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

Model Overview

- 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 Figure
  - 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 μ of each type
- Price in state s_t: $p_h(s_t)$

Model (Mortgages)

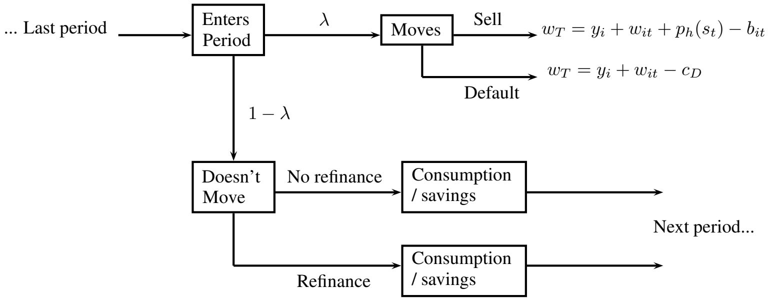
- M mortgage types, including $m = 0$ (no mortgage)
- Mortgage characterized by $z_t = (age_t, rate_t, balance_t)$
- Type determines how z_t evolves over time and translates to payments; also determines how much the lender can recover in a default
- Interest rate on new mortgage origination of type m collateralized by house type h:

$$r_h^m (b, x_{it}, s_t)$$

Model (Homeowners)

- Owns / occupies one housing unit
- Lives in housing unit until moving shock; λ probability each period
- Moving is terminal state; movers do not re-enter housing market Discussion
- Homeowners care about:
  - Flow consumption of a numeraire good: $u\left(\theta^h c_t\right)$
  - Final wealth at the time of a move: $\beta u\left(w_T\right)$
- Homeowners have constant income; can save at risk-free rate rfr_t but cannot borrow (except through mortgages)

Homeowner decision problem



Homeowner Bellman equation

- Homeowner that stays solves:

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

subject to:

$$c + \frac{1}{1+rfr_t} w' = \begin{cases} y_i + w_{it} - pay_{it} & \text{if no refinance} \\ y_i + w_{it} - b_{it} + b - pay_{it}' - c_R & \text{if refinance} \end{cases}$$

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:

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

  subject to:

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

- Buy house type h if:

$$V_h^{buy} = \max\left\{V_0^{buy}, V_1^{buy}, v_i\right\}$$

Housing demand

- Housing demand is the integral of individual buyers demands:

$$D_h(s_t) = \int_y \int_w \int_v d_h(y, w, v; s_t)\, \Gamma(y, w, v; s_t)\, dydwdv$$

- Housing market clearing condition:

$$D_h(s_t) = \lambda\mu \text{ for } h = 0, 1$$

Lenders

- Lenders correctly anticipate homeowners' default and refinance rules

$$\begin{aligned} \Pi_{it}^{move} &= \tau_{it}\psi_h^m(z_{it}, s_t) + (1-\tau_{it})\, b_{it} \\ \Pi_{it}^{stay} &= \rho_{it} b_{it} + (1-\rho_{it})\, \Pi_{it}^{norefi} \\ \Pi_{it}^{norefi} &= pay_{it} + \left(\frac{1}{1+rfr_t+a_m}\right) E\left[\lambda \Pi_{it+1}^{move} + (1-\lambda)\, \Pi_{it+1}^{stay}\right] \end{aligned}$$

- 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:

$$\Pi_{it}^{norefi}\big|_{age_t=0} - b = 0$$

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)
  - $r_h^m(b, x_{it}, s_t)$ the mortgage interest rate menu (middle nest)
  - V^{stay}, Π^{stay} (inner nest)

Implementation (Mortgage Types)

- Two mortgage types: agency and non-agency:

Table: Differences in agency and non-agency

Agency	**Non-Agency**
Lender recovers full loan amount on default	Lender recovers ϕ of collateral value on default
Cost of funds a_1	Cost of funds a_2
Cannot exceed 80% of collateral value	Cannot exceed 100% of collateral value
Payment cannot exceed 50% of income	Payment cannot exceed 50% of income
Cannot exceed cll_t	Unavailable if $mps_t = 0$

- 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

Calibration Notes

- Choose parameters to simultaneously fit moments in the data
  - Ownership durations identify λ
  - Price paths identify $\bar{v}_t$ and θ
  - Mortgage interest rates identify a and φ
  - Average LTVs identify parameters governing wealth distribution and β
  - Growth of demand shocks identified by requiring consistency between guessed and implied parameters

