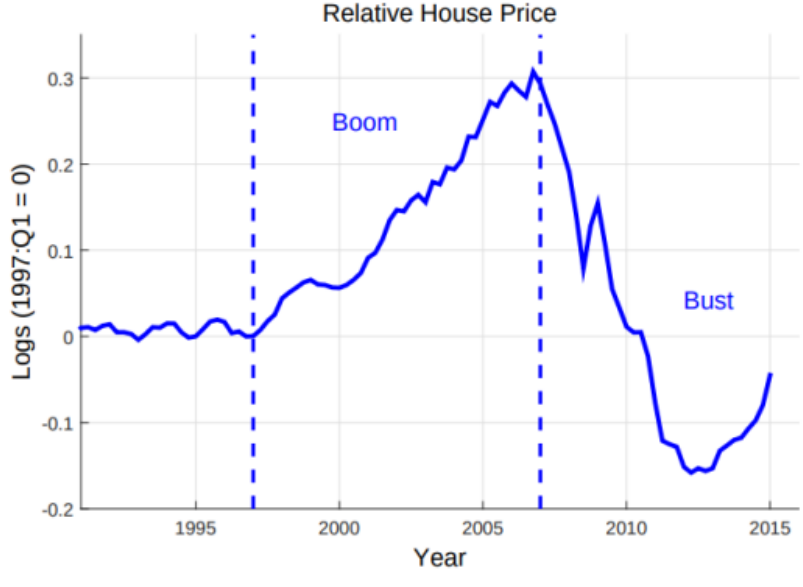
The Housing Boom and Bust: Model meets Evidence

Kaplan, Mitman, and Violante (2019)

Acalin Julien

Johns Hopkins University, Baltimore, March 2019

The Question



What caused the boom and bust in house prices?

Two Views

1. Credit view:
a. Availability of credit to marginal borrowers determines demand for housing and house prices
b. Financial deregulation and rise in securitization in early 2000s led to 'unsustainable' lending to subprime low-income borrower

2. Expectations view:
a. Waves of optimism and pessimism affect desire to borrow, housing demand and house prices
b. Middle- and high-income prime borrowers crucial to the story

- **What do the microdata say?**

Equilibrium Models of the Credit View

- **Successful in generating large house price movements**

- **What does it take for credit to push up house prices?**
  a. Large effect of credit shocks on housing risk premium
  b. Many households constrained in their housing consumption

- **Model features that deliver these outcomes:**
  a. Short term debt and no default: housing is very risky
  b. No rental market: many households that want to consume more housing but cannot

This paper

- **Equilibrium model with rental market and long-term mortgages**
- **Aggregate shocks: income, credit, beliefs**
- **Parameterize to cross-sectional and life-cycle facts**
- **Compare to aggregate time-series on: house prices, rent-price ratio, home ownership, leverage, and foreclosures**
- **Decompose the role of each shock**
- **Compare with new micro evidence**
- **Study transmission of house prices to consumption**
- **Evaluate debt forgiveness policies**

Model: Household and Financial Sectors

- OLG with two phases in lifecycle: work and retirement (80 periods)
- CES utility over ND consumption $(1 - \phi)$ and housing ϕ
- Idiosyncratic uninsurable earnings shocks y
- Saving in risk-free bonds, exogenous fixed interest rate
- Housing can be bought at p_h (sold s.t. transaction cost) or rented at ρ
- Long-term mortgages (to be repaid before death), with cash-out refi option, defaultable, competitively priced by financial intermediaries (thus reflects probability of default)
- At origination: max LTV and max PTI constraints (λ^m, λ^π) and origination costs (κ^m, ζ^m)
- Bank owns the house if default but can only sell at a discount (foreclosure is costly)
- HELOCs: one-period non defaultable debt (λ^b)

Model: Production

Final good sector

- Linear technology in labor with productivity $Z \rightarrow w = Z$

Construction sector

- Housing permits + labor $\rightarrow$ aggregate housing investments $I(p_h)$

Rental sector

- Frictionless conversion of rental units into owned units and viceversa
- Zero-profit condition yields equilibrium rental rate ρ

Model: Government

Government

- **Taxes workers (with mortgage interest deduction) and properties, sells land permits, and pays SS benefits to retirees**

