Mortgage Market Institutions and Housing Market Outcomes

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Introduction

- General framework for studying interactions between housing and mortgage markets

- Focal points of model:
  - Institutional features of mortgage market, including long-term mortgage contracts
  - Equilibrium relationship between housing demand and mortgage credit availability
Model Overview

- Housing demand
  - Demand generated by incoming buyers
  - Buyers have limited wealth
  - Whether to buy a home / type of home affected by mortgage availability

- Housing supply
  - Supply comes from existing owners who move
  - Movers can either sell house or default
  - In either case, a unit of supply is added to housing market

- House prices adjust so that housing market clears
Lenders
- Risk neutral and competitive lenders
- Mortgage interest rate set so that expected return = opportunity cost of funds
- Because of default risk, interest rate depends on house price expectations and leverage ratio

Equilibrium when all contracts earn zero net return over opportunity cost
Results Overview

- Model calibrated to data from Los Angeles, 2003 - 2010
  - Many salient features of the data are captured

- Counterfactuals studied:
  - Impact of disappearing market for non-agency mortgages
  - Effectiveness of government responses
  - Introducing shared appreciation mortgages

- General equilibrium effects are shown to be important
Related Literature

- **Models of the housing and mortgage markets**
  - Ortalo-Magne and Rady (2006); Campbell and Cocco (2014); Favilukis et al. (2015); Landvoigt et al. (2015); Corbae and Quintin (2015); Guren and McQuade (2015)

- **Empirical literature on interactions between housing and mortgages**
  - Himmelberg et al. (2005); Glaeser et al. (2010); Ferreira and Gyourko (2011); Mian and Sufi (2009); Favara and Imbs (2015); Adelino et al. (2014); Kung (2015); Hurst et al. (2015)

- **Mortgage design**
  - Caplin et al. (2007); Shiller (2008); Piskorski and Tchistyi (2010); Mian and Sufi (2014)

- **Collateral equilibrium**
  - Kiyotaki and Moore (1997); Geanakoplos (1996); Geanakoplos and Zame (2014)
Model (Preliminaries)

- Discrete time
- Housing market with two types of housing $h = 0, 1$ (vertical quality)
- Fixed stock $\mu$ of each type
- Price in state $s_t$: $p_h(s_t)$
Model (Mortgages)

- $M$ mortgage types, including $m = 0$ (no mortgage)

- Mortgage characterized by $z_t = (age_t, rate_t, balance_t)$

- Type determines how $z_t$ evolves over time and translates to payments; also determines how much the lender can recover in a default

- Interest rate on new mortgage origination of type $m$ collateralized by house type $h$:
  \[ r^m_h (b, x_{it}, s_t) \]
Model (Homeowners)

- Owns / occupies one housing unit

- Lives in housing unit until moving shock; $\lambda$ probability each period

- Moving is terminal state; movers do not re-enter housing market

- Homeowners care about:
  - Flow consumption of a numeraire good: $u(\theta^h c_t)$
  - Final wealth at the time of a move: $\beta u(w_T)$

- Homeowners have constant income; can save at risk-free rate $rfr_t$ but cannot borrow (except through mortgages)
Homeowner decision problem

... Last period

- Enters Period
  - \(\lambda\)
  - \(1 - \lambda\)

- Doesn’t Move
  - No refinance
  - Refinance

- Moves
  - Sell
    - \(w_T = y_i + w_{it} + p_h(s_t) - b_{it}\)
  - Default
    - \(w_T = y_i + w_{it} - c_D\)

Next period...

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Homeowner Bellman equation

- Homeowner that stays solves:

\[
V_{it}^{\text{stay}} = \max u(\theta^h c) + \delta E \left[ (1 - \lambda) V_{it+1}^{\text{stay}} + \lambda V_{it+1}^{\text{move}} \right]
\]

subject to:

\[
c + \frac{1}{1 + rfr_t} w' = \begin{cases} 
  y_i + w_{it} - \text{pay}_{it} & \text{if no refinance} \\
  y_i + w_{it} - b_{it} + b - \text{pay}_{it}' - c_R & \text{if refinance}
\end{cases}
\]
Potential buyers

- Buyers are heterogeneous on income $y_i$, initial wealth $w_i$, and *outside option* $v_i$

- Present value to buying house type $h$:

$$V_{h \text{buy}} (y_i, w_i, s_t) = \max u (\theta^h c) + \delta E [(1 - \lambda) V_{it+1}^{\text{stay}} + \lambda V_{it+1}^{\text{move}}]$$

subject to:

$$c + \frac{1}{1 + rfr_t} w' = y_i + w_i - p_h (s_t) + b - pay_{it}'$$

- Buy house type $h$ if:

$$V_{h \text{buy}} = \max \left\{ V_{0 \text{buy}}, V_{1 \text{buy}}, v_i \right\}$$
Housing demand

- Housing demand is the integral of individual buyers demands:

\[ D_h(s_t) = \int_y \int_w \int_v d_h(y, w, v; s_t) \Gamma(y, w, v; s_t) \, dy \, dw \, dv \]

