints + distributions)

Literature

- Focuses on **boom-bust cycles in house prices**

- * Favilukis, Ludvigson, and Van Nieuwerburgh (2016): looser credit constraints
- * Justiniano, Primiceri, and Tambalotti (2019): larger credit supply
- * Kaplan, Mitman, and Violante (2020): fluctuations in beliefs
- * Garriga and Hedlund (2020): liquidity

- Rental market

- * Traditional assumptions: no renting, inelastic rents. House prices and rents comove.
- * Gete and Zecchetto (2018): owners can rent out part of their homes, study mortgage guarantees
- * Sommer and Sullivan (2018): endogenous house prices and rents, study mortgage taxation
- * Rotberg and Steinberg (2024): highlight key role of rental supply elasticity for mortgage taxation
- * Greenwald and Guren (2024): segmentation between rental and owner-occupied housing affects reaction of house prices to credit conditions
- * This paper: house prices and rents **both endogenous**, can move in different directions

THE MODEL ECONOMY

Production

- Final Good Producer

- * Linear technology: $Y_c = A_c N$, where A_c is a parameter and N is labor

- Housing Good Producer

- * Cobb-Douglas technology: $Y_h = A_h \bar{L}^{\alpha_L} S^{1-\alpha_L}$ where \bar{L} are 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 stock* is composed by houses of different qualities: $H = \sum \tilde{h}_i H_i^{sh}$ 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 can be costly for the firm (not in today's results)
 - Households need to buy and sell to adjust their stock

Households: environment

- Life cycle model

- * Working age from $j = 1, \dots, J^{ret}$ → supply labor inelastically, idiosyncratic income
- * Retirement age from $j = J^{ret} + 1, \dots, J$
- * After age J → they die with certainty

- Preferences

$$u(c, h, \tilde{h}) = \frac{(c f(h, \tilde{h}_i))^{1-\gamma}}{1-\gamma}$$

- Assets and liabilities

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

Households: housing & mortgages

- **Housing state:** quantity and quality of housing $s := \{h, \tilde{h}\} \in \mathcal{H}$
 - * 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 quality $\{\tilde{h}_i\}$
 - * Landlord: owns multiple houses ($1 < h \leq 3$), lives in a house of quality $\{\tilde{h}_i\}$ 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 interest** and **amortize** a minimum amount per period

Household's problem

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

s.t.

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

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

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

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

Market clearing & equilibrium

- r is fixed \rightarrow small open economy
- **Housing market**
 - * houses bought = houses produced + houses sold - depreciation (- repair/conversion costs)
- **Rental market**
 - * Competitive: renters meet landlords
 - * p_r is determined using household's equilibrium distribution, $\mathcal{D}(a, s, y, j)$

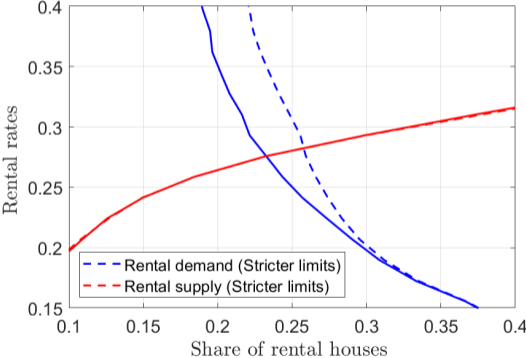
$$\underbrace{\sum_{j=1}^J \int \int \mathcal{D}(a, s_1, y, j) da dy}_{\text{renters}} = \underbrace{\sum_{j=1}^J \int \int \mathcal{D}(a, s_4, y, j) da dy}_{\text{landlords w/ 1 btl property}} + 2 \underbrace{\sum_{j=1}^J \int \int \mathcal{D}(a, s_5, y, j) da dy}_{\text{landlords w/ 2 btl properties}}$$

MODEL INTUITION

(CONSTRAINING CREDIT)

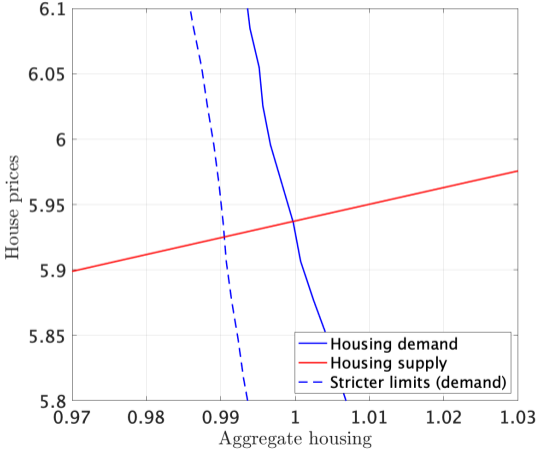
Model intuition: rents and landlord heterogeneity