Figure: Model Fit: House Prices

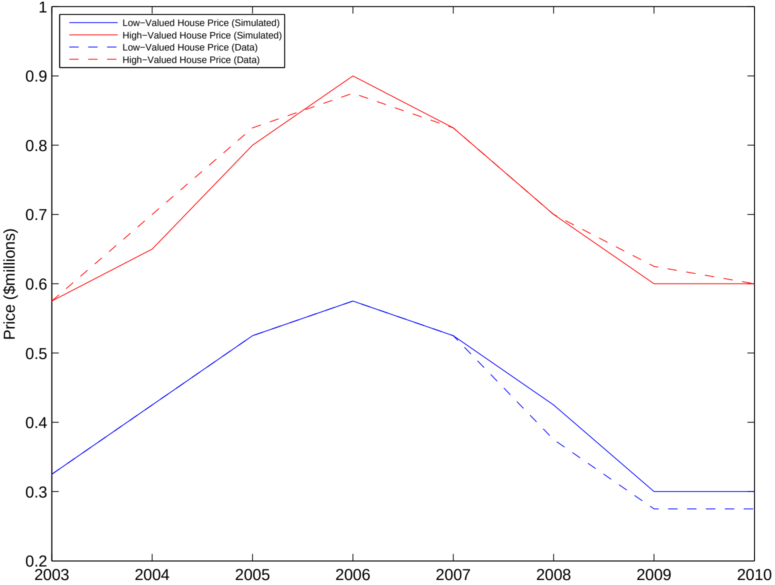


Table: Model Fit: LTVs of Home Buyers

	Real Data		Simulated Data	
Year	Low-Valued	High-Valued	Low-Valued	High-Valued
2003	0.844	0.756	0.882	0.794
2004	0.849	0.760	0.884	0.816
2005	0.857	0.760	0.867	0.873
2006	0.884	0.779	0.820	0.837
2007	0.842	0.723	0.795	0.806
2008	0.755	0.617	0.726	0.661
2009	0.725	0.608	0.698	0.629
2010	0.723	0.598	0.698	0.629

Figure: Model Fit: Cumulative Default Rates

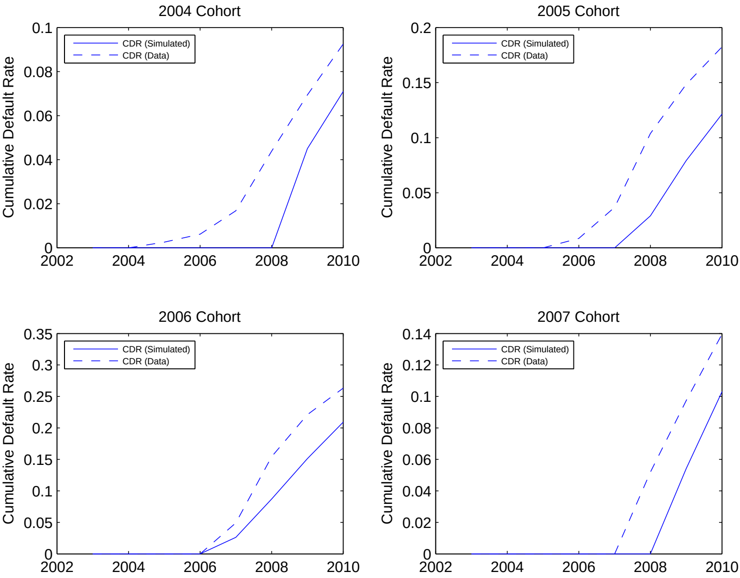


Figure: Buyer Value Functions in 2007 (Baseline)

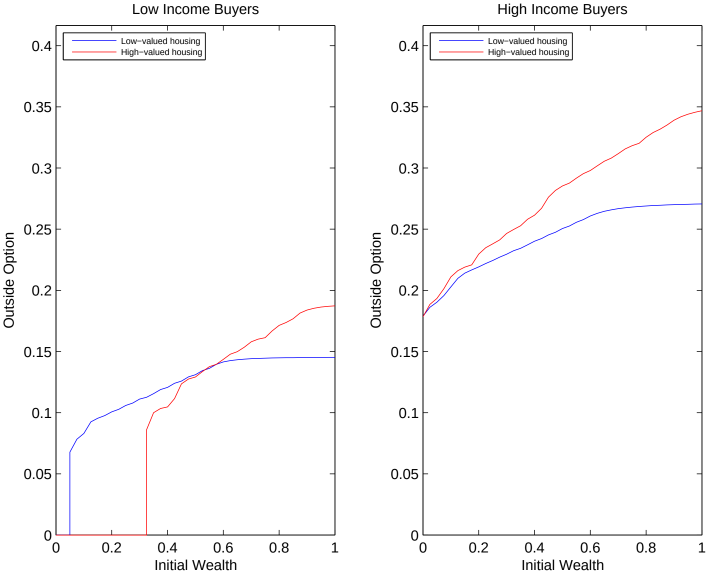
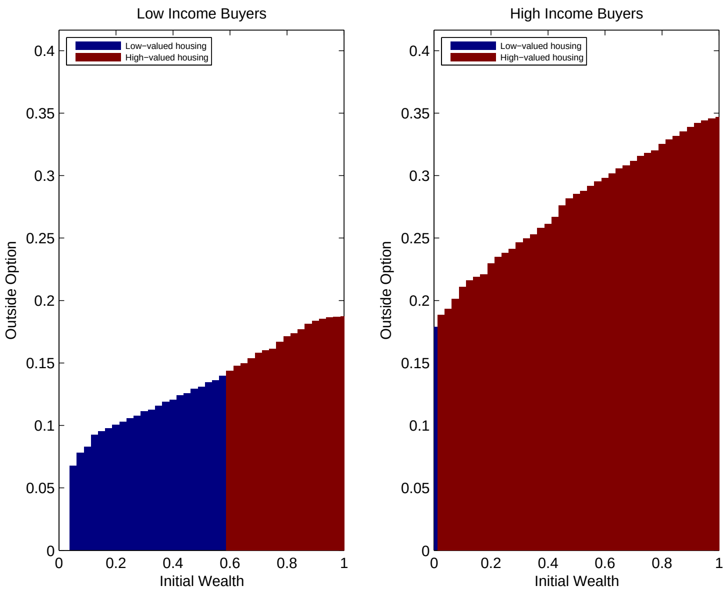


