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

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Motivation

- Housing . . .
  * is the most important **asset** for the majority of households
  * represents a large share of household's **consumption** basket (non-homeowners must rent)
- After the GFC, there was an 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 $\rightarrow$ house prices and **rents** $\rightarrow$ household's decisions and welfare

▷ 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 occasionally bind at origination
- Use the model to study the effects of credit shocks on:
  * House prices and rents
  * Homeownership rates
  * Welfare
- Two experiments:
  * The **2015 macro-prudential intervention in Ireland**
  * A permanent or transitory rise 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
- *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

The Model Economy

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 *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 is costly for the firm (not in today's results)
    - Households will need to buy and sell to adjust their stock

Household's problem

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

s.t.

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

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

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

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

▷ Details

Market clearing & equilibrium

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

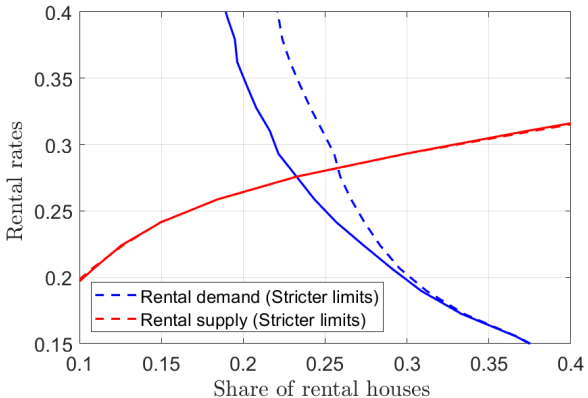
$$\sum_{h=0}^{X} (h-1) \left(\int \sum_{i=1}^{N} \int \sum_{j=1}^{J} \mathcal{D}(a, \underbrace{\{h, \tilde{h}_i\}}_{=s}, y, j) \, da \, dy \right) = 0$$

▷ Equilibrium Definition

Model's Intuition

(Constraining Credit)

Model intuition: rents and landlord heterogeneity

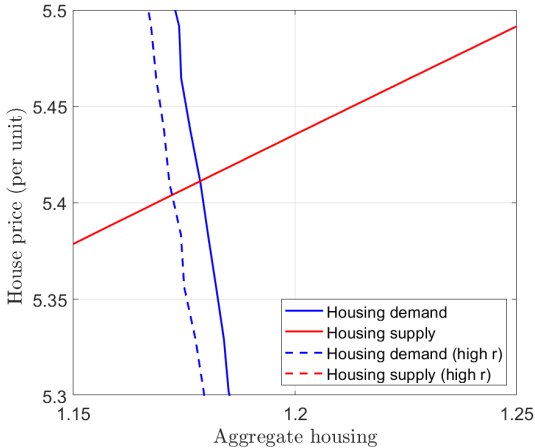


- Assume constant house prices
- The rental supply curve that is endogenously upward sloping
- A negative credit shock shifts the demand outwards

$\Longrightarrow$ reduction in the homeownership rate

$\Longrightarrow$ and increase in the rental prices

Model intuition: house prices and the quality ladder

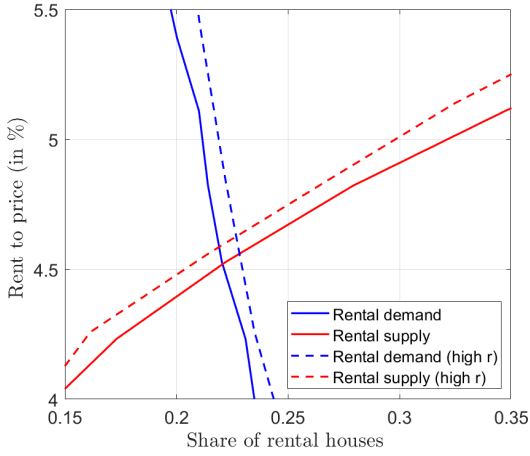


- Assume constant rental prices
- A negative credit shock shift housing demand inwards