Assume constant house prices



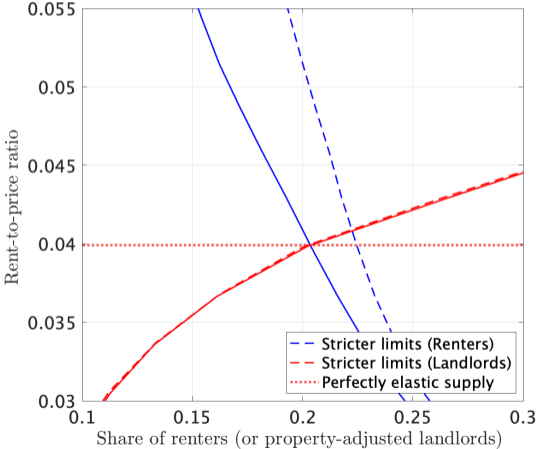
Model intuition: house prices and quality ladder

Assume constant rents



Model intuition: rent-to-price ratios and landlord heterogeneity

Both moving jointly



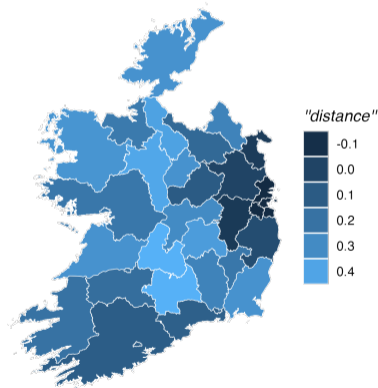
THE IRISH MACROPRUDENTIAL REFORM

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

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**:

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

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

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

	Δ House prices	Δ Rents
Distance	0.289 (0.068)	-0.171 (0.039)
Obs.	52	52
R^2	0.34	0.31

- 4-year horizon: coefficient on house prices similar, coefficient on rents **larger**
- Consistent with empirical evidence for other credit shocks (incl. MP) in the US [▶ More](#)

PARAMETRIZING THE MODEL

Internally calibrated parameters, targets, & model fit

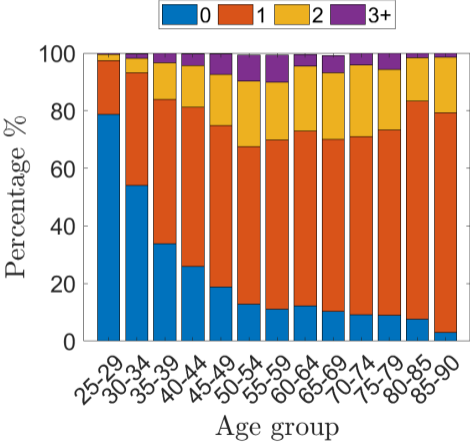
- The discount factor $\beta = 0.955$, the ownership utility premium $f(\tilde{h}_1) = 1.14$, and the scaling factor in housing production $A_h = 0.13$ are jointly chosen to match four moments of the data:

Moment	Model	Data	Source
<i>Targeted:</i>			
Wealth to income ratio	5.57	6.78	HFCS
Homeownership rate	77.97%	80%	EU-SILC
Avg. house price to income ratio	5.29	5.0	CSO
House price to rents ratio	22.09	22.58	RTB/CSO
<i>Untargeted:</i>			
Rents to avg. income ratio	0.2395	0.2216	RTB/CSO
Share of households with 3+ properties	4.45%	5.11%	HFCS

