The Effects of Loan-to-value Ratio Ceilings on House Prices

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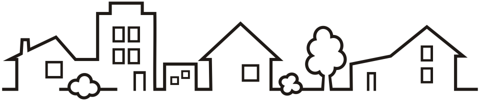


Question and Main Result

- Our **question** is how loan-to-value ratio (LTV) ceilings affect house prices
  - LTV ceiling is a government policy that limits people's mortgage borrowing as a fraction of their house value
  - It is the most widely used macroprudential policy in the developed world as of 2018 [Alam et al., 2019]
    - Examples include Canada (80%), Denmark (65%), Korea (40%), New Zealand (75%), and Singapore (35%)
  - Many have adopted the policy to dampen rising house prices, even though the causal relationsihp is unclear
- **Main result**: **(1)** A stricter (lower) LTV ceiling can **raise house prices** in the long run and **(2)** can increasingly do so with greater income disparity

Affordable Housing Rally in San Francisco

"Don't-Have-1-Million" Protest in Vancouver


"Shoe-throwing" Protest in Seoul

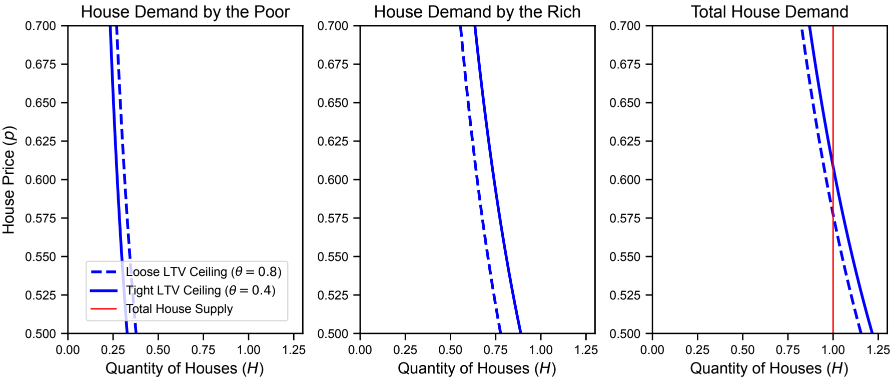
Figure: Protests about Rising House Prices Around the World

Intuition

In equilibrium, the poor-born is the borrower while the rich-born is the lender.

With tighter LTV ceiling,

- PE effect: cash for poor-born ↓ ⇒ housing demand for poor-born ↓
- GE effect: interest rate for bond ↓ ⇒ for rich-born, consumption smoothing using bond ↓ but using housing ↑ ⇒ housing demand for rich-born ↑.



Model

- We consider a 2-period $\times$ 2-agent overlapping-generations model:
  - **Agents**: Two born each period. One is born poor but earns more later. (bootstrapper?) The other is born rich but earns less later. (silver-spooner?)
  - **Intertemporal income disparity**: Let $\varepsilon \in \left(0, \frac{1}{2}\right)$. A poor-born gets ε when young and $1-\varepsilon$ when old; a rich-born gets $1-\varepsilon$ when young and ε when old

    labor choice
  - **Goods**: Consumption goods ($C_t^{i,t}$ for young period and $C_{t+1}^{i,t}$ for old period), 1-period borrowing (B), and houses (H)
    - $i \in \{poor, rich\}$ denotes poor-born households and rich-born households.
  - **Utility**:

$$U(C_t^{i,t}, C_{t+1}^{i,t}, H) = \ln C_t^{i,t} + \ln C_{t+1}^{i,t} + \ln H$$

Constraints

- For each agent type i (poor-born and rich-born), there are 3 constraints:

$$C_t^{i,t} + \underbrace{p_t H_{t+1}^i}_{\text{house purchase}} \leq \underbrace{e_t^{i,t}}_{\text{endowment}} + \underbrace{B_t^i}_{\text{borrowing}}, \qquad \text{(Budget when young)}$$

$$C_{t+1}^{i,t} + \underbrace{(1+r_t)B_t^i}_{\text{repayment}} \leq \underbrace{e_{t+1}^{i,t}}_{\text{endowment}} + \underbrace{p_{t+1} H_{t+1}^i}_{\text{house sale}}, \qquad \text{(Budget when old)}$$

$$B_t^i \leq \underbrace{\theta}_{\text{LTV ratio ceiling}} \times p_t H_{t+1}^i. \qquad \text{(Borrowing constraint)}$$