$\Longrightarrow$ households switch to smaller properties

$\Longrightarrow$ house prices go down

Model intuition: rent-to-price ratios



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

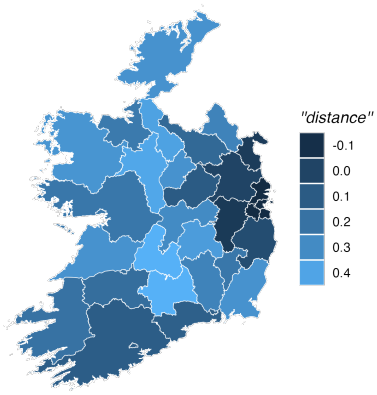
▷ Relaxation of the rules announced in October 2022

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.	52	52
R^2	0.34	0.31

▷ Data ▷ Non-parameteric ▷ Pre-Trends ▷ Other evidence (US)

Aggregate & Distributional Effects

(Steady states, Transition & Welfare)

▷ Calibration ▷ Interest Rate Experiment

Long-term aggregate effects

- Pre-reform $= \begin{cases} 100\% \text{ Loan-to-Value} \\ 6\times \text{ Loan-to-Income} \end{cases}$

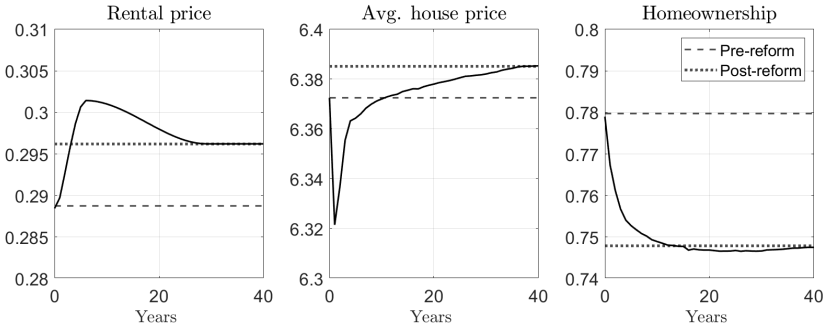
- Post-reform $= \begin{cases} 80\% \text{ Loan-to-Value if owner} \\ 70\% \text{ Loan-to-Value if landlord} \\ 3.5\times \text{ Loan-to-Income if FTB} \end{cases}$

	Pre-Reform	Post-Reform	Percentage Change
Rent-to-Price	4.53 %	4.64 %	2.45 %
Average house price to income	5.29	5.30	0.13 %
Rent to Income	0.239	0.246	2.58 %
Homeownership rate	77.97 %	74.79 %	-3.18 p.p.
Share of households with 3 properties	4.45 %	5.12 %	0.67 p.p.

- *Rent dynamics*: marginal landlord needs to be compensated even more to meet increased rental demand
- *Wealth*: more homes own by landlords ($\uparrow 14\%$) + more landlords with 3 properties ($\uparrow 15\%$)

▷ LTV vs. LTI experiments

Transition dynamics: short-term effects



- There is a substantial decrease in house prices (-0.9%) and a small increase in rents upon impact
- As relatively richer households start to save to buy houses and become landlords, house prices recover, but rents stay elevated to keep incentives in place.
- Rents peak 7 years after the reform at a level which is around 4.5% higher

Are these results quantitatively reasonable?