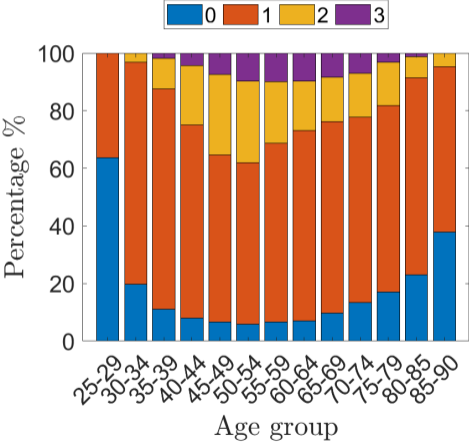
▷ Externally calibrated

▷ Small landlords

Life-cycle patterns: number of properties



(a) Data



(b) Model

AGGREGATE & DISTRIBUTIONAL EFFECTS

(STEADY STATES, TRANSITION & WELFARE)

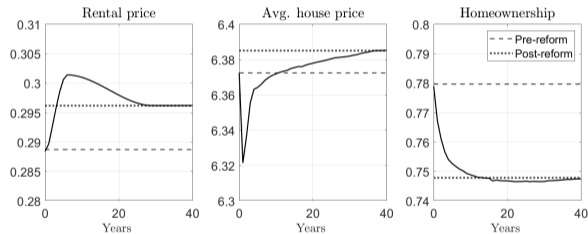
Long-term aggregate effects

	Pre-Reform	Post-Reform
	LTV = 100%, LTI = 6	LTV = 80%, LTI = 3.5
Rent-to-Price	4.53 %	4.64 %
Average house price to income	5.29	5.30
Rent to Income	0.239	0.246
Homeownership rate	77.97 %	74.79 %
Share of households with 3 properties	4.25 %	5.12 %

- Rent/Price \rightarrow 2.45% \uparrow = $\begin{cases} \text{Prices} \rightarrow 0.13\% \uparrow \\ \text{Rents} \rightarrow 2.58\% \uparrow \end{cases}$

- Homeownership rate \rightarrow 3.18pp \downarrow

Transition dynamics: short-term effects



- Rental rate peak +4.5%
- Rents increase permanently
 - * Financial constraints
 - * Distributional changes
- House price on impact -0.9%
 - * Reduced demand (downsizing)
- Long-run
 - * Rent-to-price goes up
 - * Construction adjusts, bringing house price up

Are these results quantitatively reasonable?

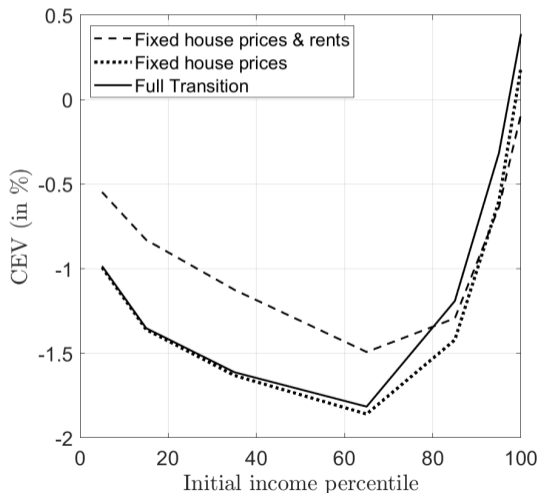
- Replicate empirical analysis in the model by simulating housing markets with different house-to-income ratios and hence different distance measures
- Look at movements in house prices and rents around the reform

	House prices	Rents
Data	0.289	-0.171
Model	0.366	-0.174

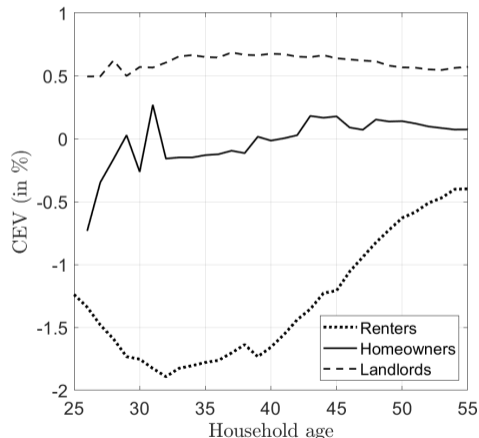
- Rental supply elasticities: 3.5 (vs 1.4 empirical estimate for the US (Rotberg and Steinberg, 2024), but ≈ 38 in models with endogenous landlords that rent out their own homes (e.g. Floetotto, Kirker and Stroebel, 2016))

Welfare: Consumption Equivalent Variation

- **Tighter LTV & LTI** limits affects potential (constrained) homebuyers in the **middle** of the income distribution
- **Increase in rental prices** hurts those at the **bottom**: more likely to be renters, harder to save for downpayment
- **Drop in house prices** benefits prospective homebuyers at the **middle** and **upper** part of the income distribution



