

# **Consumption and House Prices in the Great Recession: Model Meets Evidence**

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MFM

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# Outline

## 1. Overview

## 2. Model

## 3. Questions

Q1: What shock(s) drove the boom-bust in  $p_h$ ?

Q2: How does the fall in  $p_h$  transmit to  $C$ ?

Q3: Could a debt-forgiveness policy have cushioned the bust?

## 4. Further evidence

## 5. Conclusions

## 6. Appendix

# Three questions

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3. Could a debt-forgiveness policy have cushioned the bust?

- Big effect on foreclosures
- Negligible effect on  $p_h$  and  $C$

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- **Counterfactuals** to address our questions

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# Model

## Demographics

- OLG lifecycle economy with work & retirement

## Endowments

- Workers face uninsurable risk in individual earnings  $y$

## Preferences

- Utility over nondurable  $c$  and housing services  $h$

## Housing

- Finite number of house sizes  $h \in \mathcal{H}$
- Households can **buy** a unit of  $h$  at price  $p_h$ , or **rent** it at rate  $\rho$
- Linear **transaction cost**  $\kappa_h \cdot (p_h h)$  for sellers

# Financial instruments

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- Amortized over remaining lifetime at rate  $r_b(1 + \iota)$
- Refinancing option available (cash-out) at cost  $\kappa_m$
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HELOCs ( $b < 0$ )

- One-period borrowing ( $b \geq -\lambda_b p_h h$ ), at rate  $r_b(1 + \iota)$ , non-defaultable
- Collateralized by housing,  $b \geq -\lambda^b p_h h$

# Closing the model

## Final good sector

- $Y = Z\bar{N} \rightarrow w = Z$

## Construction sector

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

## Rental sector

- Buys housing from sellers and rents them out, or vice-versa, sells rental units to home buyers
- Operating cost  $\psi$  per unit of housing owned and rented out
- Zero-profit condition yields equilibrium rental rate  $\rho$

## Government

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



# Aggregate shocks

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2. Credit conditions: (i) credit limits  $(\lambda^m, \lambda^b, \lambda^\pi)$   
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(ii) intermediation wedge  $\iota$
3. Beliefs / News about future housing demand:

Three regimes for  $\phi$  (share of housing services in  $u$ ):

- (a)  $\phi_L$ : low housing share and unlikely transition to  $\phi_H$
- (b)  $\phi_L^*$ : low housing share and likely transition to  $\phi_H$
- (c)  $\phi_H$ : high housing share

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

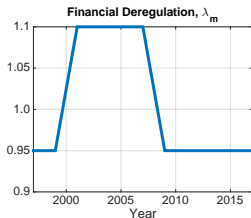
# Shock Processes

1. Aggr. labor income: NIPA wages & salaries per capita
2. Credit conditions:  $\lambda_m$ : 95%  $\rightarrow$  110%,  $\lambda_b$ : 20%  $\rightarrow$  30%  
 $\lambda_\pi$  : 25%  $\rightarrow$  60%,  $\iota^m$  : 100 BP  $\rightarrow$  75 BP
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## Realized path for shocks