Aggregate Shocks

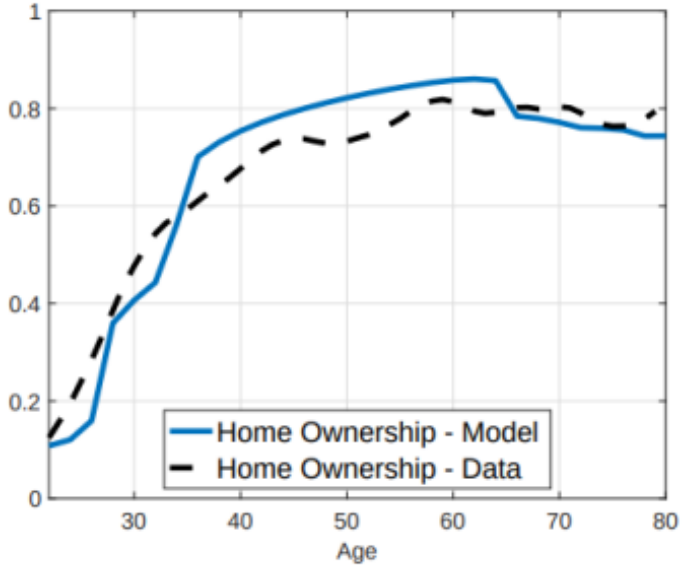
- **Aggregate labor income: Z**
- **Credit conditions:**
  - **mortgage origination cost (κ^m, ζ^m) reflecting securitization**
  - **LTV and PTI limits (λ^m, λ^π)**

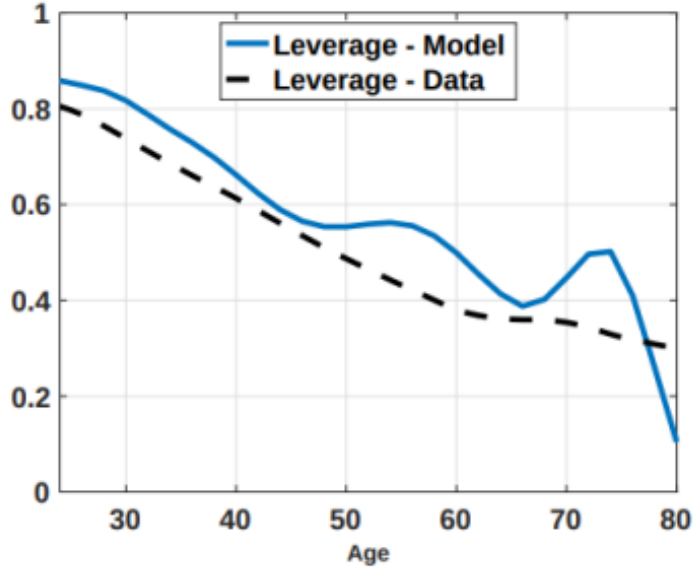
- **Beliefs / News about future housing demand**
  Three regimes for φ (share of housing services in u):

  a/ φ_L: low housing share and unlikely transition to φ_H
  b/ φ_L^*: low housing share and likely transition to φ_H
  c/ φ_H: high housing share

Boom-Bust: shift from (a) to (b), and back to (a)

Parameterization: Lifecycle Profiles of Ownership and Leverage





The model replicates:

- **Steep rise in home ownership from age 25 to 50**
- **Home ownership remains flat during retirement**
- **Sharp decline in leverage over the life cycle**

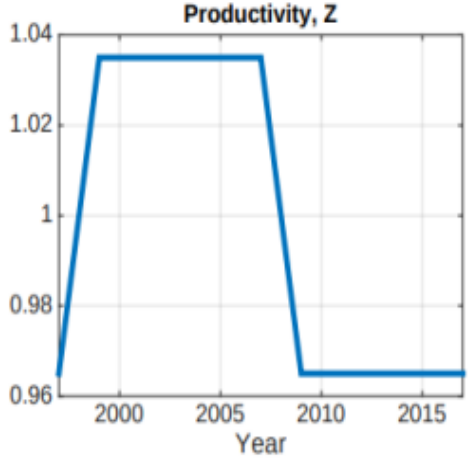
- **Calibration of news shock: use data on expectations (OECD)**

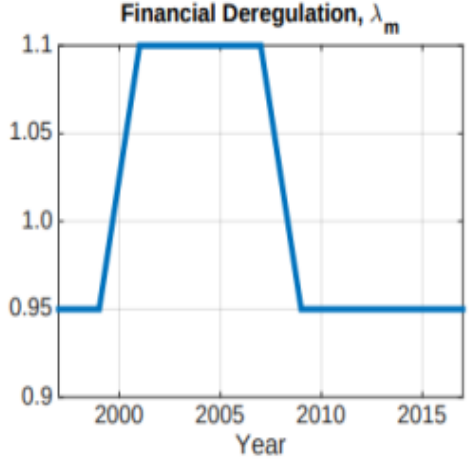
Parameterization

Moment	Empirical value	Model Value
Fraction homeowners w/ mortgage	0.66	0.57
Aggr. mortgage debt / housing value	0.42	0.36
P10 LTV ratio for mortgagors	0.15	0.14
P50 LTV ratio for mortgagors	0.57	0.59
P90 LTV ratio for mortgagors	0.92	0.92
Aggr. home-ownership rate	0.66	0.67
P10 house value / earnings	0.90	1.0
P50 house value / earnings	2.1	2.0
P90 house value / earnings	5.5	4.5
Avg.-size owned house / rented	1.5	1.4
Avg. earnings owners / renters	2.05	2.02
BPP consumption insurance coef	0.36	0.43