Heterogenous effects: the housing tenure status



- **Renters are the biggest losers:** harder to access homeownership + they pay higher rental prices
- **Homeowners are indifferent**
- **Landlords benefit:** higher cash flows from their housing portfolio

CONCLUDING REMARKS

Main Takeaways

- **Empirically**, the Irish LTV/LTI reform had **opposite effects on house prices and rents**

Main Takeaways

- **Empirically**, the Irish LTV/LTI reform had **opposite effects on house prices and rents**
- We build an **equilibrium model with landlord heterogeneity** to evaluate the aggregate and distributional effects of the reform:
 - * across steady states: homeownership ↓ 3.2 pp, rents ↑ 2.6%, house prices ↑ 0.1%
 - * across transition: rents ↑ 4.5%, house prices ↓ 0.9%
 - * 😞 poor and middle income → higher rents + postpone/cancel buying
 - * 😊 top-earners → not constrained, higher returns at lower costs

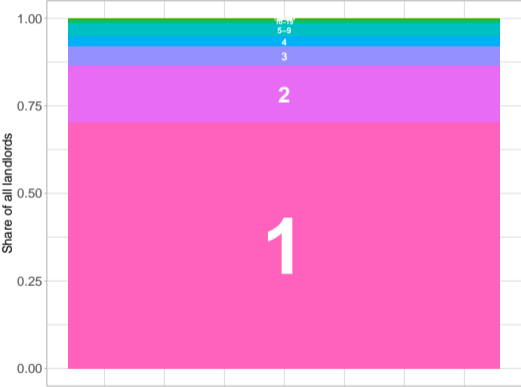
Main Takeaways

- **Empirically**, the Irish LTV/LTI reform had **opposite effects on house prices and rents**
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 - * 😞 poor and middle income → higher rents + postpone/cancel buying
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- **Real rate increase:**
 - * Similar implications
 - * Highlights separate impact of credit shocks, incl. MP, on house prices and rents

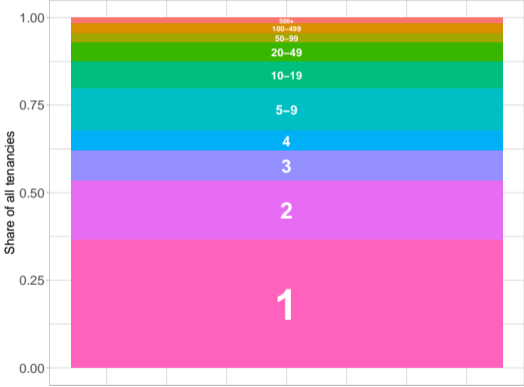
APPENDIX

Why we only model small landlords?

Share of landlords by number of registered tenancies (RTB)

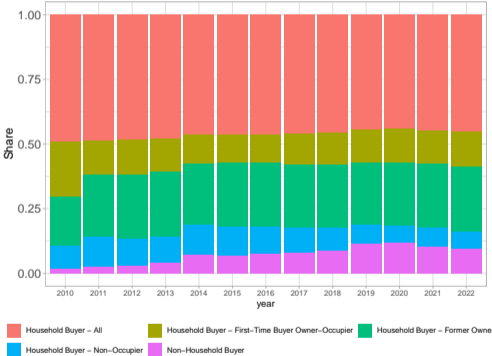


Share of tenancies owned by landlords

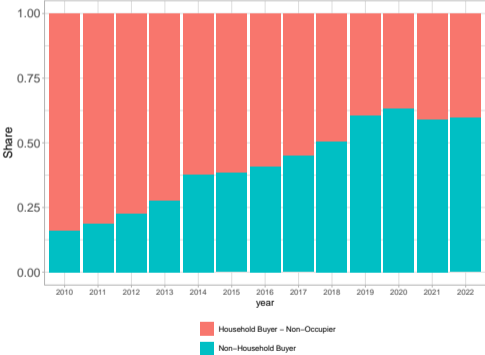


Who is the marginal investor?

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.