- The **shift in beliefs** hits in 2001 and reverts back in 2007

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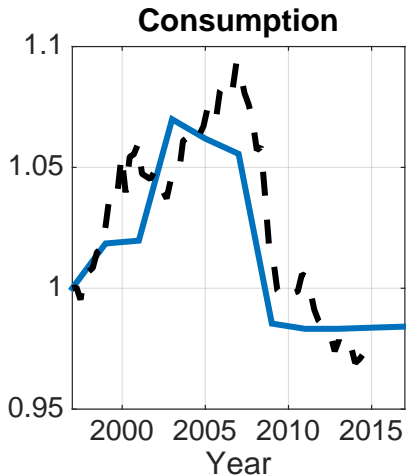
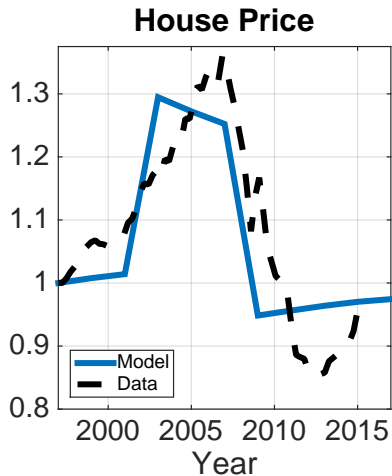
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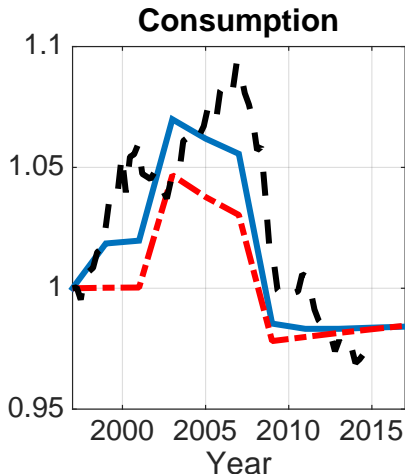
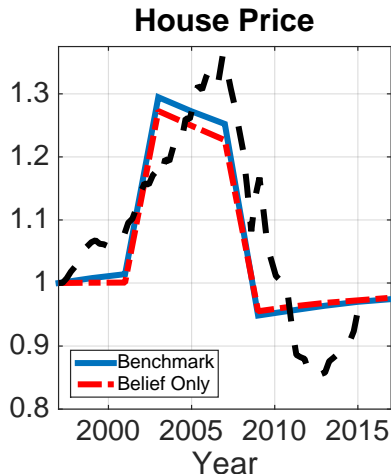
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# Consumption and house price dynamics

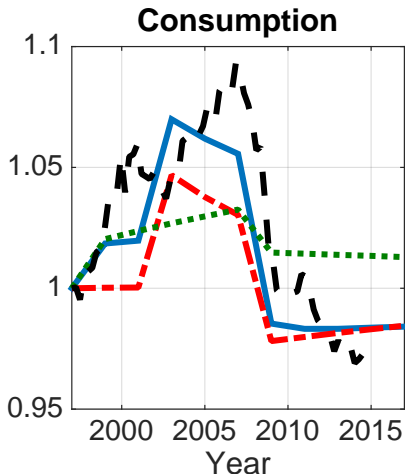
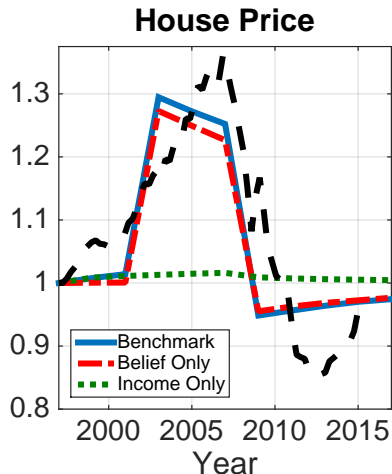


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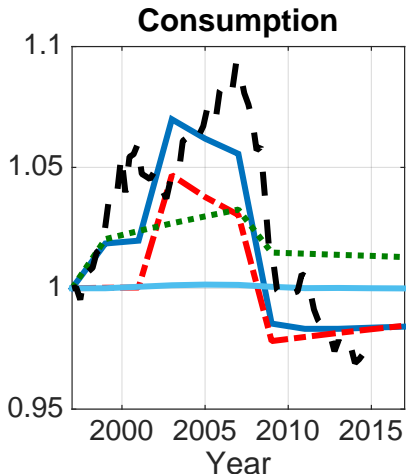
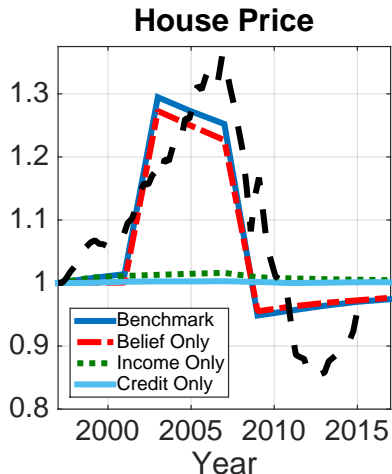