Figure: Housing Demand Profile in 2007 (Baseline)



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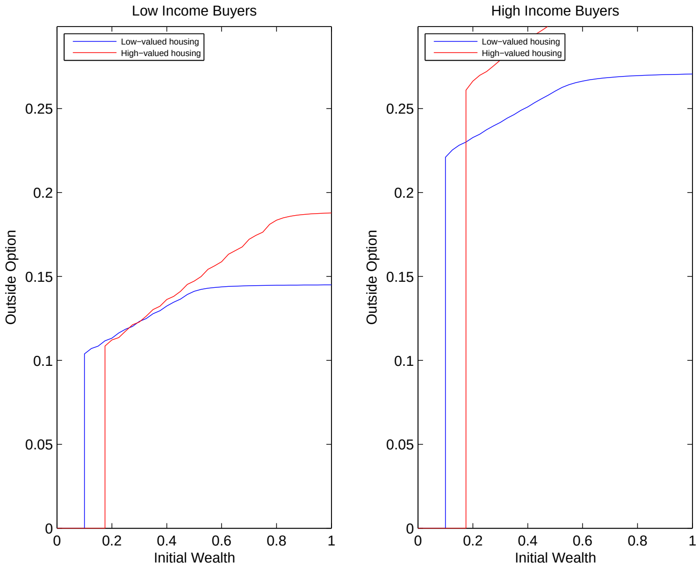

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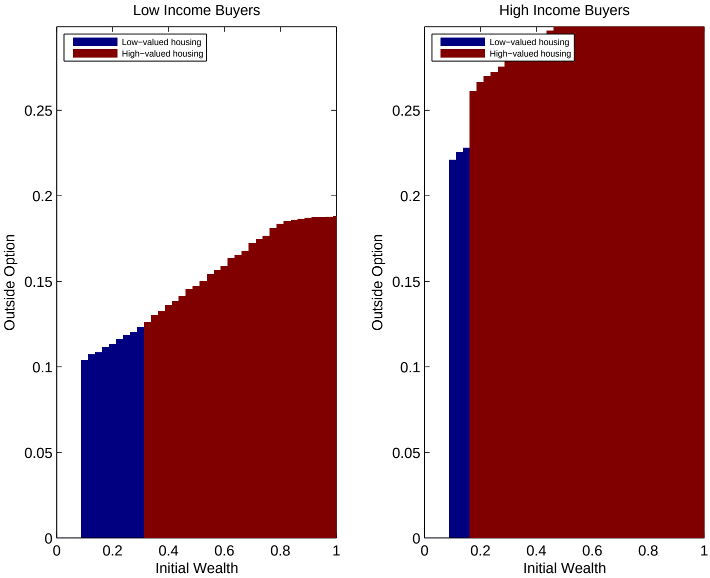

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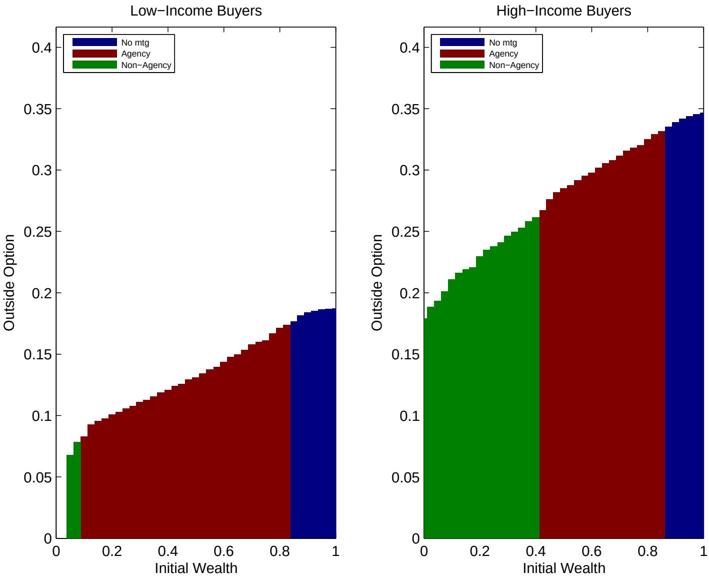

