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

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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

1. What shock(s) drove the boom-bust in $p_h$?
   - Expectations about future growth in $p_h$
   - Credit conditions important for homeownership, leverage and foreclosure

Kaplan, Moll and Violante (2017)
Three questions

1. What shock(s) drove the boom-bust in $p_h$?

   • Expectations about future growth in $p_h$
   • Credit conditions important for homeownership, leverage and foreclosure

2. How does the fall in $p_H$ transmit to $C$?

   • Mostly a wealth effect, not collateral effect

Kaplan, Moll and Violante (2017)
Three questions

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   - Expectations about future growth in $p_h$
   - Credit conditions important for homeownership, leverage and foreclosure

2. How does the fall in $p_H$ transmit to $C$?
   - Mostly a wealth effect, not collateral effect

3. Could a debt-forgiveness policy have cushioned the bust?
   - Big effect on foreclosures
   - Negligible effect on $p_h$ and $C$
Methodology

• Model: aggregate shocks move equilibrium $p_h$

Kaplan, Moll and Violante (2017)
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• Parameterize: match cross-sectional and lifecycle micro data

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- Parameterize: match cross-sectional and lifecycle micro data
- Simulate boom-bust
- Compare with aggregate time-series data
  - House prices
  - Consumption
  - Rent-price ratio
  - Home ownership
  - Leverage
  - Foreclosures
  - Compare against micro data
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- Compare against micro data
- 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

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Financial instruments

Liquid saving \((b > 0)\): one-period bond, exogenous interest rate \(r_b\) (fixed)
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Mortgages \((m)\): long-term, fixed-rate debt contract

- Price schedule \(q_j(h, m, b, y)\) set by competitive banking sector
- Amortized over remaining lifetime at rate \(r_b (1 + \iota)\)
- Refinancing option available (cash-out) at cost \(\kappa_m\)
- Max Loan-to-Value at origination only \(m \leq \lambda^m p_h h\)
- Max Payment-to-Income at origination only \(\pi \leq \lambda^\pi y\)

Kaplan, Moll and Violante (2017)
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Foreclosure

- Default on mortgage debt: incur a utility loss
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Foreclosure

- Default on mortgage debt: incur a utility loss

HELOCs \((b < 0)\)

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

Final good sector

• \( Y = \bar{Z} \bar{N} \rightarrow w = Z \)

Construction sector

• Labor + housing permits → aggregate housing investments \( I(p_h) \)

Rental sector

• Brobury 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

1. Aggregate labor income: $Z$

2. Credit conditions: (i) credit limits ($\lambda^m, \lambda^b, \lambda^\pi$) 
   (ii) intermediation wedge $\iota$

Kaplan, Moll and Violante (2017)
Aggregate shocks

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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)

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Shock Processes

1. **Aggr. labor income**: NIPA wages & salaries per capita

2. **Credit conditions**: $\lambda_m$: 95% → 110%, $\lambda_b$: 20% → 30%
   $\lambda_\pi$: 25% → 60%, $\iota^m$: 100 BP → 75 BP

3. **Beliefs**: Case-Shiller-Thompson & Burnside-Eichenbaum-Rebelo
Shock Processes

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   \( \lambda_\pi: 25\% \rightarrow 60\%, \lambda^m: 100 \text{ BP} \rightarrow 75 \text{ BP} \)

3. **Beliefs**: Case-Shiller-Thompson & Burnside-Eichenbaum-Rebelo

   - The shift in beliefs hits in 2001 and reverts back in 2007
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Consumption and house price dynamics

House Price

Year | 2000 | 2005 | 2010 | 2015
---|---|---|---|---
Data | 0.95 | 1.05 | 1.1 | 1.1
Model | 0.9 | 1 | 1.05 | 1.1

Consumption

Year | 2000 | 2005 | 2010 | 2015
---|---|---|---|---
Data | 0.8 | 0.9 | 1 | 1
Model | 0.9 | 1 | 1.05 | 1

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Consumption and house price dynamics

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Consumption and house price dynamics