- The market clearing conditions in each period t are

$$C_t^{poor,t-1} + C_t^{rich,t-1} + C_t^{poor,t} + C_t^{rich,t} = 2, \qquad \text{(Goods)}$$

$$B_t^{poor} + B_t^{rich} = 0, \qquad \text{(Mortgages)}$$

$$H_{t+1}^{poor} + H_{t+1}^{rich} = 1. \qquad \text{(Houses)}$$

Steady-state Equilibrium

Definition

- A (competitive) equilibrium is an allocation $\{C_t^i, C_{t+1}^i, B_t^i, H_{t+1}^i\}_{t=0}^{\infty}$ and prices $\{r_t, p_t\}_{t=0}^{\infty}$ such that, given the prices, (a) all agents solve their maximization problems and (b) markets clear.

- Suppose an equilibrium satisfies, for all t,

$$B_t^{\text{poor}} = B, \qquad B_t^{\text{rich}} = -B,$$

$$H_{t+1}^{\text{poor}} = H, \qquad H_{t+1}^{\text{rich}} = 1 - H,$$

$$r_t = r,$$

$$p_t = p.$$

Then the tuple (B, H, r, p) is called a steady-state equilibrium.

Results

Proposition (Pareto optimal borrowing)

Suppose (B, H, r, p) is a steady-state equilibrium under parameters (θ, ε). Suppose that the borrowing constraint does not bind. Then (B, H, r, p) does not depend on θ and

$$\frac{B}{pH} = \frac{\sqrt{3} - 1 - 2\sqrt{3}(\sqrt{3} - 1)\varepsilon}{\sqrt{3} - 1 + 2\varepsilon}.$$

Proof idea: The equilibrium must satisfy (a) intertemporal optimality and (b) consumption-housing optimality conditions for the two agents

$$MU^i_{\text{young}} = (1 + r) MU^i_{\text{old}},$$

$$MU^i_{\text{young}} = \frac{1}{p} MU^i_{\text{house}} + MU^i_{\text{old}}.$$

The four equations yield an algebraic solution of (B, H, r, p).

An LTV ceiling binds when it is lower than a threshold θ^*

Corollary

Let $\varepsilon \in (0, \frac{1}{2})$, and define $\theta^* = \frac{B}{pH}$ as in the earlier Proposition. Then any equilibrium with $\theta < \theta^*$ is binding. The lower the ε, the more likely to bind.

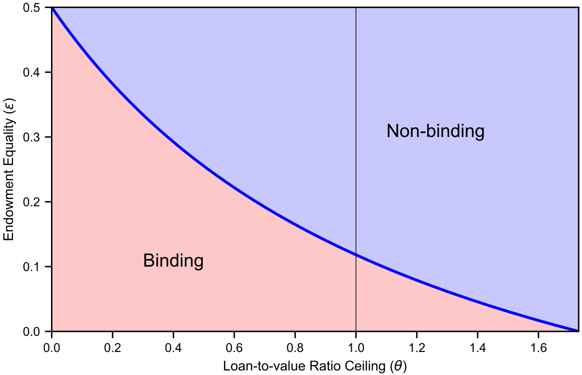


Figure: Binding and Non-binding Equilibria

Effects of Binding LTV Ceiling on House Prices

Proposition

Suppose (B, H, r, p) is a steady-state equilibrium under parameters (θ, ε). Suppose that the borrowing constraint binds. Then

$$p = \frac{2}{3} \cdot \frac{1-\varepsilon}{2(1-H)+\theta H}$$

Proof idea: Use (a) intertemporary and (b) consumption-housing optimality conditions of the rich-born agents and (c) binding borrowing constraint $B = \theta p H$ and solve for p.