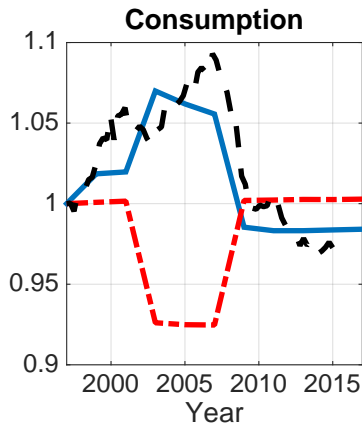
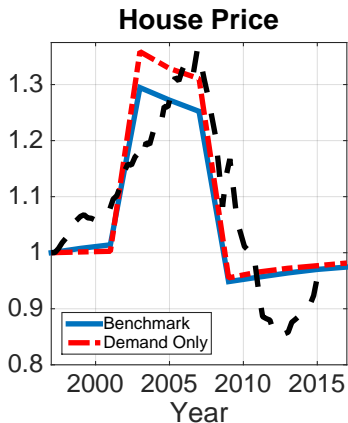
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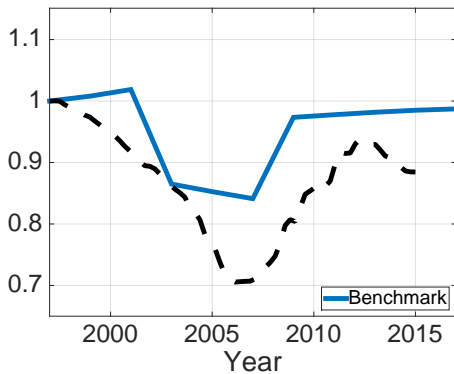


# Beliefs vs actual change in preferences

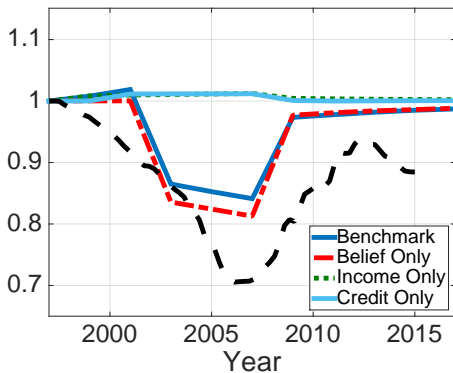


- Preference shock: similar rise in  $p_h$ , but  $C$  falls!

# Dynamics of rent-price ratio



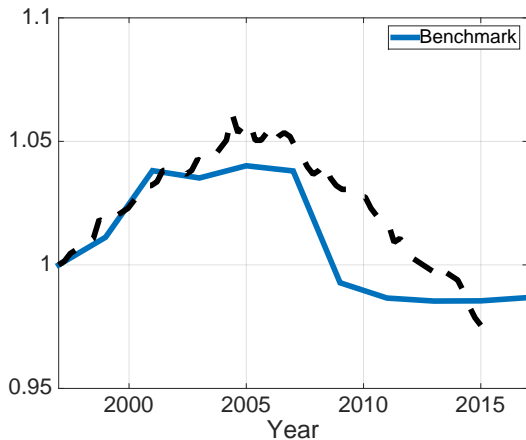
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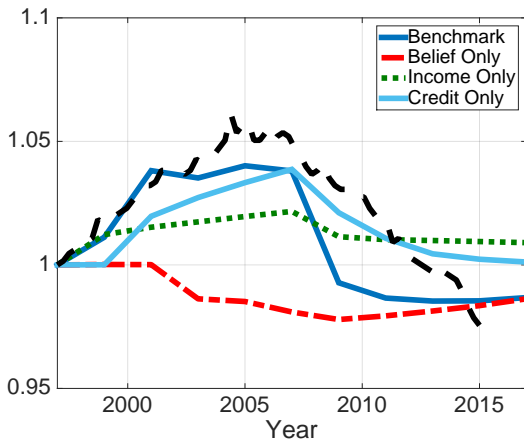
$$\rho = \psi + p_h - \left( \frac{1 - \delta_h - \tau_h}{1 + r^b} \right) \mathbb{E}_{p_h} [\rho'_h]$$