Shocks and Household Expectations in the Model

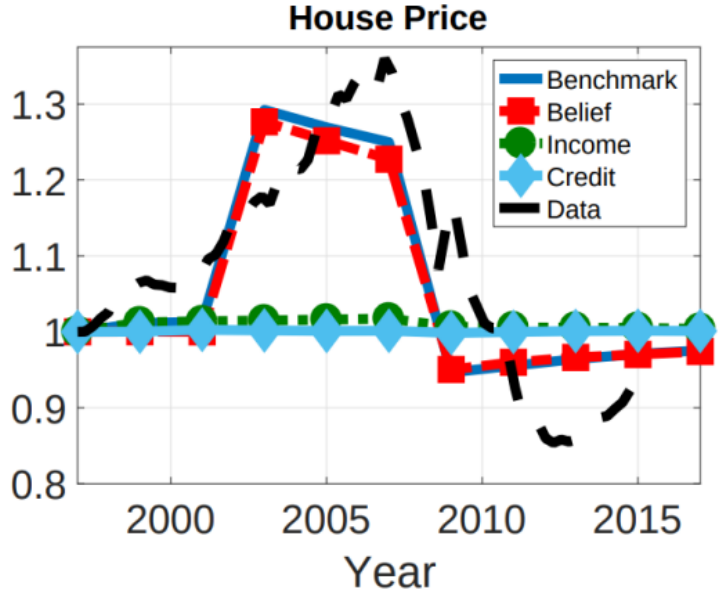
Realized path for shocks





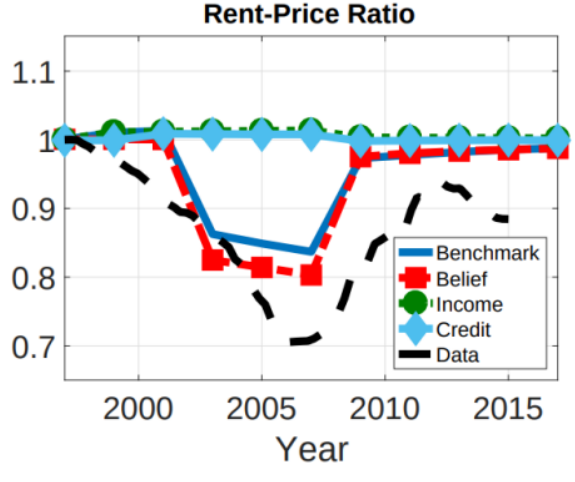
- **For boom years, consistent with survey evidence in Case-Shiller-Thompson which shows US households expected house price to grow 5-10 pct per year**

House Prices



- Decomposition is unique as shocks are orthogonal
- Belief shock accounts for all boom-bust in house prices
- Households unconstrained with respect to housing consumption, thus loosening credit does not do anything to the price

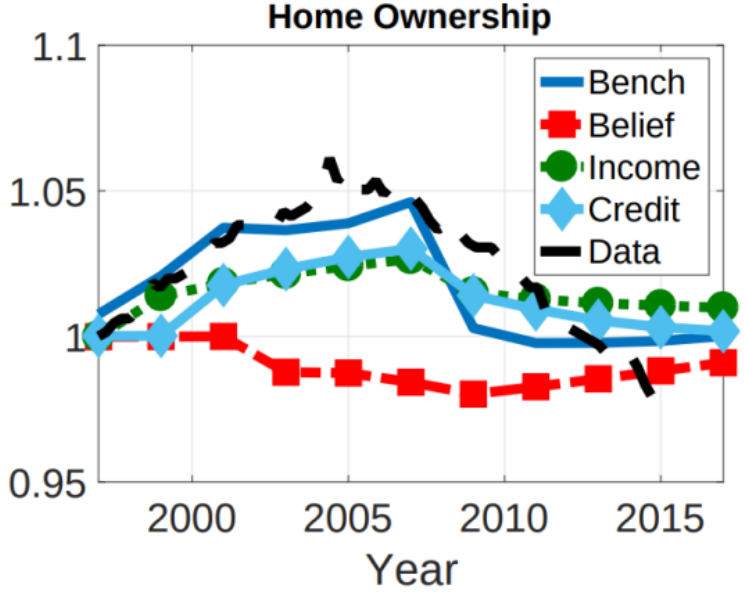
Rent-Price Ratio



$$\rho = \psi + p_h - \left(\frac{1-\delta_h-\tau_h}{1+r^b}\right)\mathbb{E}_{p_h}\left[p'_h\right]$$