- Housing market clearing condition:

\[ D_h(s_t) = \lambda \mu \text{ for } h = 0, 1 \]
Lenders correctly anticipate homeowners’ default and refinance rules

\[
\begin{align*}
\Pi_{it}^{move} &= \tau_{it} \psi_{it}^{m} (z_{it}, s_{t}) + (1 - \tau_{it}) b_{it} \\
\Pi_{it}^{stay} &= \rho_{it} b_{it} + (1 - \rho_{it}) \Pi_{it}^{norefi} \\
\Pi_{it}^{norefi} &= \text{pay}_{it} + \left( \frac{1}{1 + rfr_{t} + a_{m}} \right) E \left[ \lambda \Pi_{it+1}^{move} + (1 - \lambda) \Pi_{it+1}^{stay} \right]
\end{align*}
\]

- \( a_{m} \) is the opportunity cost of funds
  - Can differ by mortgage type to reflect higher liquidity in agency market
  - May be higher than \( rfr_{t} \) to reflect better investment opportunities available to lenders than borrowers

Mortgage market clearing condition:

\[
\Pi_{it}^{norefi} \big|_{aget=0} - b = 0
\]
Equilibrium

- Equilibrium solved via fixed point iteration on three nests

- Equilibrium objects to solve for:
  - $p_h(s_t)$ the price of housing in each state (outer nest)
  - $r^m_h(b, x_{it}, s_t)$ the mortgage interest rate menu (middle nest)
  - $V^{\text{stay}}, \Pi^{\text{stay}}$ (inner nest)
Two mortgage types: agency and non-agency:

<table>
<thead>
<tr>
<th>Agency</th>
<th>Non-Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lender recovers full loan amount on default</td>
<td>Lender recovers $\phi$ of collateral value on default</td>
</tr>
<tr>
<td>Cost of funds $a_1$</td>
<td>Cost of funds $a_2$</td>
</tr>
<tr>
<td>Cannot exceed 80% of collateral value</td>
<td>Cannot exceed 100% of collateral value</td>
</tr>
<tr>
<td>Payment cannot exceed 50% of income</td>
<td>Payment cannot exceed 50% of income</td>
</tr>
<tr>
<td>Cannot exceed $cll_t$</td>
<td>Unavailable if $mps_t = 0$</td>
</tr>
</tbody>
</table>

Contracts are 30-year fixed-rate mortgages
Other Implementation Notes

- Aggregate state variables:
  - risk-free rate
  - conforming loan limit
  - availability of non-agency mortgages
  - unobserved demand shock
  - expected growth or decline of demand shock

- Ruthless default and no refinancing

- No savings
Choose parameters to simultaneously fit moments in the data

- Ownership durations identify $\lambda$
- Price paths identify $\tilde{\nu}_t$ and $\theta$
- Mortgage interest rates identify $a$ and $\varphi$
- Average LTVs identify parameters governing wealth distribution and $\beta$
- Growth of demand shocks identified by requiring consistency between guessed and implied parameters
Figure: Model Fit: House Prices

- Low-Valued House Price (Simulated)
- High-Valued House Price (Simulated)
- Low-Valued House Price (Data)
- High-Valued House Price (Data)
### Table: Model Fit: LTVs of Home Buyers

<table>
<thead>
<tr>
<th>Year</th>
<th>Low-Valued (Real Data)</th>
<th>High-Valued (Real Data)</th>
<th>Low-Valued (Simulated Data)</th>
<th>High-Valued (Simulated Data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>0.844</td>
<td>0.756</td>
<td>0.882</td>
<td>0.794</td>
</tr>
<tr>
<td>2004</td>
<td>0.849</td>
<td>0.760</td>
<td>0.884</td>
<td>0.816</td>
</tr>
<tr>
<td>2005</td>
<td>0.857</td>
<td>0.760</td>
<td>0.867</td>
<td>0.873</td>
</tr>
<tr>
<td>2006</td>
<td>0.884</td>
<td>0.779</td>
<td>0.820</td>
<td>0.837</td>
</tr>
<tr>
<td>2007</td>
<td>0.842</td>
<td>0.723</td>
<td>0.795</td>
<td>0.806</td>
</tr>
<tr>
<td>2008</td>
<td>0.755</td>
<td>0.617</td>
<td>0.726</td>
<td>0.661</td>
</tr>
<tr>
<td>2009</td>
<td>0.725</td>
<td>0.608</td>
<td>0.698</td>
<td>0.629</td>
</tr>
<tr>
<td>2010</td>
<td>0.723</td>
<td>0.598</td>
<td>0.698</td>
<td>0.629</td>
</tr>
</tbody>
</table>
Figure: Model Fit: Cumulative Default Rates

2004 Cohort

2005 Cohort

2006 Cohort

2007 Cohort
Figure: Buyer Value Functions in 2007 (Baseline)

Low Income Buyers

High Income Buyers

Low-valued housing

High-valued housing
Figure: Housing Demand Profile in 2007 (Baseline)
Figure: Buyer Value Functions in 2008 (Baseline)