- Belief about future appreciation shared by investment company

# Dynamics of home ownership

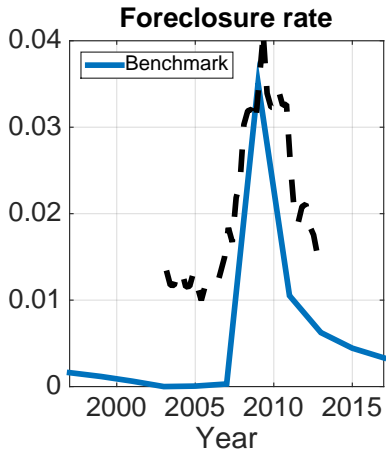
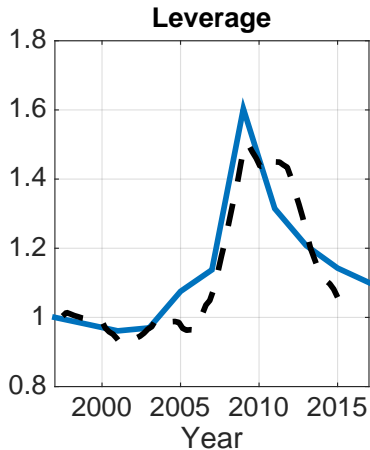


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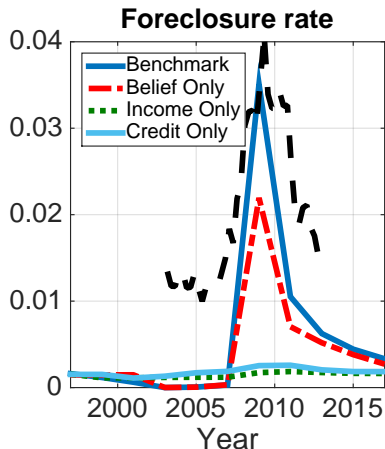
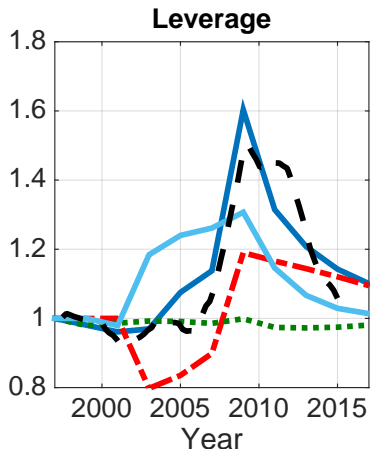
- Loosening of credit limits drives rise in home-ownership
- Households constrained in tenure choice, not in housing choice

# Dynamics of leverage and foreclosure





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- Credit loosening is key for constant leverage pre-boom
- Interaction between beliefs and credit important for foreclosure

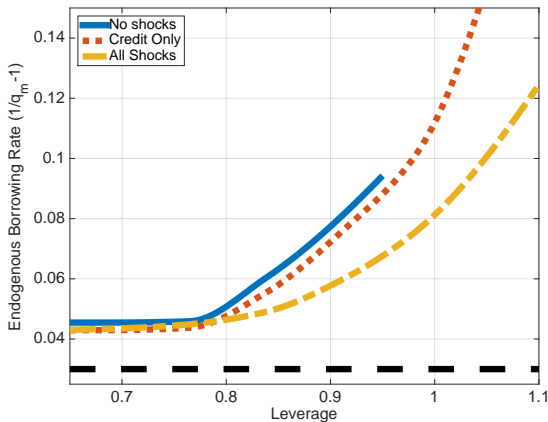
## Why credit shock does not affect $p_h$

- Max LTV/PTI ratios affect housing demand if renters (extensive margin) or home-owners (intensive margin) are constrained in housing choice (not tenure choice)
  1. BOOM: Rental market relaxes these constraints
  2. BUST: Long-term mortgage debt relaxes these constraints

# Why credit shock does not affect $p_h$

- Max LTV/PTI ratios affect housing demand if renters (**extensive margin**) or home-owners (**intensive margin**) are constrained in **housing** choice (not tenure choice)
  1. BOOM: Rental market relaxes these constraints
  2. BUST: Long-term mortgage debt relaxes these constraints
- Are we missing the ‘credit supply’ aspect of the shock, i.e. cheap credit flowing to low-quality borrowers?
- No: **endogenous relaxation in lending standards** in response to belief-driven boom