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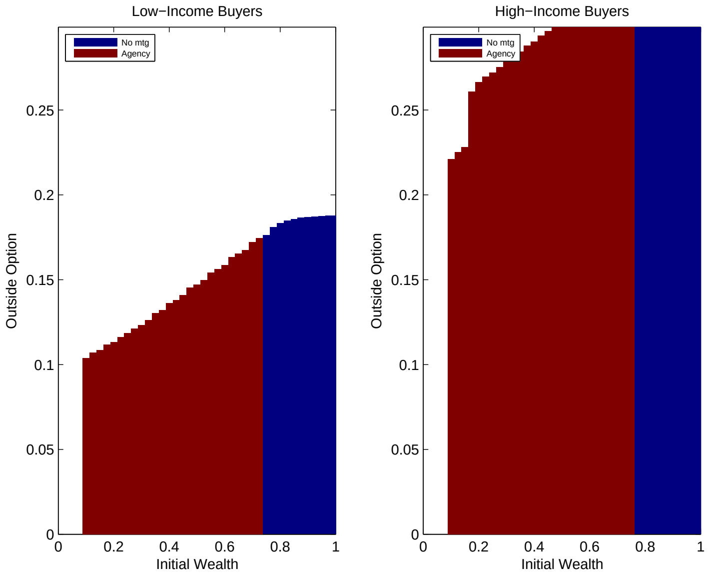


The Impact of Non-Agency Availability

- 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+

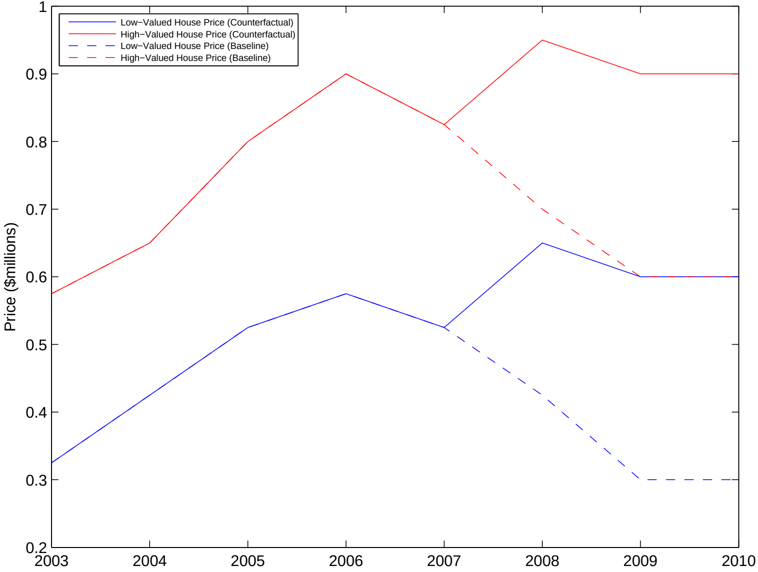


Figure: Housing Demand Profile in 2008 (Counterfactual)

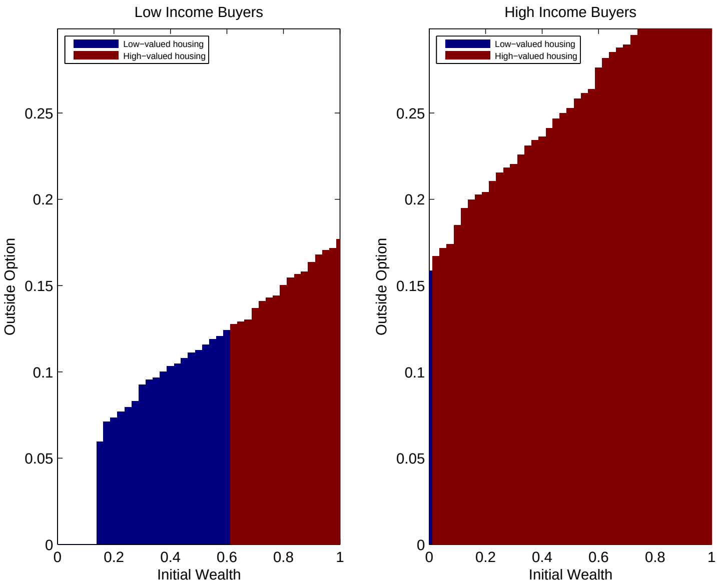


Figure: Mortgage Demand Profile in 2008 (Counterfactual)

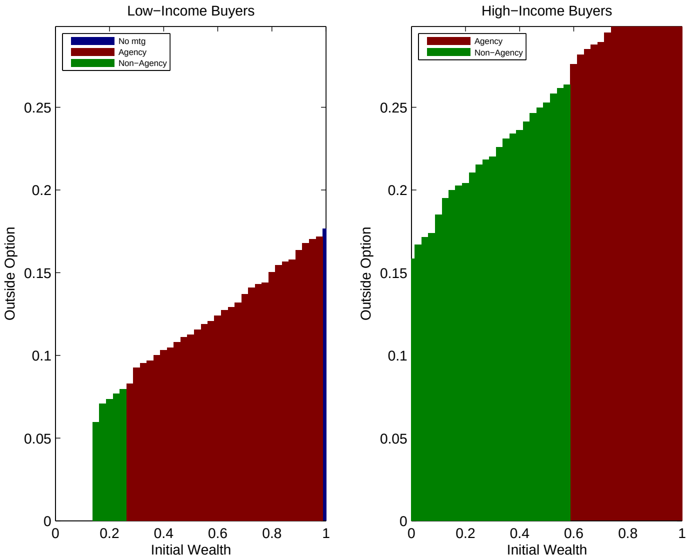


Figure: Mortgage Rates in 2008 (Counterfactual)