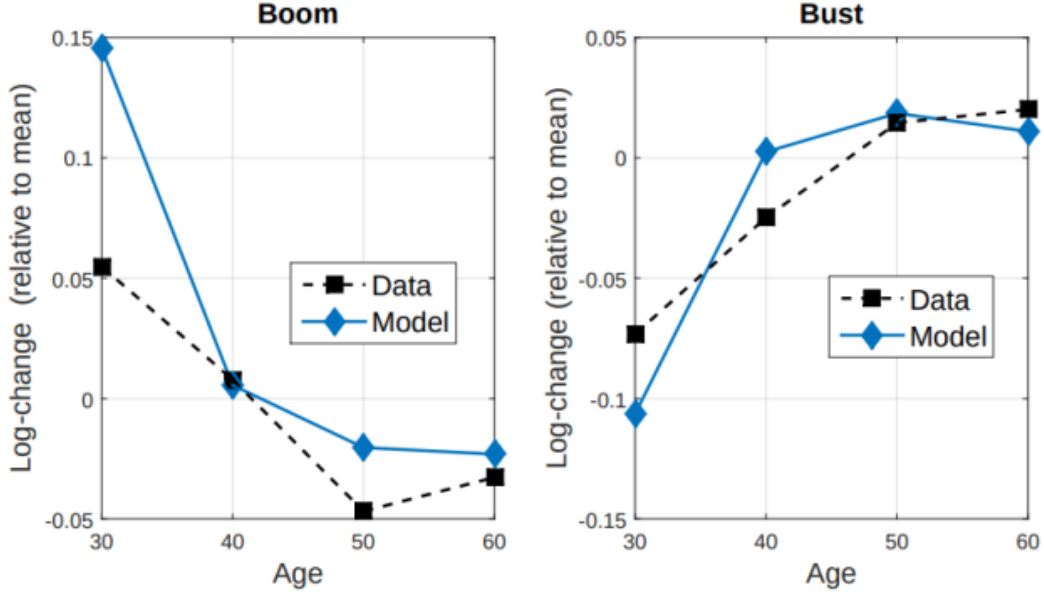
- Mirror image of house price
- Model can explain about 2/3 of change in data
- Belief about future appreciation shared by investment company

Home Ownership Rate



- **Belief shock makes renting more appealing, so should decrease home ownership**
- **Cheap credit drives rise in home ownership**
- **Households constrained in tenure choice, not housing choice**

Change in Home Ownership: Data and Model



- **It is the young who go in/out of the housing market**

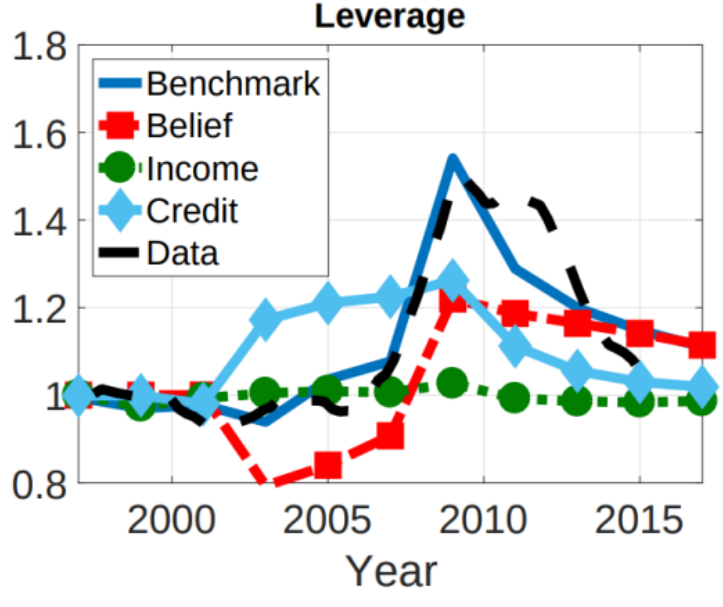
Explaining the Effects of Credit Shocks

- **Why looser/tighter credit does not affect housing demand?**
  - **Defaultable long-term debt: housing risk premium is small**
  - **Rental market: buyers are not constrained in housing choice**

- **Why is rise in home ownership disconnected from house prices?**
  - **Renters buy houses of similar size of those they rented**
  - **It's the current home owners who upsize and push up demand**

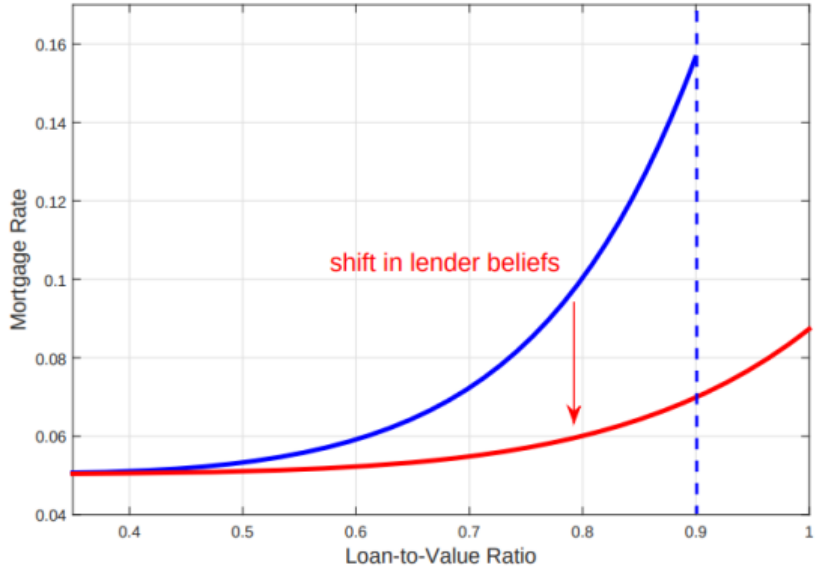
- **If HH's already consume optimal amount of housing, why buy more?**
  - **Housing is both a consumption good and an asset**
  - **Many households buy larger houses to realize expected capital gain**