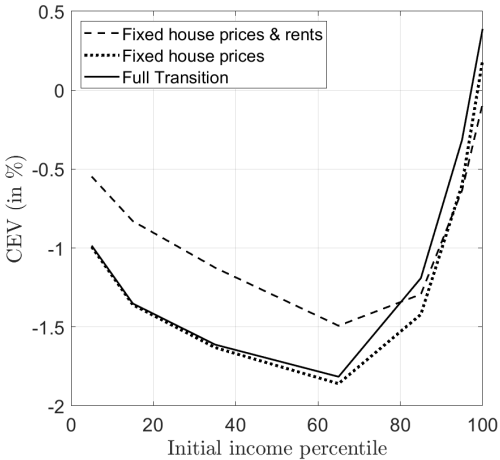
- Replicate empirical analysis in the model is challenging as
  - it relies on the cross-sectional variation of the reform intensity across different housing markets
  - our main model results are based on a single, nationally aggregated version of the Irish housing market
- Our approach:
  - simulate housing markets with different house-to-income ratios and apply the same macroprudential reform across all of them
  - use these results to regress the region-specific changes in house prices and rental rates on a model-based pre-reform distance measure

	Δ **House Prices**	Δ **Rents**
Data	0.289	-0.171
	(0.068)	(0.039)
Model	0.366	-0.174

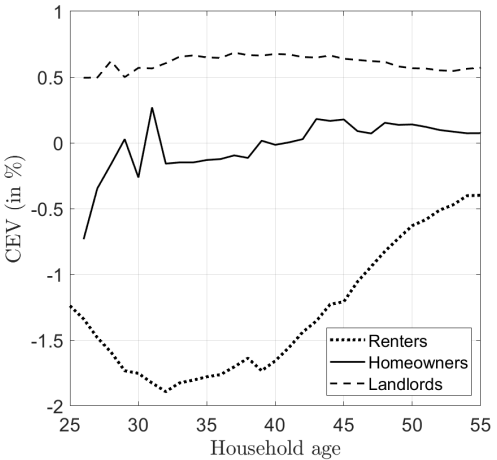
- We find that the reaction of rents to the reform is, as in the data, stronger in those counties in which house price to income ratios are initially higher, and, thus, many households are constrained as a result of the reform

Welfare: Consumption Equivalent Variation

- *Tighter LTV & LTI* limits affects potential (constrained) homebuyers in the **middle** of the income distribution
- *The increase in rental prices . . .*
  * **hurts** those at the **bottom**: more likely to be renters, harder to save for downpayment, less resources for consumption
  * **benefits** those at the **top**: typically landlords that receive a larger cash flow from their real estate investment
- *The drop in house prices* **benefits** those **above the median** as they are more likely to be prospective buyers



Heterogenous effects: the housing tenure status



- **Renters are the biggest losers**: harder to access homeownership + they pay higher rental prices
- **Homeowners are indifferent** (or lose slightly due to the temporary drop in house prices)
- **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**

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- We build an **equilibrium model with landlord heterogeneity** to evaluate the *aggregate* and *distributional* effects of the reform:
  * homeownership $\downarrow$, rents $\uparrow\uparrow$, house prices $\downarrow$
  * ☹ poor and middle income $\rightarrow$ higher rents + postpone/cancel buying
  * ☺ top-earners $\rightarrow$ not constrained, higher returns at lower costs

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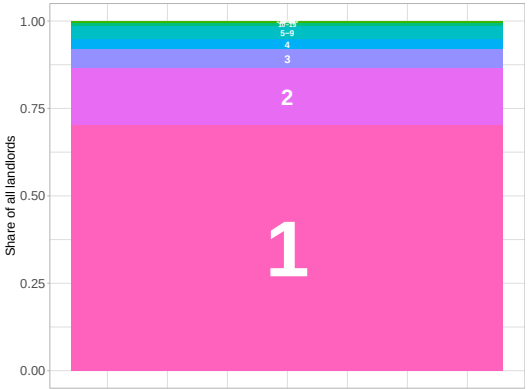
THANK YOU!