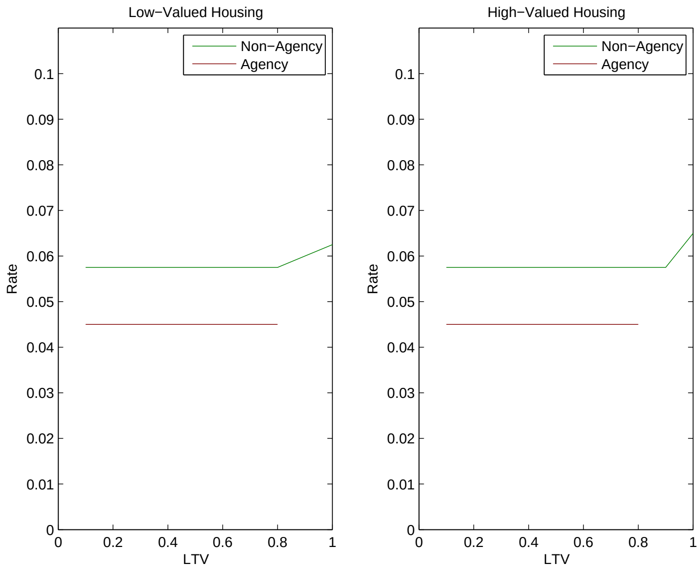


Figure: Mortgage Rates in 2008 (Baseline)

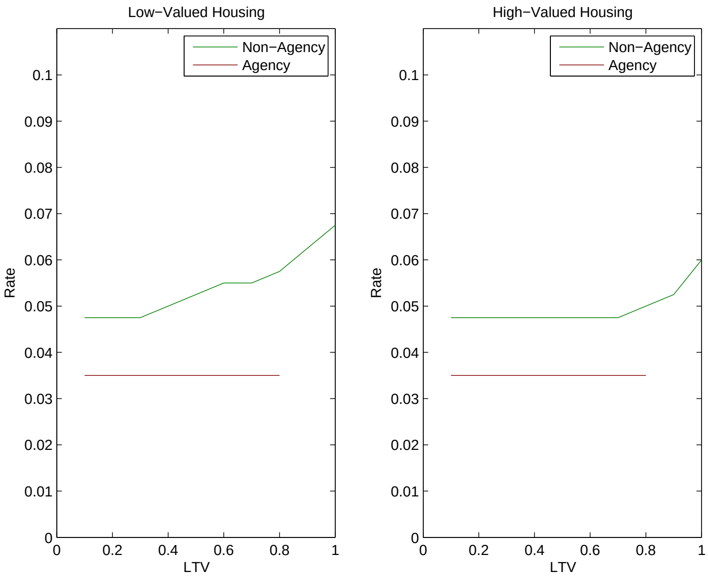


Figure: Sensitivity of Prices to Demand Shocks

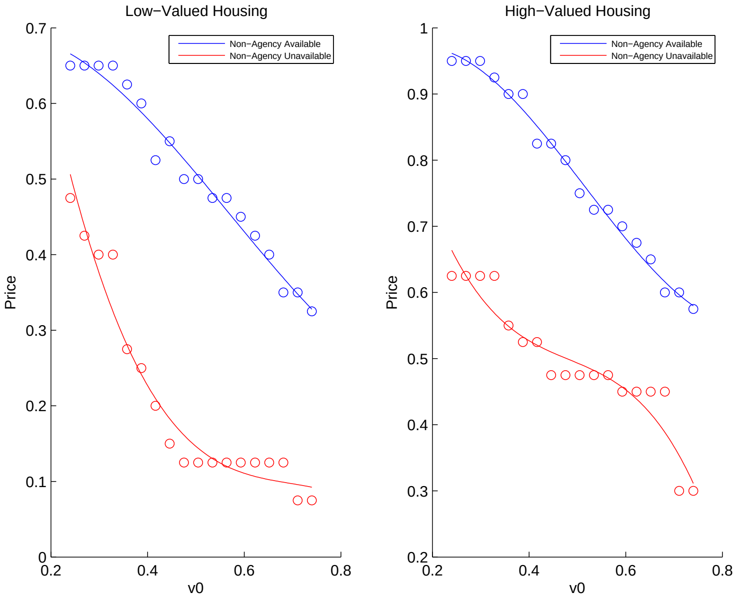
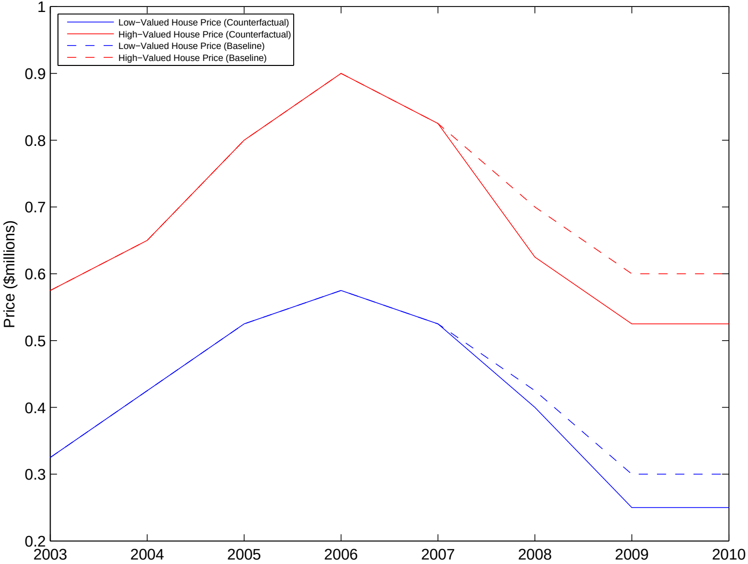