Leverage (debt/house value)



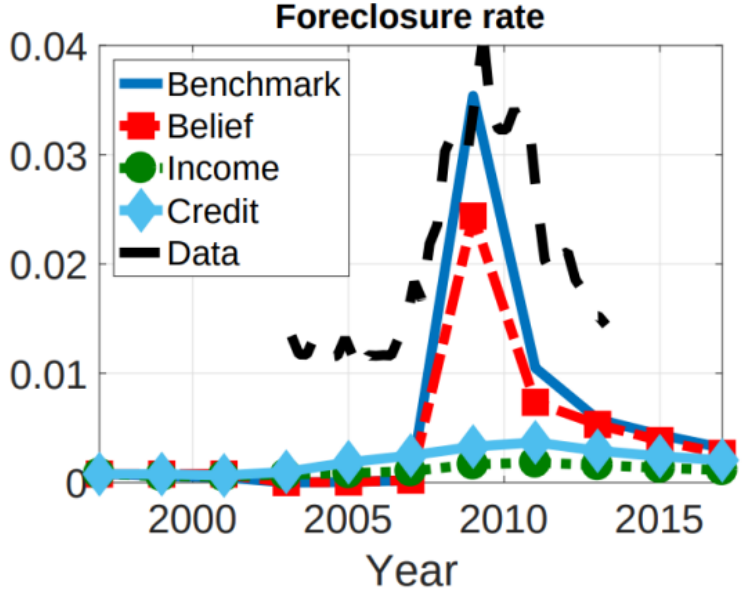
- Mechanically went up in the bust as house prices fall
- Credit loosening is crucial to maintain constant leverage pre-boom
- Credit shocks important for leverage and home ownership but not house prices

Endogenous Credit Boom through Beliefs



- **Mortgage rate as function of loan to value ratio reflects probability of default thus convex. Exogenous limit is set at 90%.**
- **During boom: Lender's optimistic beliefs $\longrightarrow$ lower expected default rates $\longrightarrow$ lower mortgage rates, especially for subprime borrowers, and limit disappears**

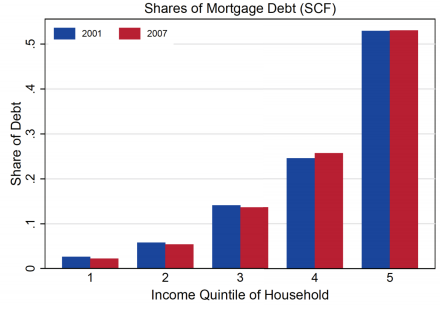
Foreclosure Rate



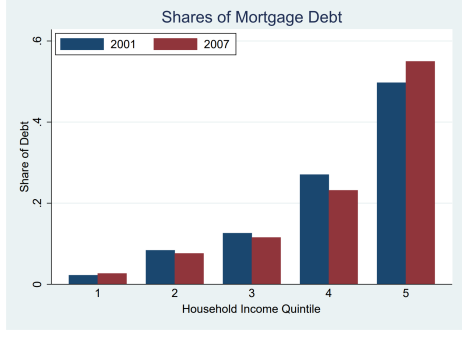
- **Complementarity between optimistic belief and looser credit**