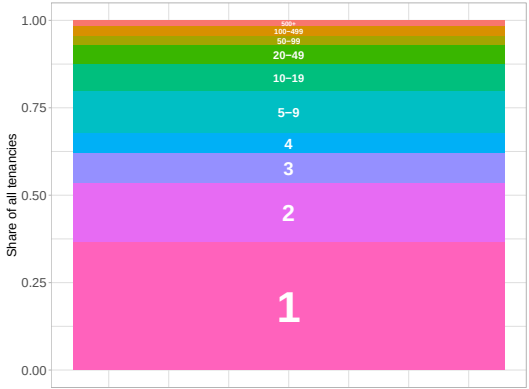
Appendix

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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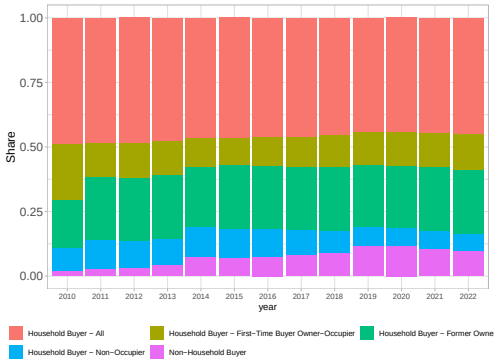
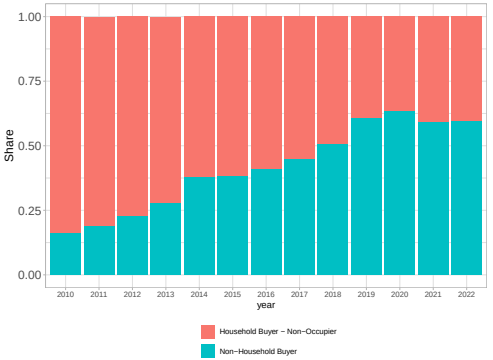
Who is the marginal investor?

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 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

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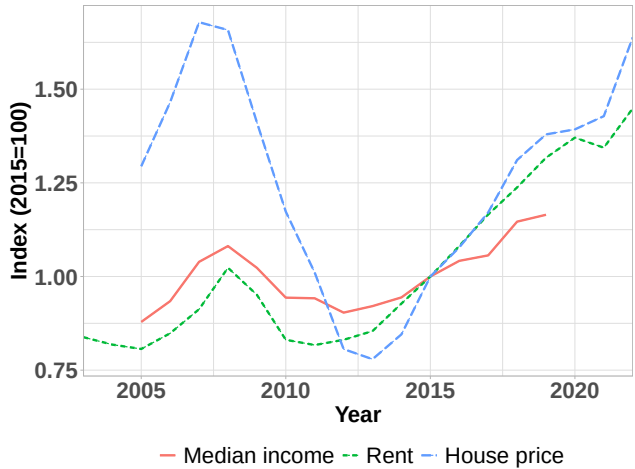
Cyclical evolution of house prices and rents in Ireland



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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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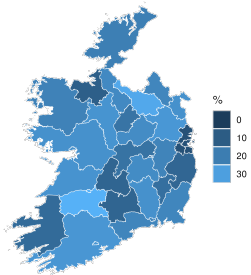
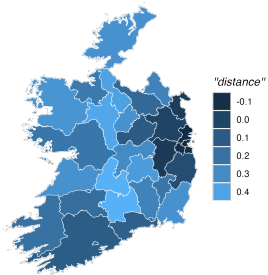
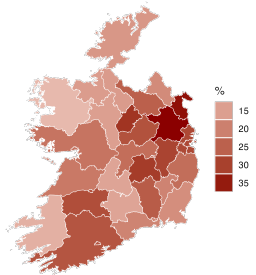
Non-parametric evidence



(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).