Figure: Effectiveness of Government Response



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: House Prices if PSAMs Available 2003-2007

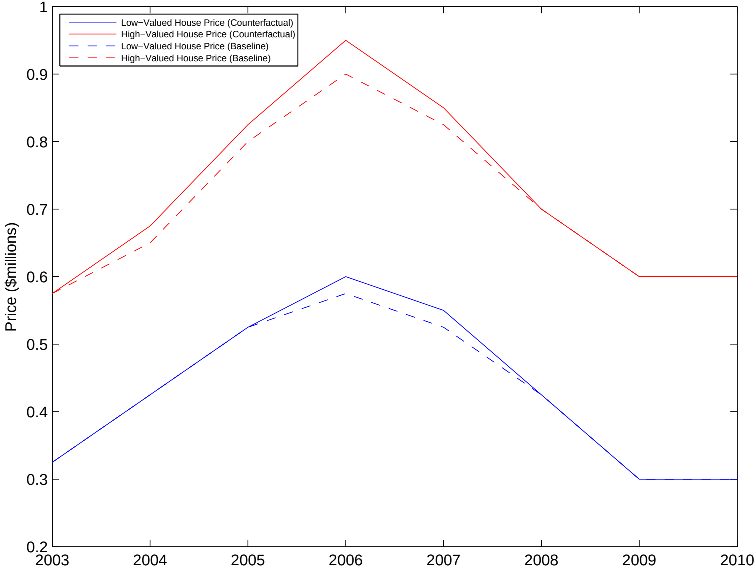


Figure: Mortgage Demand Profile in 2005 (PSAMs Available)

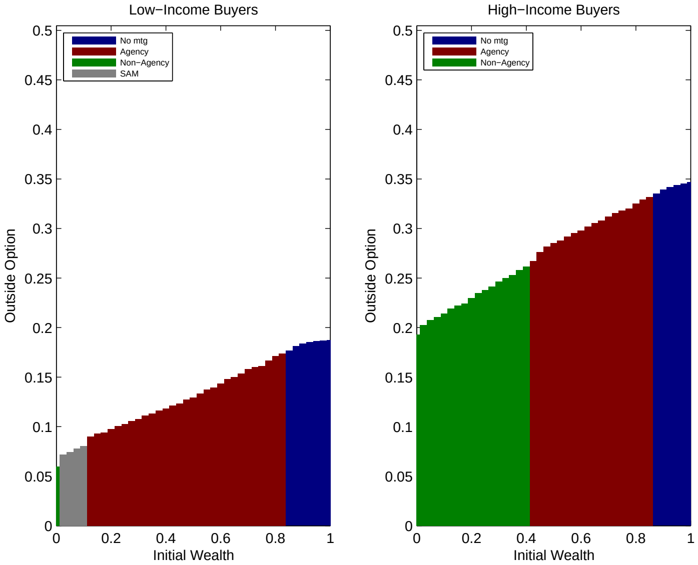


Figure: Interest Rates in 2005 (PSAMs Available)

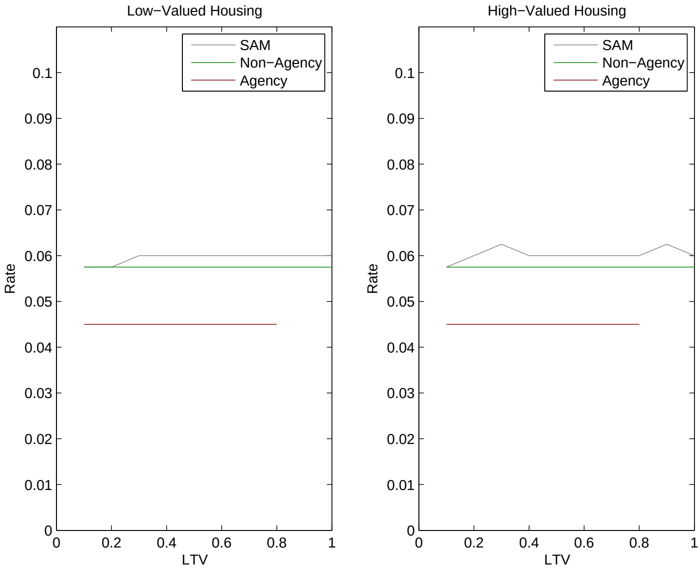


Figure: Mortgage Demand Profile in 2007 (PSAMs Available)