# Cheaper credit for 'low-quality' borrowers



- Lenders also expect prices to rise and default rates to fall

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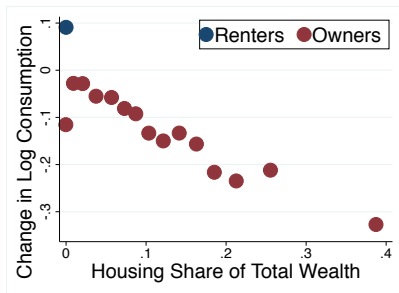
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# Deleveraging or wealth effect in the bust?



Deleveraging: WEAK



Wealth effect: STRONG

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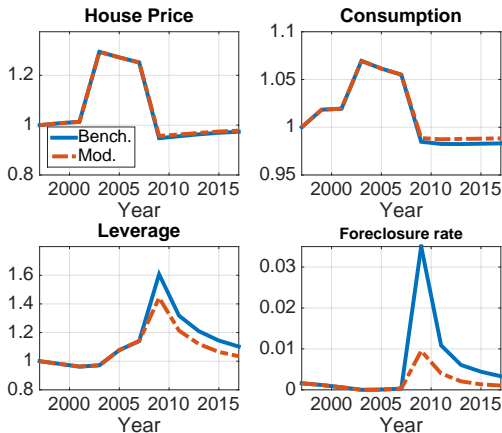
# Counterfactual principal reduction program

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- Beneficiaries account for small share of C

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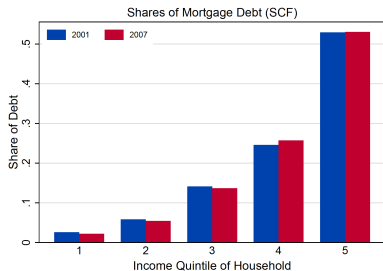
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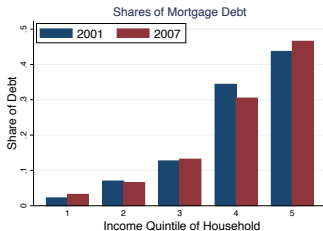
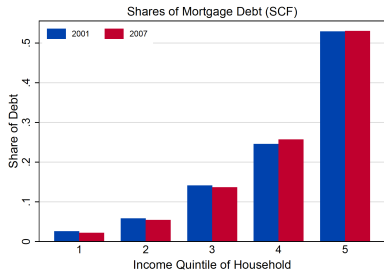
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- **Foote et al.:** no, equally distributed across income groups



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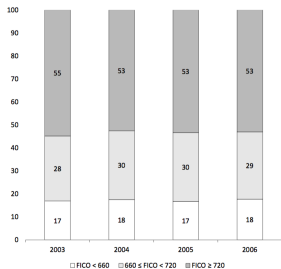
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- Low-income hh switch from rent to buy, high-income hh upsize

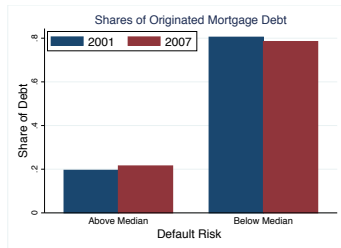
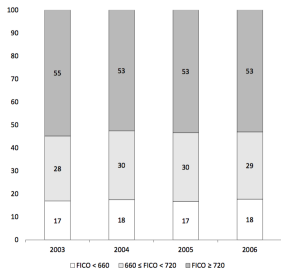
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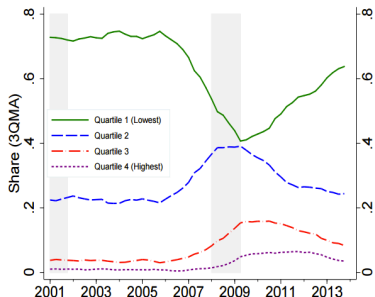
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- Young hh switch from rent to buy, older hh upsize