Micro Evidence: Distribution of Debt and Foreclosures

- **Credit growth during boom uniform accross income levels**

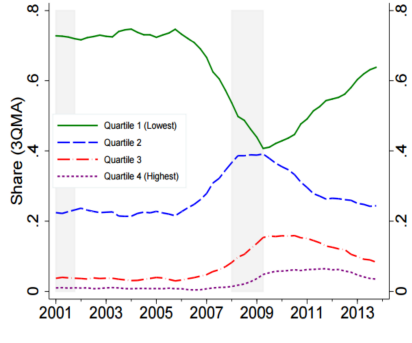


(a) Data

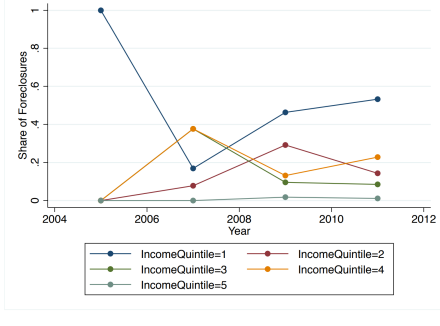


(b) Model

- **Foreclosure rise during bust disproportionately large for prime borrowers**

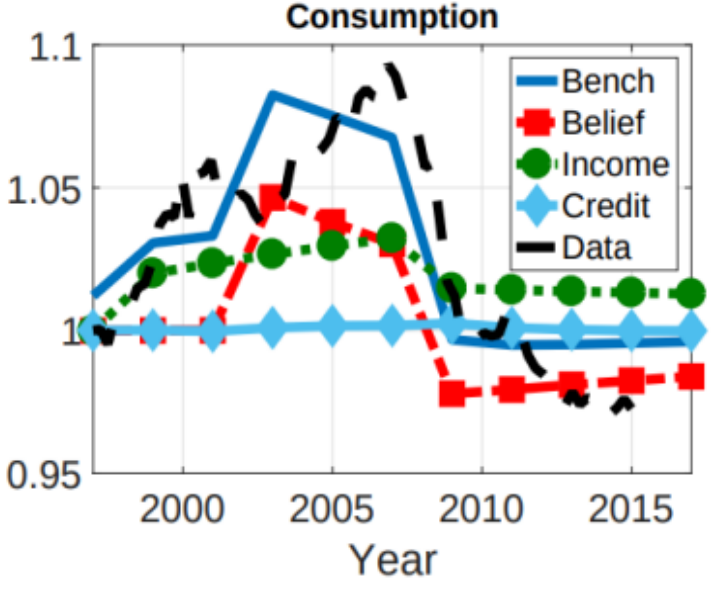


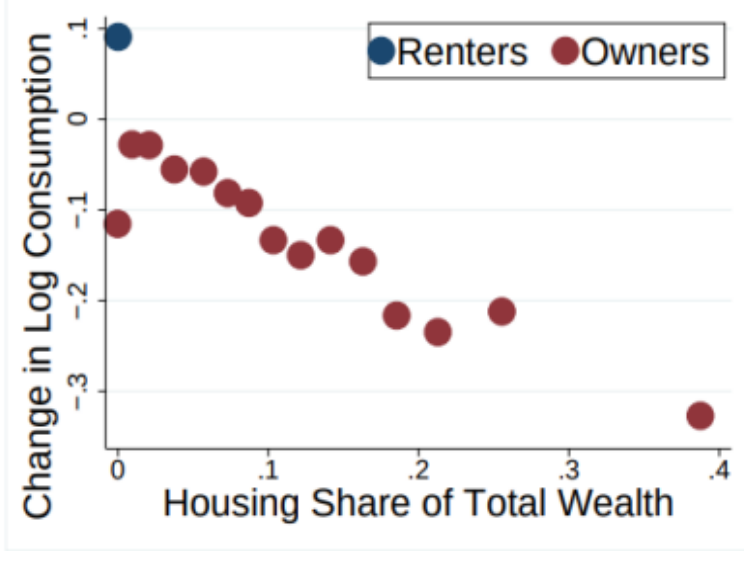
(e) Data



(f) Model

How does the fall in housing price transmit to consumption?





- Credit plays no role, belief and income shocks do
- House prices explain 1/2 of boom and bust in C
- Change in consumption growth negatively correlated with housing share of total wealth (balance sheet effect a la Mian and Sufi)
- No relation between change in consumption and debt as a fraction of wealth: no deleveraging effect

Summary: What Did We Learn from the Model?

- **Shift in expected house appreciation drives the boom-bust in p_h**
- **Credit not important to explain prices, but important for home ownership, leverage, and foreclosures**
- **Rental market + long-term mortgages are the key model features**
- **Micro evidence and aggregate time series are consistent**
- **Changes in p_h transmit to C through wealth effect**
- **Principal reduction program would not have cushioned the bust**

Appendix

Demographics and preferences

- Households work, retire, and live until age J
- Lifetime utility of household i:

$$\mathbb{E}_0 \left[\sum_{j=1}^{J} \beta^{j-1} u_j(c_{ij}, s_{ij}) + \beta^J v(\mathfrak{b}_i) \right]$$

c : ND consumption, s : housing services, $\mathfrak{b}$: bequest

$$u_j(c,s) = \varphi_j \frac{\left[(1-\phi)c^{1-\gamma} + \phi s^{1-\gamma}\right]^{\frac{1-\sigma}{1-\gamma}} - 1}{1-\sigma}, \quad \gamma, \sigma \in [0, \infty)$$

- ϕ: relative taste for housing
- $1/\gamma$: elasticity of substitution between (c, s)

Endowments

- Working households receive idiosyncratic income endowment:

$$\log y_{ij} = w(\Omega) + \chi_j + z_{ij}$$

  where w is the aggregate wage, χ_j is a deterministic profile, and z_{ij} follows a discrete Markov process,

- Retired households receive social security benefits from govt

- Newborn households endowed with draw from pool of bequeathed assets, correlated with initial draw of earnings