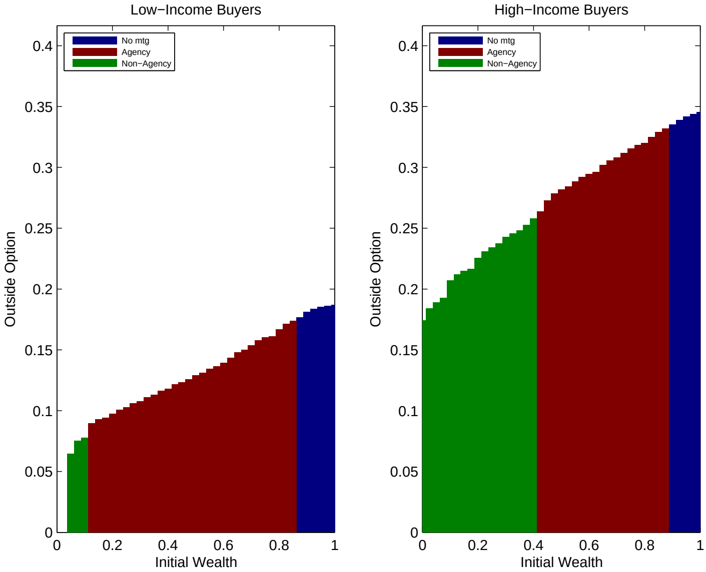


Figure: Interest Rates in 2005 (PSAMs Available)

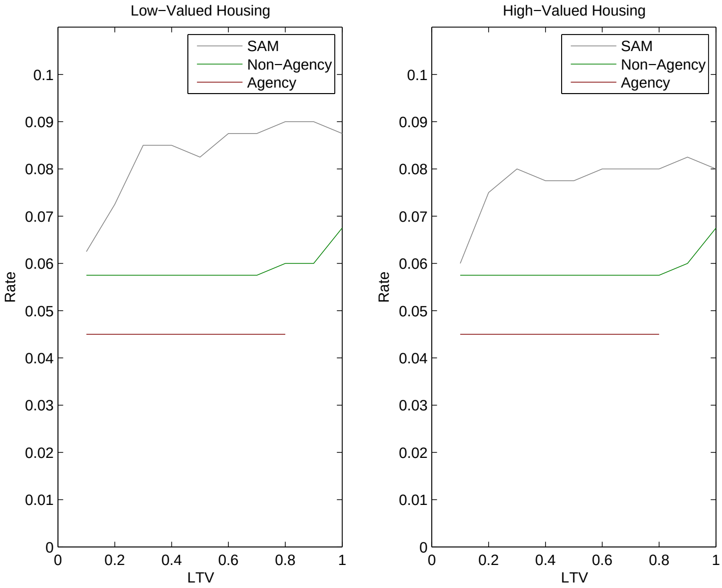


Figure: Cumulative Default Rates (PSAMs Available)