Corollary

Suppose in a binding steady state equilibrium that H decreases as θ decreases. Then p increases as θ decreases.

Effects of LTV Ceilings on Allocation and Prices

Numerical solution when $\varepsilon = 0.2$, $\bar{\theta} = 0.67$

Closer look: a binding ceiling reduces mortgage rates

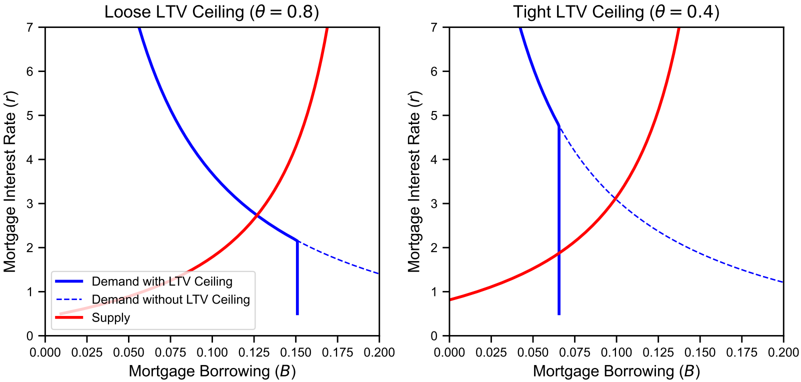


Figure: Supply and Demand for Mortgage Funds

- An LTV ceiling creates a vertical kink in the mortgage demand. A stricter ceiling (θ) shifts the kink to the left and pushes down the equilibrium mortgage interest rate (r)

A binding LTV ceiling increases overall house demand

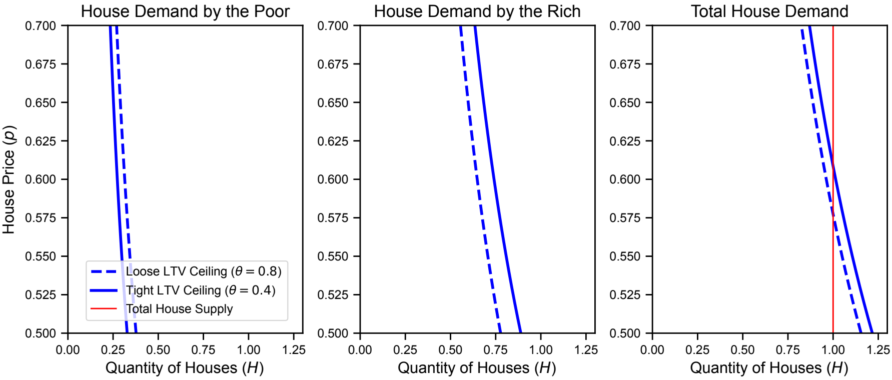
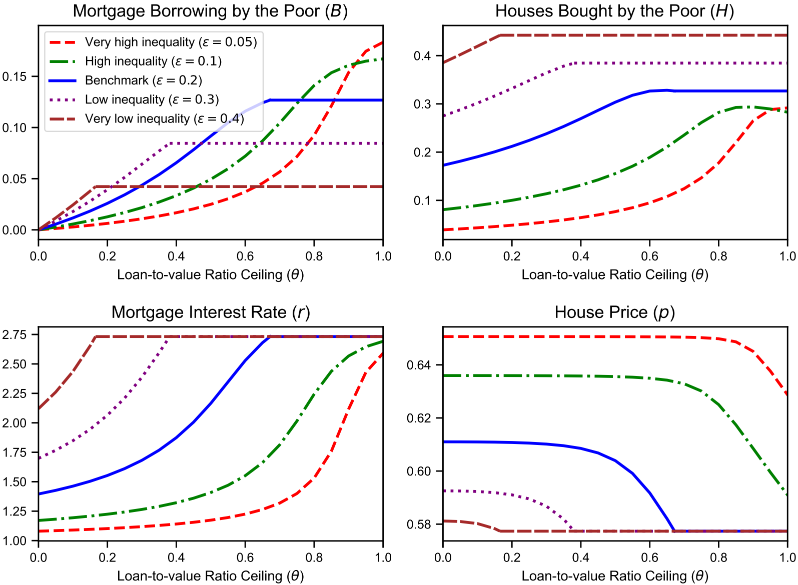