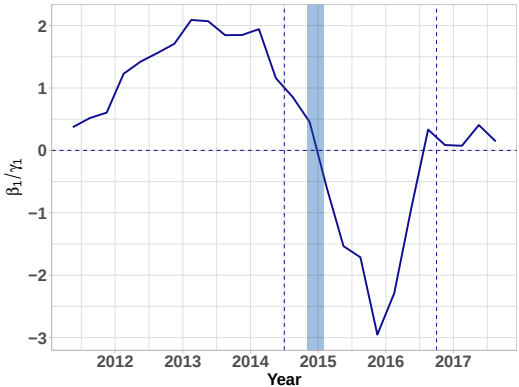
▷ Back

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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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

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The Model Economy

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**

$$u(c, h, \tilde{h}) = \frac{\left(c\, f(h, \tilde{h}_i)\right)^{1-\gamma}}{1-\gamma} \quad \text{where} \quad f(h, \tilde{h}_j) = \begin{cases} \left(\tilde{h}_j / \tilde{h}_1\right)^{\alpha_h} & \text{if} \quad h = 0 \\ \left(\left(\tilde{h}_j / \tilde{h}_1\right) \theta\right)^{\alpha_h} & \text{if} \quad h \geq 1 \end{cases}$$

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

▷ Back

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 interests** and **amortize** a minimum amount per period for the remaining life of the mortgage

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Equilibrium Definition

Definition 1: Competitive Equilibrium

For a given sequence of exogenous fundamentals $\{z_t\}_{t=0}^T$ (e.g. borrowing limits, the risk-free rate), a competitive equilibrium in this economy consists of:

- sequences of value functions, housing, consumption and asset policy functions for the **households**: $\{V_t, s_{t+1}, c_t, a_{t+1}\}_{t=0}^T$,
- a sequence of (generally non-stationary) distributions over households' state: $\{\mathcal{D}_t\}_{t=0}^T$,
- sequences of policy functions for the **firms**: $\{N_t, L_t, S_t\}_{t=0}^T$, and
- sequences of **prices**: $\{w_t, p_{L,t}, p_{h,t}, p_{r,t}\}_{t=0}^T$,

such that they jointly solve the household, final-good firm and construction firm problems at each t, are consistent with rational expectations about future prices, and as well as satisfy the following **market clearing** conditions:

$$\sum_{h=0}^{X} (h-1) \left(\int \int \sum_{j=1}^{J} \mathcal{D}_t(a,s,y,j)\, da\, dy \right) = 0 \tag{8}$$

$$\underbrace{\sum_{n=1}^{N} \tilde{h}_n H_{n,t+1}^{sh}}_{=H_{t+1}} = \left(1 - \delta_h - \frac{1}{J}\right) \underbrace{\sum_{n=1}^{N} \tilde{h}_n H_{n,t}^{sh}}_{=H_t} + Y_{h,t} \tag{9}$$

$$Y_{c,t} = C_t + S_t \tag{10}$$

$$\bar{L} = L_t \tag{11}$$

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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
X	Maximum amount of houses owned	3
α_h	Curvature in utility premium function $f(\cdot)$	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	Risk-free rate	0.02
κ	Intermediation wedge	1
A_c	Aggregate labor productivity	1.2055
$\bar{L}$	Amount of land	1.0
α_L	Share of land in production	0.33

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Internally calibrated parameters, targets & model fit

- The discount factor $\beta = 0.955$, the ownership utility premium $\theta = 1.14$, 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
Targeted:			
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
Untargeted:			
Rents to avg. income ratio	0.2395	0.2216	RTB/CSO
Share of households with 3+ properties	4.45%	5.11%	HFCS