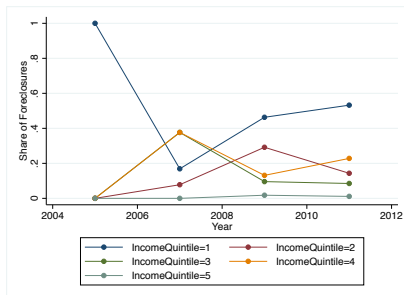
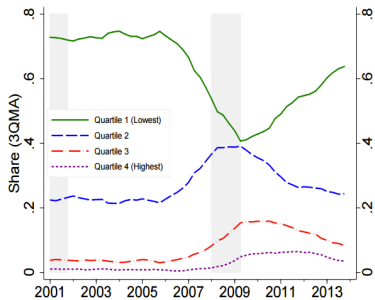
# Foreclosures

- [Mian-Sufi](#): foreclosures concentrated in subprime groups
- [Albanesi et al.](#): no, proportionally rising more for other groups



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- Everyone levers up, including middle-income households



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# What did we learn from the model?

1. Shift in **expected house appreciation** key to boom-bust in  $p_H$
2. This explanation is consistent with recent micro evidence
3. Endogenous relaxation of credit conditions from change in beliefs
4. Credit important for home-ownership, leverage, foreclosures, but not  $p_H$
5.  $\Delta p_h$  transmits to  $\Delta C$  through **wealth effects**
6. Principal reduction program would **not** have mitigated drop in  $C$

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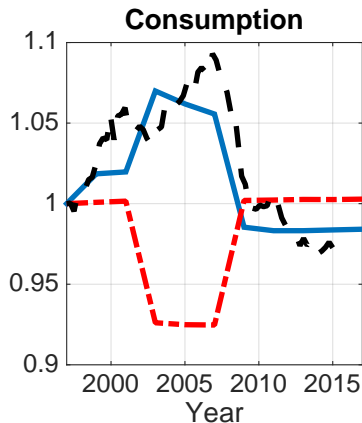
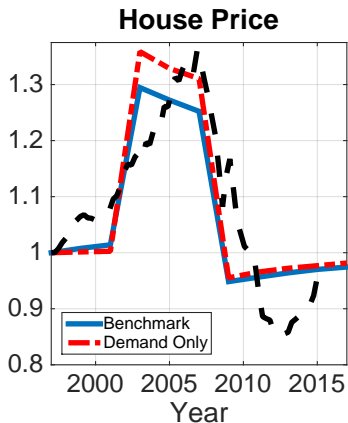
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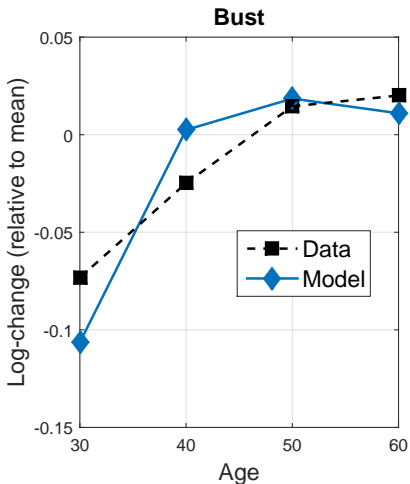
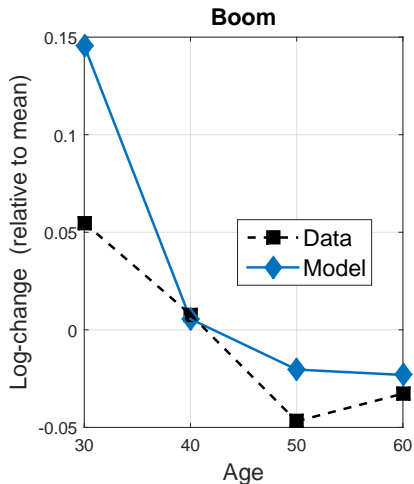
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# Beliefs vs actual change in preferences