Figure: Supply and Demand for Houses

- The poor's house demand falls as a direct result of a stricter LTV ceiling
- However, in the general equilibrium, the fall in mortgage rates induce the rich to demand more houses. As a result, the total house demand rises.

The effects are more severe with greater income disparity



Takeaway

- Contrary to its often-intended effects, stricter LTV ceilings can raise house prices in the long run in a simple OLG model with within-generation heterogeneity
  - In a general equilibrium, reduced mortgage rates induce richer households to subtitute to investing in houses instead
  - Our results also suggest that greater income inequality can contribute to binding collateral constraints and rising house prices
- In the rest of the paper, we also find that LTV ceilings are overall bad and especially bad to the poor. We find that it is difficult to mitigate the adverse effects with taxes

Literature

1. **Empirical**: existing literature uses country-level panel data and find small negative or negligible effects of LTV ceilings on house prices in the short run
   - Kuttner and Shim (2016), Cerutti et al. (2017), Alam et al. (2019), Poghosyan (2020)

2. **Macro-Housing**: quantitative general equilibrium models with housing collateral contraints find negative or ambiguous effects in the short run
   - Kiyotaki et al. (2011), Favilukis et al. (2017), Garriga et al. (2019), Justiniano et al. (2019), Greenwald et al. (2019), Kaplan et al. (2020), Kiyotaki et al. (2020)

3. **Finance and Inequality**: emerging literature finds that widening inequality contributes to financial instability
   - Kumhof et al. (2015), Perugini et al. (2016), Mitkov and Schüwer (2020)

⇒ Unlike **(1)** and **(2)**, **our work** uses a simple two-period overlapping-generations (OLG) model and finds a long-run positive effect. Our result also supports **(3)**

Appendix

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Extension with Labor Choice: Household Problem Back

To justify the endowment assumption in baseline model, we give HH labor choice in their old period and prove that in the non-binding equilibrium, the **poor-born will choose more labor than the rich-born**. Initial poor choose its labor supply $n_{t+1}^{poor,t}$, while initial rich chooses $n_{t+1}^{rich,t}$. To elaborate, HH's utility is given by

$$U(C_t^{i,t}, C_{t+1}^{i,t}, H_{t+1}^i, n_{t+1}^{i,t}) = \ln C_t^{i,t} + \ln C_{t+1}^{i,t} + \ln H_{t+1}^i + \ln(1 - n_{t+1}^{i,t}), \quad (1)$$

and the corresponding constraints are

$$C_t^{i,t} + p_t H_{t+1}^i \leq e_t^i + B_t^i, \quad (2)$$

$$C_{t+1}^{i,t} + (1 + r_t) B_t^i \leq w_t n_{t+1}^i + p_{t+1} H_{t+1}^i, \quad (3)$$

$$B_t^i \leq \theta p_t H_{t+1}^i, \quad (4)$$

Given the above constraints, households choose $(C_t^{i,t}, C_{t+1}^{i,t}, B_t^i, H_{t+1}^i, n_{t+1}^{i,t})$ to maximize the lifetime utility (1) subject to (2), (3), and (4).

Extension with Labor Choice: Firm and Market Clear

Back

Firm hires old households to maximize the profit with labor-only technology, i.e.,

$$\max_{N_t} N_t^{\nu} - w_t N_t, \tag{5}$$

where $N_t = n_t^{poor,t-1} + n_t^{rich,t-1}$ is the aggregate labor supply, and equilibrium wage that clears the labor market is given by $w_t = \nu N_t^{\nu-1}$.