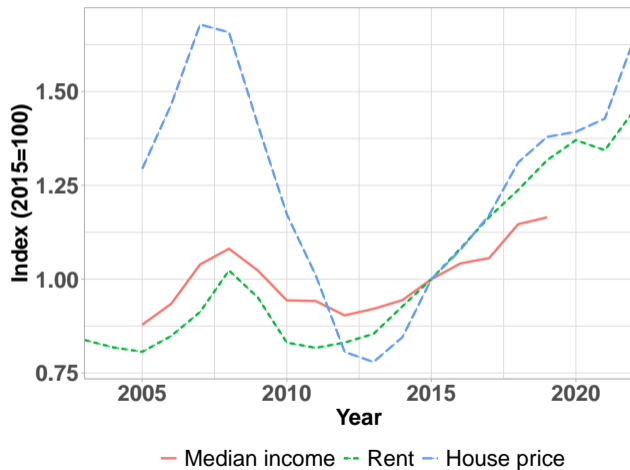


THE IRISH MACRO-PRUDENTIAL FRAMEWORK

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

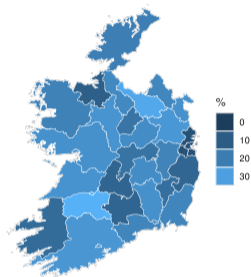
Cyclical evolution of house prices and rents in Ireland



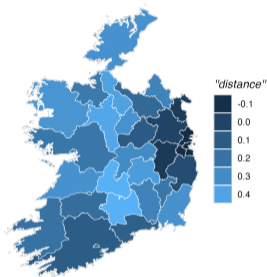
Data Sources

- 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

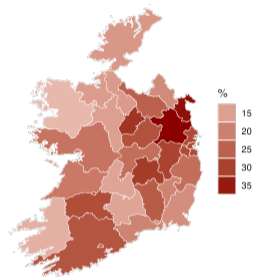
Non-parametric evidence



(a) House price growth



(b) Distance measure

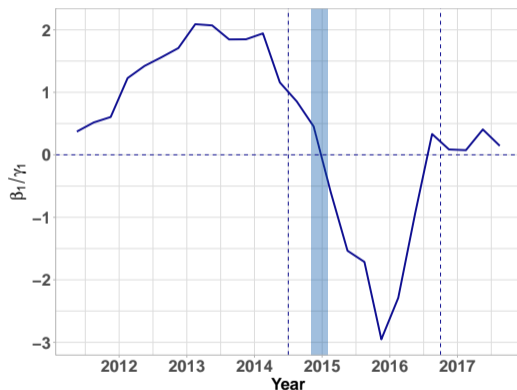


(c) Rental price growth

- 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).

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



THE MODEL ECONOMY

Households: environment

- Life cycle model

- * Working age from $j = 1, \dots, J^{ret}$ → supply labor inelastically, idiosyncratic income
- * Retirement age from $j = J^{ret} + 1, \dots, J$ →
- * After age J → they die with certainty

- Preferences

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

$$f(h, \tilde{h}_j) = \begin{cases} (\tilde{h}_j / \tilde{h}_1)^{\alpha_h} & \text{if } h = 0 \\ ((\tilde{h}_j / \tilde{h}_1) \theta)^{\alpha_h} & \text{if } h \geq 1 \end{cases} \quad (8)$$

Households: housing & mortgages

- **Housing state:** quantity and quality of housing $s := \{h, \tilde{h}\} \in \mathcal{H}$
 - * Renter: doesn't own ($h = 0$), lives in a small rented house $\{\tilde{h}_1\}$, and pays rent p_r
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$$a' \geq -\lambda_{LTV} p_h(\tilde{h}') h'$$

$$a' \geq -\lambda_{LTI} y$$

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

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:

$$\sum_{j=1}^J \int \int \mathcal{D}(a, s_1, y, j) da dy = \sum_{j=1}^J \int \int \mathcal{D}(a, s_4, y, j) da dy + 2 \sum_{j=1}^J \int \int \mathcal{D}(a, s_5, y, j) da dy \quad (9)$$

$$Y_h = \left(\delta_h + \frac{1}{J} \right) H \quad (10)$$

$$Y_c = C + S \quad (11)$$

Other empirical evidence (US)

- **Gete and Reher (2017)**: contraction of mortgage supply after the Great Recession increased rents
- **Dias and Duarte (2022)**: rents increase after contractionary MP shock
 - * Use average rent index
 - * House prices drop
 - * Homeownership drops
- **Abramson, De Llanos, Han (2025)**: rents increase after contractionary MP shock
 - * Use repeat-rent index from microdata
 - * Mechanism: shifts from owner-occupied to rental market