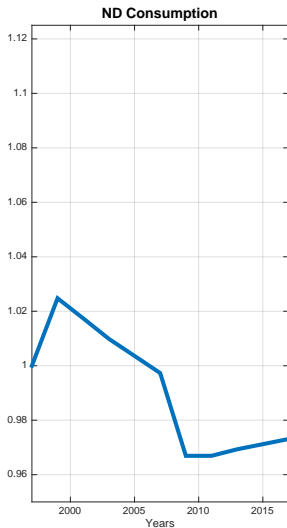
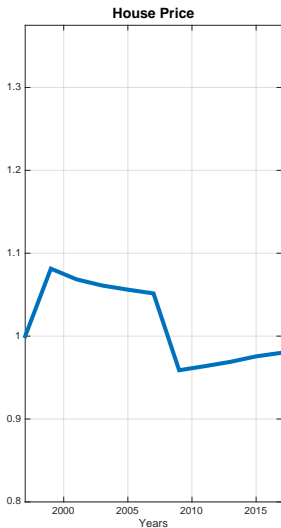
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# Change in home ownership by age

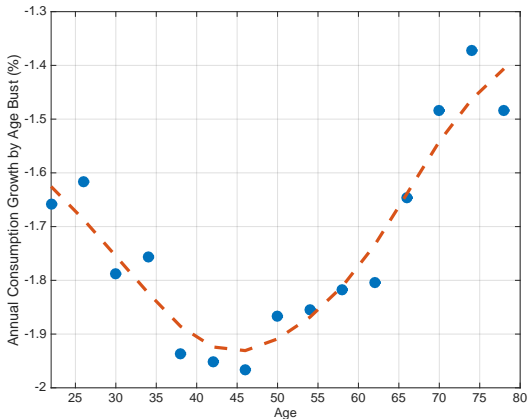


- It's the young who go in/out of housing market

# Shock to Interest Rate



# Consumption response by age during Bust



- $\Delta c$  in the baseline -  $\Delta c$  in the Income-only counterfactual

# Parameterization strategy

Parameter values disciplined by facts from household-level micro-data

- Distributional stats: mortgages, , renters, and consumption

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	0.28
P90 LTV ratio for mortgagors	0.92	0.76
	0.66	0.65
	0.11	0.12
	0.95	0.98
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



# Solution and simulation

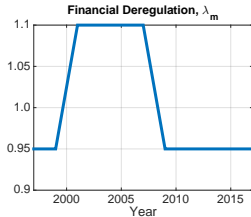
- Equilibrium computed with a version of [Krusell-Smith \(1998\)](#)
- Forecasting rule used by households in their problem:

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

- **Aggregate consistency:** in equilibrium, forecasting rule is also law of motion for prices
- Note:  $\rho$  computable from zero-profit condition, given  $p_h$  and  $\mathbb{E}[p'_h]$

# Solution and simulation

Simulation of boom-bust: realized path for shocks



1. **Productivity**: aggregate earnings data
2. **Credit conditions**: max LTV: 85% - 100%, HELOC limit: 20% - 30%, origination costs: 1% - 0
3. **Beliefs**: expected house price growth from Case-Shiller survey

# Household problem: Renter

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

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

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

- Those who choose to rent solve:

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

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:

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

*s.t.*

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

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

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

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

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

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

# Household problem: Homeowner

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

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 :

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

s. t.

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

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

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

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

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

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

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

**Note:** Collateral effect for owners only through HELOCs

# Household problem: Default

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

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  $\xi$
- Household must rent for a period

▶ Return

# Mortgage pricing

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

$$\begin{aligned} qm(x_{j+1}, z_j; \Omega) &= \frac{1}{(1+rm)m_{j+1}} \cdot \mathbb{E}_{z_j, \Omega} \left\{ [g_{j+1}^n + g_{j+1}^f] (1+rm)m_{j+1} \right. \\ &\quad \left. + g_{j+1}^d \min \left\langle (1 - \delta_h^d) p_h(\Omega') h_{j+1}, (1+rm)m_{j+1} \right\rangle \right. \\ &\quad \left. + [1 - g_{j+1}^n - g_{j+1}^f - g_{j+1}^d] \left[ \pi m(x_{j+2}, z_{j+1}; \Omega') + qm(x_{j+2}, z_{j+1}; \Omega') m_{j+2} \right] \right\} \end{aligned}$$

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



# Rental company

- Rental company owns housing units and rents them out to hh
- It can buy/sell units frictionlessly on the housing market

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

- Optimization implies the equilibrium **rental rate**:

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

▶ Return