The market clearing conditions for consumption goods, bonds, and housing at each period t is given by

$$C_t^{poor,t-1} + C_t^{rich,t-1} + C_t^{poor,t} + C_t^{rich,t} = e_t^{poor} + e_t^{rich} + N^{\nu} = 1 + N^{\nu} \tag{6}$$

$$B_t^{poor} + B_t^{rich} = 0 \tag{7}$$

$$H_{t+1}^{poor} + H_{t+1}^{rich} = 1. \tag{8}$$

A *competitive equilibrium* is an allocation of $\left\{C_t^{i,t}, C_{t+1}^{i,t}, B_t^{i}, H_{t+1}^{i}, n_{t+1}^{i,t}\right\}_{t=0}^{\infty}$ and prices $\{r_t, p_t, w_t\}_{t=0}^{\infty}$ such that all markets clears and all agents solve their problem.

Extension with Labor Choice: Analysis

Back

Following the notations in the baseline model, there are 6 FOCs to solve $\{B, H, r, p, n^p, n^r\}$.

$$[B^{poor}]: \quad \frac{1}{C^{poor}_{young}} = \frac{(1+r)}{C^{poor}_{old}}, \qquad [B^{rich}]: \quad \frac{1}{C^{rich}_{young}} = \frac{1+r}{C^{rich}_{old}},$$

$$[H^{poor}]: \quad \frac{1}{C^{poor}_{young}} = \frac{1}{pH} + \frac{1}{C^{poor}_{old}}, \qquad [H^{rich}]: \quad \frac{1}{C^{rich}_{young}} = \frac{1}{p(1-H)} + \frac{1}{C^{rich}_{old}},$$

$$[n^{poor}]: \quad \frac{w}{C^{poor}_{old}} = \frac{1}{1-n^p}, \qquad [n^{rich}]: \quad \frac{w}{C^{rich}_{old}} = \frac{1}{1-n^r},$$

where

- $C^{poor}_{young} = \epsilon + B - pH$, $C^{poor}_{old} = wn^p + pH - (1+r)B$, and
- $C^{rich}_{young} = 1 - \epsilon - B - p(1-H)$, $C^{rich}_{old} = wn^r + p(1-H) + (1+r)B$.

Extension with Labor Choice: Analysis (Cont.) Back

Since the LHS of $[B^{poor}]$ and $[H^{poor}]$ and that of $[B^{rich}]$ and $[H^{rich}]$ are equal, we get

$$\frac{r}{C_{old}^{poor}} = \frac{1}{pH}; \quad \frac{r}{C_{old}^{rich}} = \frac{1}{p(1-H)} \Rightarrow \frac{C_{old}^{rich}}{C_{old}^{poor}} = \frac{1-H}{H}, \tag{9}$$

We will show (1) $H < \frac{1}{2}$, and (2) $n^r < n^p$

1. If $H > \frac{1}{2}$, then $C_{old}^{poor} > C_{old}^{rich}$. From $[B^{poor}]$ and $[B^{rich}]$, we know $C_{young}^{poor} > C_{young}^{rich}$, i.e.,

$$\epsilon + B - pH > 1 - \epsilon - B - p(1-H) \Rightarrow p < \frac{1+2B}{1-2H} < 0 \quad \rightarrow\!\leftarrow .$$

2. If $n^r > n^p$, from $[n^{poor}]$ and $[n^{rich}]$, we know

$$w = \frac{C_{old}^{poor}}{1-n^p} = \frac{C_{old}^{rich}}{1-n^r} \Rightarrow C_{old}^{rich} < C_{old}^{poor} \quad \rightarrow\!\leftarrow . \tag{10}$$