**House Price**

- Benchmark
- Belief Only
- Income Only
- Credit Only

**Consumption**

- Benchmark
- Belief Only
- Income Only
- Credit Only

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Beliefs vs actual change in preferences

House Price

Year
0.8
0.9
1
1.1
1.2
1.3

Consumption

Year
0.9
0.95
1
1.05
1.1

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

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Dynamics of rent-price ratio

Kaplan, Moll and Violante (2017)
Dynamics of rent-price ratio

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

- 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

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Dynamics of leverage and foreclosure

**Leverage**

**Foreclosure rate**

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Dynamics of leverage and foreclosure

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

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Why credit shock does not affect $\rho_h$

- 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 $\rho_h$

- 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

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Cheaper credit for ‘low-quality’ borrowers

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

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Deleveraging or wealth effect in the bust?

Deleveraging: WEAK

Wealth effect: STRONG

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Counterfactual principal reduction program

All homeowners with LTV >95%: forgive excess debt
Counterfactual principal reduction program

All homeowners with LTV >95%: forgive excess debt

- Beneficiaries account for small share of $C$

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Credit growth

- Mian-Sufi: credit growth concentrated in low-income groups
- Foote et al.: no, equally distributed across income groups
Credit growth

• Mian-Sufi: credit growth concentrated in low-income groups

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

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

- **Mian-Sufi**: mortgage origin. concentrated in subprime groups

- **Adelino et al.**: no, equally distributed across groups
Moregtridge origination

- **Mian-Sufi**: mortgage origin. concentrated in subprime groups
- **Adelino et al.**: no, equally distributed across groups

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

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**Share of Debt Above Median Below Median Default Risk Shares of Originated Mortgage Debt**

<table>
<thead>
<tr>
<th>Year</th>
<th>Above Median</th>
<th>Below Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td>2004</td>
<td>18</td>
<td>30</td>
</tr>
<tr>
<td>2005</td>
<td>17</td>
<td>30</td>
</tr>
<tr>
<td>2006</td>
<td>18</td>
<td>29</td>
</tr>
</tbody>
</table>

**Shares of Originated Mortgage Debt**

- **2001**: Above Median, Below Median
- **2007**: Above Median, Below Median
Foreclosures

- Mian-Sufi: foreclosures concentrated in subprime groups

- Albanesi et al.: no, proportionally rising more for other groups

![Graph showing share of foreclosures by income quintiles over years 2004 to 2012.](image)
Foreclosures

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

- 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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Beliefs vs actual change in preferences

- Preference shock: similar rise in $p_h$, but $C$ falls!
Change in home ownership by age

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

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Shock to Interest Rate

House Price

ND Consumption

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Consumption response by age during Bust

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

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Parameterization strategy

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

- Distributional stats: mortgages, renters, and consumption

<table>
<thead>
<tr>
<th>Moment</th>
<th>Empirical value</th>
<th>Model Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fraction homeowners w/ mortgage</td>
<td>0.66</td>
<td>0.57</td>
</tr>
<tr>
<td>Aggr. mortgage debt / housing value</td>
<td>0.42</td>
<td>0.36</td>
</tr>
<tr>
<td>P10 LTV ratio for mortgagors</td>
<td>0.15</td>
<td>0.28</td>
</tr>
<tr>
<td>P90 LTV ratio for mortgagors</td>
<td>0.92</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td>0.66</td>
<td>0.65</td>
</tr>
<tr>
<td></td>
<td>0.11</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>0.95</td>
<td>0.98</td>
</tr>
<tr>
<td>Avg.-size owned house / rented</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Avg. earnings owners / renters</td>
<td>2.05</td>
<td>2.02</td>
</tr>
<tr>
<td>BPP consumption insurance coef</td>
<td>0.36</td>
<td>0.43</td>
</tr>
</tbody>
</table>
Solution and simulation

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

\[ \log p_h' = a_0(Z, Z') + a_1(Z, Z') \log p_h \]