Low Income Buyers

High Income Buyers
Figure: Housing Demand Profile in 2008 (Baseline)

Low Income Buyers

High Income Buyers

Initial Wealth

Outside Option

Lowvalued housing

Highvalued housing

Lowvalued housing

Highvalued housing
Figure: Mortgage Demand Profile in 2007 (Baseline)

Low-Income Buyers

High-Income Buyers

Initial Wealth

Outside Option
Figure: Mortgage Demand Profile in 2008 (Baseline)
In the baseline, non-agency loans disappear in 2008

Low wealth buyers are priced out of the housing market

What if non-agency loans were made available in 2008?
Figure: House Prices of Non-Agency Available 2008+
Figure: Housing Demand Profile in 2008 (Counterfactual)

Low Income Buyers

High Income Buyers
Figure: Mortgage Demand Profile in 2008 (Counterfactual)

Low-Income Buyers

- No mtg
- Agency
- Non-Agency

High-Income Buyers

- Agency
- Non-Agency
Figure: Mortgage Rates in 2008 (Counterfactual)

Low-Valued Housing

- Non-Agency
- Agency

High-Valued Housing

- Non-Agency
- Agency
Figure: Mortgage Rates in 2008 (Baseline)

Low-Valued Housing

High-Valued Housing

Rate

LTV

Non-Agency

Agency

Non-Agency

Agency
Figure: Sensitivity of Prices to Demand Shocks

Low-Valued Housing

High-Valued Housing

Price

v0

Non-Agency Available
Non-Agency Unavailable
Figure: Effectiveness of Government Response

- Low-Valued House Price (Counterfactual)
- High-Valued House Price (Counterfactual)
- Low-Valued House Price (Baseline)
- High-Valued House Price (Baseline)
Takeaways

▶ Availability of non-agency financing is an important driver of housing demand and house prices

▶ High leverage loans can *reduce* house-price volatility
  ▶ Allows more households with inelastic housing demand to afford homes

▶ Government policy was effective in manipulating house prices
Introducing Shared Appreciation Mortgages

- Introduce two types of shared-appreciation mortgages from 2003 to 2007 as a non-agency option
  - FSAM: indexed to house prices on both up and downside
  - PSAM: indexed to house prices on only downside

- Payments and balances go up or down proportionally with house prices

- Homeowners are never underwater
Figure: Mortgage Demand Profile in 2005 (PSAMs Available)

Low-Income Buyers

High-Income Buyers
Figure: Interest Rates in 2005 (PSAMs Available)

Low-Valued Housing

- SAM
- Non-Agency
- Agency

High-Valued Housing

- SAM
- Non-Agency
- Agency
Figure: Mortgage Demand Profile in 2007 (PSAMs Available)
Figure: Interest Rates in 2005 (PSAMs Available)
Figure: Cumulative Default Rates (PSAMs Available)

2004 Cohort

2005 Cohort

2006 Cohort

2007 Cohort
Figure: House Prices if FSAMs Available 2003-2007

- Low-Valued House Price (Counterfactual)
- High-Valued House Price (Counterfactual)
- Low-Valued House Price (Baseline)
- High-Valued House Price (Baseline)
Figure: Mortgage Demand Profile in 2005 (FSAMs Available)

Low-Income Buyers

High-Income Buyers

- No mtg
- Agency
- SAM

Outside Option vs Initial Wealth for Low-Income Buyers.

Outside Option vs Initial Wealth for High-Income Buyers.
Figure: Interest Rates in 2005 (FSAMs Available)

Low-Valued Housing

High-Valued Housing
Figure: Cumulative Default Rates (FSAMs Available)
Takeaways

- SAMs can be welfare-enhancing
- Uptake can be positive even if they don’t receive the liquidity benefits of the GSEs
- Uptake depends on expectations on house-price growth, contract design
- Defaults can go up if not everyone chooses a SAM
Figure: Agency and Non-Agency MBS Issuance (USD Billions)
Age profile of house value—2005 homeowners

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Evidence on within-market movers

\[
\log \text{house\_value}_i = \beta_0 + \beta_1 \text{moved\_from\_within}_i + \beta_2 \text{moved\_from\_outside}_i + X_i \beta_3 + \epsilon_i
\]

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All ages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moved from within</td>
<td>0.0047*</td>
<td>0.0458***</td>
<td>-0.0488***</td>
</tr>
<tr>
<td></td>
<td>(0.0026)</td>
<td>(0.0032)</td>
<td>(0.0041)</td>
</tr>
<tr>
<td>Moved from outside</td>
<td>0.0105***</td>
<td>0.0561***</td>
<td>-0.0379***</td>
</tr>
<tr>
<td></td>
<td>(0.0027)</td>
<td>(0.0034)</td>
<td>(0.0041)</td>
</tr>
<tr>
<td>(N)</td>
<td>2,439,293</td>
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<thead>
<tr>
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<th>Age(&lt;45)</th>
<th>Age(\geq45)</th>
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<td>Moved from within</td>
<td>0.0047*</td>
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