Effects on Consumption

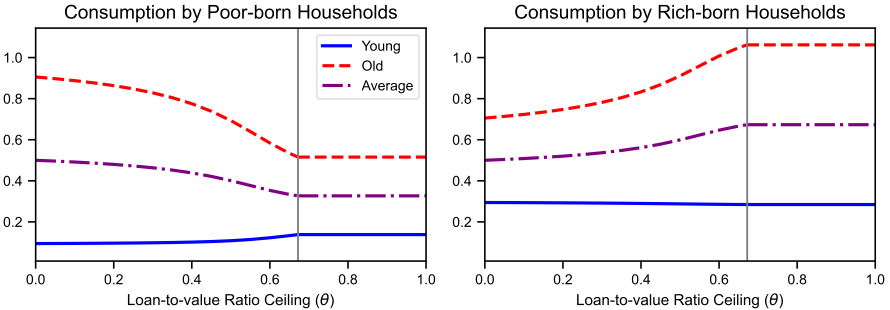


Figure: The Effects of Loan-to-value Ratio Ceilings on Consumption

- A stricter LTV ratio ceiling reduces consumption smoothing for borrowers and reduces profitable investment for lenders

Effects on Welfare

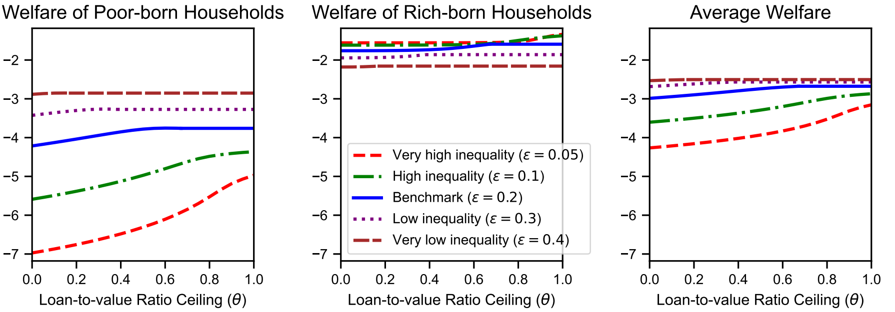
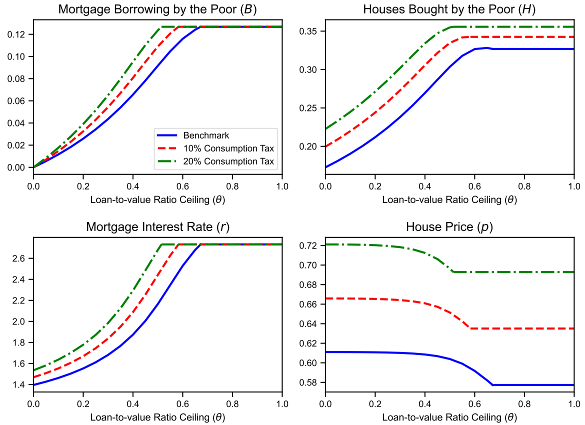


Figure: The Effects of Loan-to-value Ratio Ceilings on Welfare

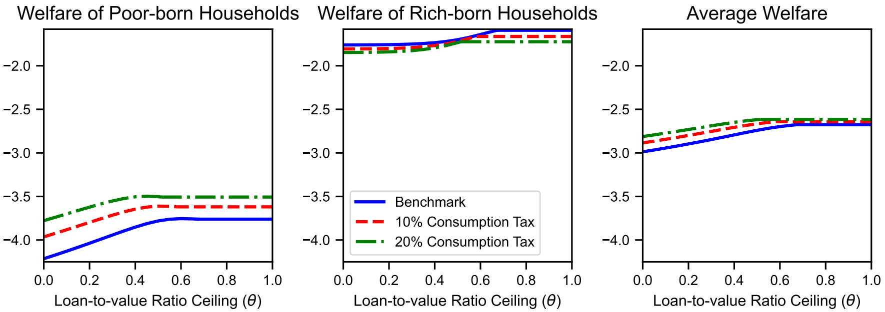
- ... as a result, stricter loan-to-value ceilings hurt everyone