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

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

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

• Those who choose to rent solve:

\[
V^r(b_j, z_j; \Omega) = \max_{c_j, h_j, b_{j+1}} u_j(c_j, s_j) + \beta \mathbb{E}_{z_j, \Omega} [V^n(b_{j+1}, z_{j+1}; \Omega')] \\
\text{s.t.} \\
c_j + \rho(\Omega) h_j + q_b b_{j+1} \leq b_j + y_j - \mathcal{T}(y_j, 0) \\
b_{j+1} \geq 0 \\
s_j = h_j \in \tilde{\mathcal{H}} \\
z_{j+1} = \gamma(z_j) \quad \Omega' = \Gamma(\Omega)
\]
Household problem: Buyer

- Those who choose to buy and become owners solve:

\[
V^o(b_j, z_j; \Omega) = \max_{c_j, b_{j+1}, h_{j+1}, m_{j+1}} \ u_j(c_j, s_j) + \beta \mathbb{E}_{z_j, \Omega} [V^h(x_{j+1}, z_{j+1}; \Omega')] \\
\text{s.t.} \\
c_j + q_b b_{j+1} + p_h(\Omega) h_{j+1} + \kappa_m \leq b_j + y_j - T(y_j, 0) + q_m(x_{j+1}, z_j; \Omega) m_{j+1} \\
m_{j+1} \leq \lambda^m p_h(\Omega) h_{j+1} \\
b_{j+1} \geq 0 \\
h_{j+1} \in \mathcal{H}, \quad s_j = \omega h_{j+1} \\
z_{j+1} = \gamma(z_j), \quad \Omega' = \Gamma(\Omega) \\
\text{where } x_{j+1} := (b_{j+1}, h_{j+1}, m_{j+1})
\]
Household problem: Homeowner

\[ V^h(x_j, z_j; \Omega) = \max \begin{cases} 
\text{Pay:} & V^p(x_j, z_j; \Omega) \\
\text{Refinance:} & V^f(x_j, z_j; \Omega) \\
\text{Sell:} & V^n(\tilde{b}_j, z_j; \Omega) \\
\text{Default:} & V^d(b_j, z_j; \Omega) \end{cases} \]

where \( x_j := (b_j, h_j, m_j) \)

• 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:

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

\[
s.t.
\]
\[
c_j + q_b(b) b_{j+1} + (\delta_h + \tau_h) p_h(\Omega) h_j + \pi_m \leq b_j + y_j - T(y_j, m_j)
\]
\[
\pi_m \geq \pi_m^*
\]
\[
m_{j+1} = (1 + r_m) m_j - \pi_m
\]
\[
b_{j+1} \geq -\lambda^b p_h(\Omega) h_{j+1}
\]
\[
s_j = \omega h_j, \quad h_{j+1} = h_j
\]
\[
z_{j+1} = \gamma(z_j), \quad \Omega' = \Gamma(\Omega)
\]

where \(x_j := (b_j, h_j, m_j)\)

Note: Collateral effect for owners only through HELOCs
Household problem: Default

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

s.t.
\[ c_j + \rho(\Omega) h_j + q_b b_{j+1} \leq b_j + y_j - \mathcal{T}(y_j, 0) \]
\[ b_{j+1} \geq 0 \]
\[ s_j = h_j \]
\[ z_{j+1} = \gamma(z_j), \quad \Omega' = \Gamma(\Omega) \]

- Disutility of default $\xi$
- Household must rent for a period
Mortgage pricing

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

$$qm(x_{j+1}, z_{j+1}; \Omega) = \frac{1}{(1 + rm) m_{j+1}} \cdot \mathbb{E}_{z_j, \Omega} \left\{ [g^n_{j+1} + g^f_{j+1}] (1 + rm) m_{j+1} ight.$$ 

$$+ g^d_{j+1} \min \left\{ (1 - \delta^d_h) \rho_h(\Omega') h_{j+1}, (1 + rm) m_{j+1} \right\}$$

$$+ [1 - g^n_{j+1} - g^f_{j+1} - g^d_{j+1}] \left[ \pi m(x_{j+2}, z_{j+2}; \Omega') + qm(x_{j+2}, z_{j+2}; \Omega') m_{j+2} \right] \}$$

- $g^n$ : 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:

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