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
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
ζ	Adjustment cost scale in housing production	0.0

Externally calibrated parameters

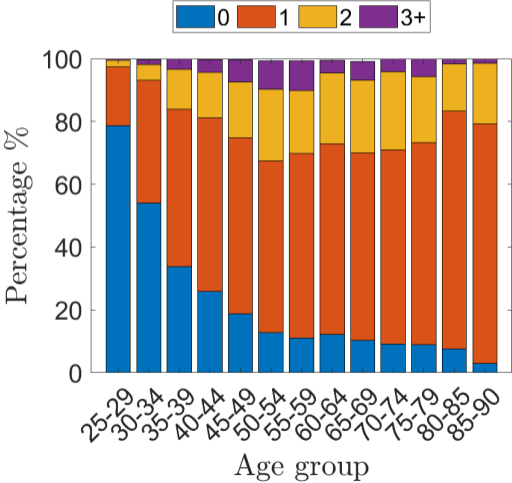
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$\{\tilde{h}_1, \tilde{h}_2, \tilde{h}_3, \tilde{h}_4\}$	Housing qualities	{1.0, 1.03, 1.21, 1.37}
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ζ	Adjustment cost scale in housing production	0.16

Internally calibrated parameters, targets & model fit

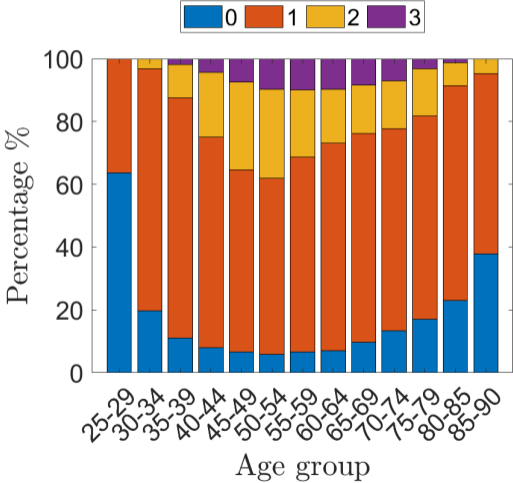
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House price to rents ratio	22.59	22.58	RTB/CSO
<i>Untargeted:</i>			
Rents to avg. income ratio	0.226	0.2216	RTB/CSO
Share of households with 3+ properties	4.25%	5.11%	HFCS

Life-cycle patterns: number of properties



(a) Data



(b) Model

TIGHTER LTV & LTI LIMITS

Isolating the effects of each limit

	Full-Reform	Only LTI	Only LTV
$\Delta\%$ Rent-to-Price	+2.98 %	+2.93 %	+1.92 %
$\Delta\%$ Average house price to income	+0.05 %	-0.01 %	+0.04 %
$\Delta\%$ Rent to Income	+3.49 %	+2.81 %	+2.38 %
Δ Homeownership rate	-3.17 p.p	-2.02 p.p.	-2.24 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

A RISE IN THE REAL INTEREST RATE

Decomposing effects from savings and mortgage rates

	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 %

- $\uparrow r^s$ has large portfolio effects on landlords, substitute away from housing
 - * SE > IE \rightarrow homeownership $\downarrow 0.6p.p.$, $p_r \uparrow 11.38\%$, $p_h^{avg} \downarrow 0.50\%$
- $\uparrow r^b$ generates a large downsizing effect, choose smaller mortgages
 - * homeownership $\downarrow 0.33p.p.$, $p_r \uparrow 1.22\%$, $p_h^{avg} \downarrow 1.1\%$

Long-term effects with loose credit conditions

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

	Loose Credit Conditions			Tight Credit Conditions		
	Higher r	Higher r^b	Higher r^s	Higher r	Higher r^b	Higher r^s
Average house price to income	-1.93 %	-0.93 %	-1.01 %	-1.62 %	-1.1 %	-0.5 %
Rent to Income	12.84 %	1.13 %	11.57 %	12.70 %	1.22 %	11.38%
Homeownership rate	-1.07 p.p.	-0.58 p.p.	-0.49 p.p.	-0.92 p.p.	-0.33 p.p.	-0.6 p.p.

Transition dynamics: short-term effects

▷ Back

Housing tenure flows

▷ Back