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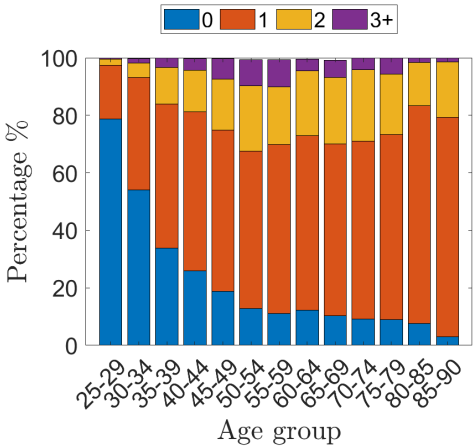
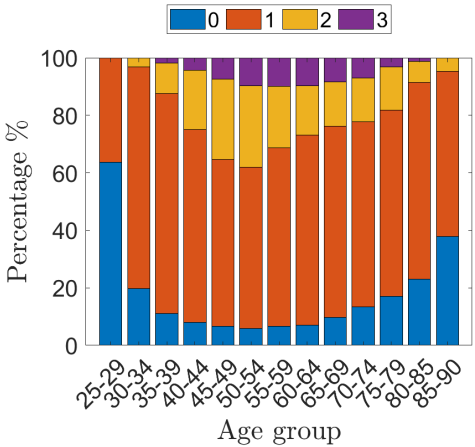
Life-cycle patterns: number of properties



(a) Data



(b) Model

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Tighter LTV & LTI limits

Isolating the effects of each limit

	Full-Reform	Only LTI	Only LTV
Δ% Rent-to-Price	+2.45 %	+2.46 %	+0.3 %
Δ% Rent-to-Income	+2.58 %	+2.48 %	+0.56 %
Δ% Price-to-Income	+0.13 %	+0.02 %	+0.23 %
Δ Homeownership rate	-3.18 p.p	-2.83 p.p.	-1.45 p.p.

- LTI constraint is the most impactful if imposed in isolation
  * rise in the rent-to-price ratio similar to the full reform
  * fall in the homeownership rate was also more pronounced
- These results are specific to our case study, Note that the LTI introduced in Ireland was quite stringent relative to those introduced in other countries (e.g. 4.5 in the UK).

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A Rise in the Real Interest Rate

Long run effects: a permanent increase of 20 basis points

	Low Int. Rate	Decomposition	High Int. Rate	
	$r^s = 2\%, r^b = 4\%$	$r^s = 2.2\%, r^b = 4\%$	$r^s = 2.2\%, r^b = 4.2\%$	
Income effect compensation		No	No	Yes
Rent-to-Price	4.52 %	4.57 %	4.62 %	4.91%
Average house price to income	5.29	5.27	5.26	5.48%
Rent to Income	0.239	0.241	0.243	0.269
Homeownership rate	77.97 %	77.73 %	77.49 %	76.07%

- Effects go in the same direction as the LTV/LTI intervention: $\downarrow$ homeownership, $\uparrow\uparrow$ p_r, $\downarrow$ p_h^{avg}
- $\uparrow r^s$: substitution and income effects go in opposite directions (SE $>$ IE)
- $\uparrow r^b$: income and substitution effects pull in the same direction (larger effects)
- Shutting down aggregate income effects $\implies$ larger rent response
  - Landlords are also subject to financial constraints and . . .
  - higher income help overcoming those constraints

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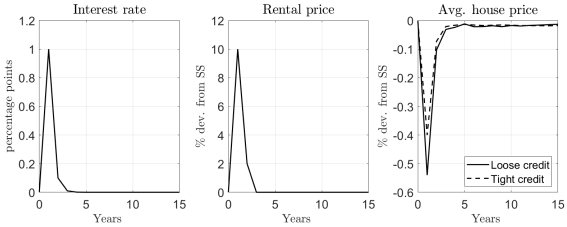
Interactions with credit conditions

- *Short-run*: a 100 bps transitory shock



- *Long-run*: a 20 bps increase in the real rate

	Loose Credit (Pre-reform)	Tight Credit (Post-reform)
Δ Rent-to-Price	+10 bps	+10 bps
Δ% Average house price to income	-0.61 %	-0.4 %
Δ% Rent to Income	+1.44 %	+1.5 %
ΔHomeownership rate	-0.48 p.p	-0.3 p.p.

- The fall in the average house price is weaker when credit limits are more stringent
- While rental rates continue to rise by similar magnitude
  - Marginal landlord potentially unconstrained
- Macroprudential policies are effective in moderating house price cycles
  - Still more work needed to asses optimal LTV/LTI

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