Effects of a Consumption Tax on House Prices



- Consider a government adopting a consumption tax and using the revenue to make equal lump-sum transfers to all agents
- The policy would only raise the house price further

Effects of a Consumption Tax on Welfare

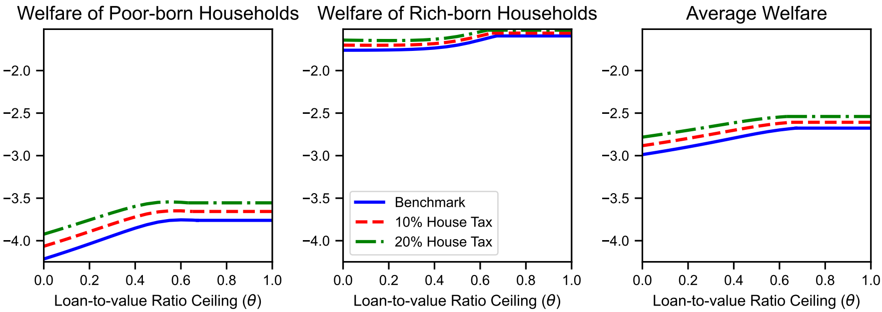


- ... although it could compensate the poor for their lost welfare due to an LTV ceiling

Effects of a House Tax on House Prices

- Similarly, an accompanying house tax and equal lump-sum transfers can only exacerbate the higher house price
- However, the effect on the house price is smaller than the consumption tax of the same rate

Effects of a House Tax on Welfare



- Such a house tax could help both the poor and the rich by greater amount than the consumption tax of the same rate

Robustness

- To see if our results are robust to alternative utility functions, we use CES utility:

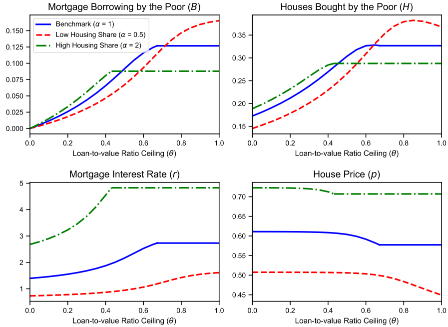
$$U(C_1, C_2, H) = \left(C_1^{\frac{\sigma-1}{\sigma}} + \beta C_2^{\frac{\sigma-1}{\sigma}} + \alpha H^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{1-\sigma}}$$

  - α is the utility share of houses
  - β is the inter-generational discount factor
  - σ is the elasticity of substitution

- Our benchmark results were for the special case with $\alpha = 1,\ \beta = 1$, and $\sigma = 1$. Now we explore other cases

Robustness to Alternative House Shares

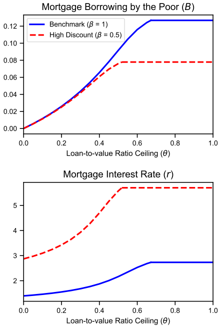
Common House Share ($\alpha_{poor} = \alpha_{rich}$)



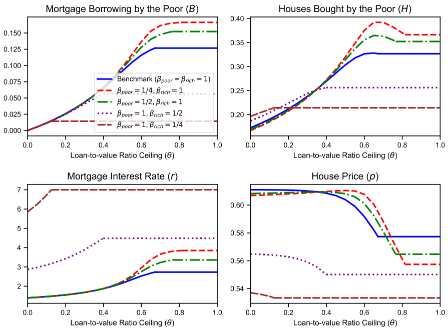
Differing House Shares ($\alpha_{poor} \neq \alpha_{rich}$)

Robustness to Alternative Discount Factors

Common Discount Factor ($\beta_{poor} = \beta_{rich}$)

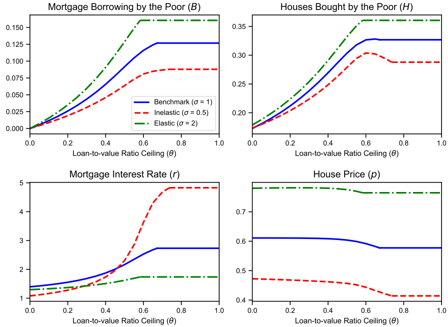


Differing Discount Factors ($\beta_{poor} \neq \beta_{rich}$)