Housing

- Finite number of house sizes $h \in \mathcal{H}$
- Households can buy at price p_h, or rent at rate ρ, per unit
- Advantages of owning vs renting:
  - Yields higher consumption flow per unit of h
  - Tax advantage: mortgage-interest deduction
  - Housing wealth can be used as collateral
- Disadvantages of owning vs renting:
  - Owning requires a minimum downpayment
  - Linear transaction cost $\kappa_h \cdot (p_h h)$ for selling

Financial instruments

- Liquid saving ($b > 0$): one-period bond, exogenous interest rate r_b
- Mortgages (m): long-term, fixed rate
  - Origination / (cash-out) refinancing cost κ_m
  - Max loan-to-value at origination only $m \leq \lambda^m p_h h$
  - Competitively determined price schedule $q(h, m, b, y; \Omega)$
  - Amortized over remaining lifetime at rate $r_m = r_b (1 + \iota_m)$
- Foreclosure
  - Default on mortgage debt: utility loss ξ
  - Bank repossess and sells, but must pay financial cost δ^f
- HELOCs ($b < 0$)
  - One-period borrowing collateralized by housing, $b \geq -\lambda^b p_h h$
  - At rate $r_b (1 + \iota_b)$, non-defaultable

Household decisions

- All households choose consumption and liquid savings
- Non-home owner

  Rent choose: $h \in \widetilde{\mathcal{H}} \subset \mathcal{H}$

  Buy choose: $h \in \mathcal{H}$

  mortgage $\leq p_h h$ - min down payment
- Home owner

  Pay mortgage payment $\geq$ min repayment
  HELOC borrowing

  Refinance pay old and get new mortgage (w/ Cash-Out)

  Sell rent or buy

  Default utility cost, must rent

Production of goods and housing

- Final good sector: $Y = ZN \quad \rightarrow \quad w = Z$
- Construction sector: goods + housing permits $\rightarrow$ new houses

$$\max_{N_h} \quad p_h I_h - w N_h$$

$$\text{subject to} \quad I_h = (ZN_h)^{\alpha} \left(\bar{L}\right)^{1-\alpha}, \quad 0 < \alpha < 1$$

where $\bar{L}$ are new housing permits issued by government and sold at market price

- Competition among builders: aggr. housing investment function

$$I_h \quad = \quad (p_h)^{\frac{\alpha}{1-\alpha}} (\alpha)^{\frac{\alpha}{1-\alpha}} \bar{L},$$

- Housing supply elasticity given by $\frac{\alpha}{1-\alpha} \in [0, \infty)$

Rental sector and government

- Rental sector owns rental stock
- Buys housing from sellers, transform to rentals, or vice-versa, sells rental units to home buyers
- Operating cost ψ per unit of housing owned and rented out
- Zero-profit condition yields equilibrium rental rate ρ

$$\rho = \psi + p_h - \left(\frac{1 - \delta_h - \tau_h}{1 + r^b} \right) \mathbb{E}_{p_h} \left[p_h' \right]$$

- Government: spends, pays social security to the retirees, taxes workers (with mortgage interest deduction) and properties, collects revenues from selling new land permits

Housing market equilibrium

Aggregate Supply

Post-depreciation past housing stock

+ New investment of the construction sector (including maintenance)

+ Homes sold and foreclosed

+ Homes bequeathed and then liquidated

=

Aggregate Demand

Housing occupied by “staying” owners

+ Net purchases of the rental company (converted into rentals)

+ Purchases by former renters and former owners up-/down-grading

Computation of equilibrium

- Households require conditional forecast of prices $\boldsymbol{p'_h}$
- Housing market must clear every period at p_h
- Given $\left\{p_h, \boldsymbol{p'_h}\right\}$, ρ follows from the FOC of rental company
- Version of the Krusell-Smith (1998) algorithm:
  - Forecasting rule used by households in their DP problem:

$$\log p'_h = a_0(\mathcal{Z}, \mathcal{Z}') + a_1(\mathcal{Z}, \mathcal{Z}') \log p_h$$

  - Aggregate consistency: in equilibrium, forecasting rule is also law of motion for prices

Appendix II

Household problem: Renter

- A non-homeowner can stay a renter or become an owner:

$$\mathbf{V}^n(b_j, z_j; \Omega) = \max\left\{V^r(b_j, z_j; \Omega), V^o(b_j, z_j; \Omega)\right\},$$

where Ω denotes the vector of aggregate states $(\mathcal{Z}, \mu)$

- Those who choose to rent solve:

$$V^r(b_j, z_j; \Omega) = \max_{c_j, h_j, b_{j+1}} u_j(c_j, s_j) + \beta \mathbb{E}_{z_j, \Omega}\left[\mathbf{V}^n(b_{j+1}, z_{j+1}; \Omega')\right]$$

$$s.t.$$

$$c_j + \rho(\Omega) h_j + q_b b_{j+1} \leq b_j + y_j - \mathcal{T}(y_j, 0)$$

$$b_{j+1} \geq 0$$

$$s_j = h_j \in \tilde{\mathcal{H}}$$

$$z_{j+1} = \Upsilon(z_j) \quad \Omega' = \Gamma(\Omega)$$

Household problem: Buyer

- Those who choose to buy and become owners solve:

$$V^o(b_j, z_j; \Omega) = \max_{c_j, b_{j+1}, h_{j+1}, m_{j+1}} u_j(c_j, s_j) + \beta \mathbb{E}_{z_j, \Omega} \left[\mathbf{V}^h(\mathbf{x}_{j+1}, z_{j+1}; \Omega') \right]$$

$$s.t.$$

$$c_j + q_b b_{j+1} + p_h(\Omega) h_{j+1} + \kappa_m \leq b_j + y_j - \mathcal{T}(y_j, 0) + q_m(\mathbf{x}_{j+1}, z_j; \Omega) n$$

$$m_{j+1} \leq \lambda^m p_h(\Omega) h_{j+1}$$

$$b_{j+1} \geq 0$$

$$h_{j+1} \in \mathcal{H}, \quad s_j = \omega h_{j+1}$$

$$z_{j+1} = \Upsilon(z_j), \quad \Omega' = \Gamma(\Omega)$$

where $\mathbf{x}_{j+1} := (b_{j+1}, h_{j+1}, m_{j+1})$

Household problem: Homeowner

$$\mathbf{V}^h(\mathbf{x}_j, z_j; \Omega) \quad = \quad \max \left\{ \begin{array}{ll} \text{Pay:} & V^p(\mathbf{x}_j, z_j; \Omega) \\ \text{Refinance:} & V^f(\mathbf{x}_j, z_j; \Omega) \\ \text{Sell:} & \mathbf{V}^n(\tilde{b}_j, z_j; \Omega) \\ \text{Default:} & V^d(b_j, z_j; \Omega) \end{array} \right\}$$

where $\mathbf{x}_j := (b_j, h_j, m_j)$

- Seller's liquid assets after transaction:

$$\tilde{b}_j = b_j - \kappa_h p_h(\Omega) h_j - (1 + r_m)\, m_j + (1 - \delta_h - \tau_h)\, p_h(\Omega) h_j$$

Household problem: Homeowner

- A household that makes its mortgage payment solves :

$$V^p(\mathbf{x}_j, z_j; \Omega) = \max_{c_j, b_{j+1}, \pi_m} u(c_j, s_j) + \beta \mathbb{E}_{z_j, \Omega} \left[\mathbf{V}^h(\mathbf{x}_{j+1}, z_{j+1}; \Omega') \right]$$

$$s.t.$$

$$c_j + q_b(b) b_{j+1} + (\delta_h + \tau_h) p_h(\Omega) h_j + \pi_m \leq b_j + y_j - \mathcal{T}\left(y_j, m_j\right.$$

$$\pi_m \geq \pi_m^*$$

$$m_{j+1} = (1 + r_m) m_j - \pi_m$$

$$b_{j+1} \geq -\lambda^b p_h(\Omega) h_{j+1}$$

$$s_j = \omega h_j, \quad h_{j+1} = h_j$$

$$z_{j+1} = \Upsilon(z_j), \quad \Omega' = \Gamma(\Omega)$$

where $\mathbf{x}_j := (b_j, h_j, m_j)$

Note: Collateral effect for owners only through HELOCs

Household problem: Default

$$V^d(b_j, z_j; \Omega) = \max_{c_j, h_j, b_{j+1}} u(c_j, s_j) - \xi + \beta \mathbb{E}_{z_j, \Omega} \left[\mathbf{V}^r(b_{j+1}, z_{j+1}; \Omega') \right]$$

$$s.t.$$

$$c_j + \rho(\Omega) h_j + q_b b_{j+1} \leq b_j + y_j - \mathcal{T}(y_j, 0)$$

$$b_{j+1} \geq 0$$

$$s_j = h_j$$

$$z_{j+1} = \Upsilon(z_j), \quad \Omega' = \Gamma(\Omega)$$

- Disutility of default ξ
- Household must rent for a period

Mortgage pricing

- Zero-profit condition by type j, $\mathbf{x} = (b, h, m)$, z yields:

$$q_m(\mathsf{x}_{j+1}, z_j; \Omega) = \frac{1}{(1+r_m)\, m_{j+1}} \cdot \mathbb{E}_{z_j,\Omega} \left\{ \left[g^n_{j+1} + g^f_{j+1} \right] (1+r_m)\, m_{j+1} \right.$$

$$+ g^d_{j+1} \min \left\langle \left(1 - \delta^d_h\right) p_h(\Omega') h_{j+1}, (1+r_m)\, m_{j+1} \right\rangle$$

$$\left. + \left[1 - g^n_{j+1} - g^f_{j+1} - g^d_{j+1}\right] \left[\pi_m(\mathsf{x}_{j+2}, z_{j+1}; \Omega') + q_m(\mathsf{x}_{j+2}, z_{j+1}; \Omega') m_{j+2}\right] \right\}$$

- g^n : sell
- g^f : refinance
- g^d : default
- $g^n = g^f = g^d = 0 \rightarrow$ make mortgage payment