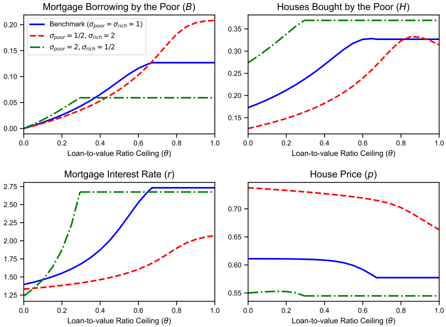


Robustness to Alternative Elasticities

Common Elasticity ($\sigma_{poor} = \sigma_{rich}$)



Differing Elasticities ($\sigma_{poor} \neq \sigma_{rich}$)



Overview

I consider a QOLG model with income heterogeneity and financial friction:

- **income heterogeneity**: born with type w, affects initial and lifetime income
- **Households**: trading housing and bonds to smooth against idio. endowment
  - Values housing service: unit of housing bought is in utility
  - Flow income $y_f(w,j) = a(w,j) + \epsilon_f(j)$, where a: deterministic; ϵ: idio
  - Collateral constraint: $B' \leq \theta p H'$ subject to LTV ceiling θ

Investing Household's Problem

An investing household of age $j = 1, \dots, 6$ solves

$$V(w, j, \epsilon_f, H, B) = \max_{C, H' \in \mathbf{H}, B' \in \mathbf{B}} \left(u(C, H) + \beta \sum_{g=1}^{N_\epsilon} \pi_{fg}^{N_\epsilon} V(w', j+1, \epsilon_g, H', B') \right)$$

subject to

$$y_f(w, j) = a(w, j) + \epsilon_f(j) \qquad \text{(endowment process)}$$

$$C + pH' - qB' \leq W(j) + y_f(w, j) \qquad \text{(age j budget constraint)}$$

$$W(1) = \underline{W}(w) \qquad \text{(initial wealth)}$$

$$W(j) = pH - B, \quad j = 2, \dots, 6 \qquad \text{(accumulated wealth)}$$

$$B' \leq \bar{B} \equiv \theta p H' \qquad \text{(collateral constraints)}$$

$$C \geq 0; \quad H \geq 0; \qquad \text{(non-negativity constraints)}$$

where $\mathbf{H} \equiv \left[0, \frac{W(j) + y_f(j)}{p(1 - q\theta)}\right]$ is the choice set for the housing.

Non-investing Household's Problem & Market Clear

A household of age $j = 7$ solves

$$\max_{C} \left(u(C,H)\right) \text{ subject to } \quad C \leq a(w,7) + \epsilon_f(7) + pH - B$$

The stationary distribution of households, $\{\mu_j\}_{j=2}^{7}$, satisfies

$$\mu_j(w,\epsilon_g,H,B) = \sum_{f=1}^{N_\epsilon} \pi_{fg}^{N_\epsilon} \int_{\{(H,B)|g(w,j,\epsilon_f,H,B)\in\mathbf{H}\times\mathbf{B}\}} \mu_{j-1}(w,\epsilon_f,dH,dB). \quad (11)$$

The equilibrium prices p^* and q^* clears the housing and mortgage market:

$$0 = \sum_{j=1}^{6}\sum_{g=1}^{N_\epsilon} \int_{\{(H,B)|g(w,j+1,\epsilon_g,H',B')\in\mathbf{H}\times\mathbf{B}\}} B\mu_j(w,\epsilon_g,dH,dB) \quad (12)$$

$$1 = \sum_{j=1}^{6}\sum_{g=1}^{N_\epsilon} \int_{\{(H,B)|g(w,j+1,\epsilon_g,H',B')\in\mathbf{H}\times\mathbf{B}\}} H\mu_j(w,\epsilon_g,dH,dB) \quad (13)$$