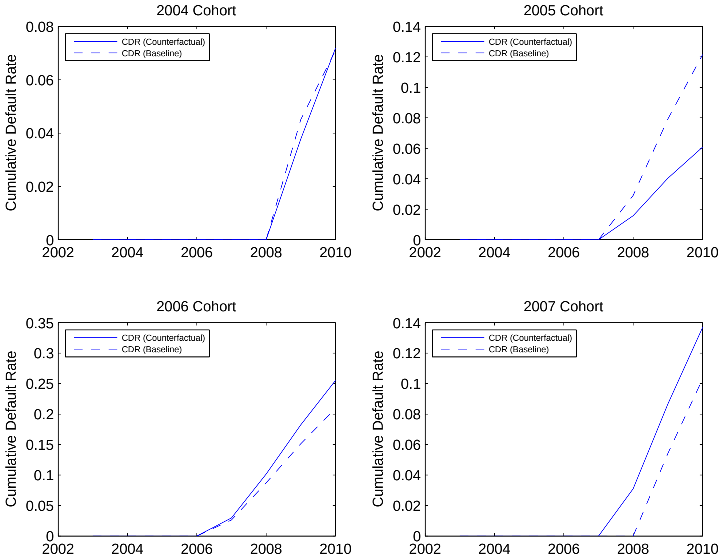


Figure: House Prices if FSAMs Available 2003-2007

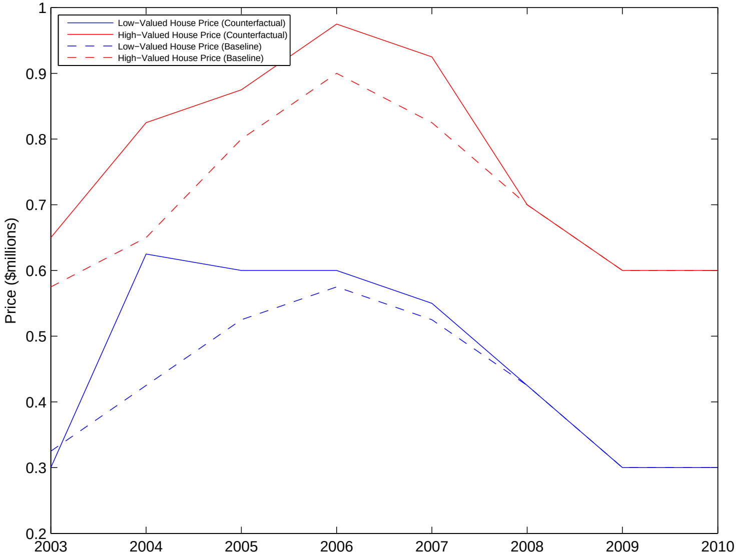
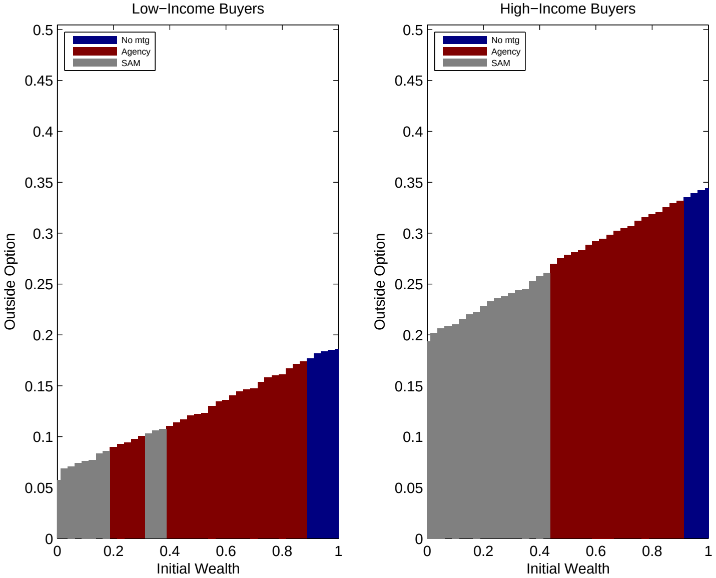


Figure: Mortgage Demand Profile in 2005 (FSAMs Available)



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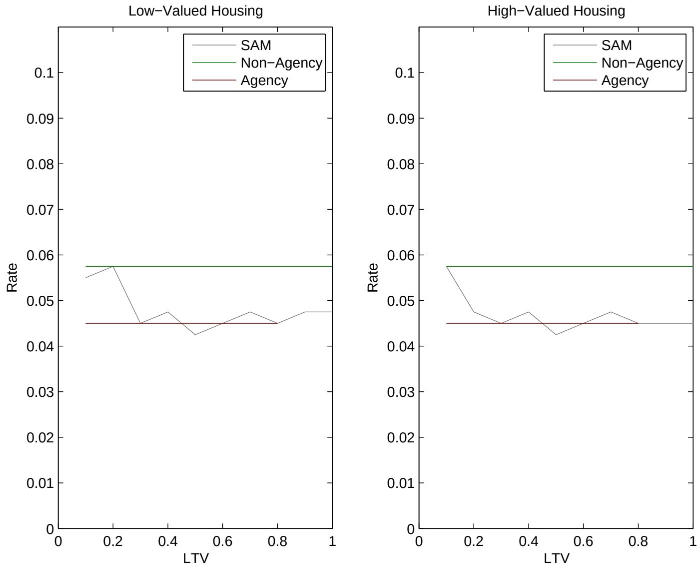

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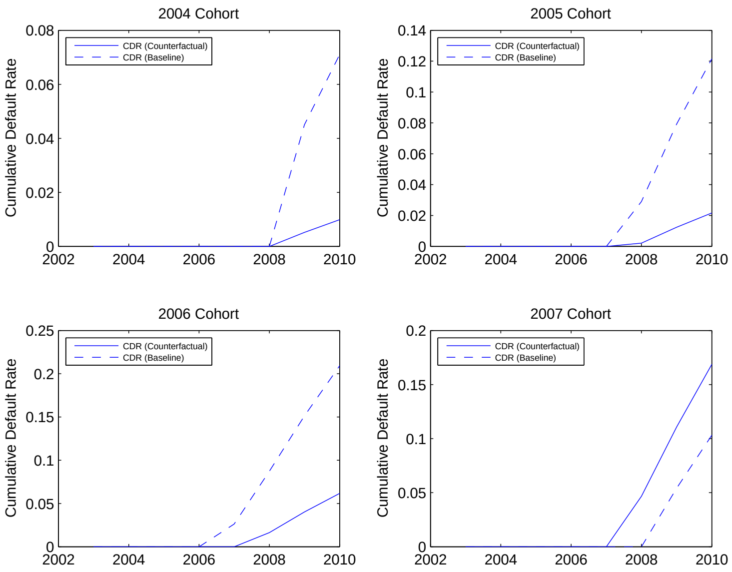
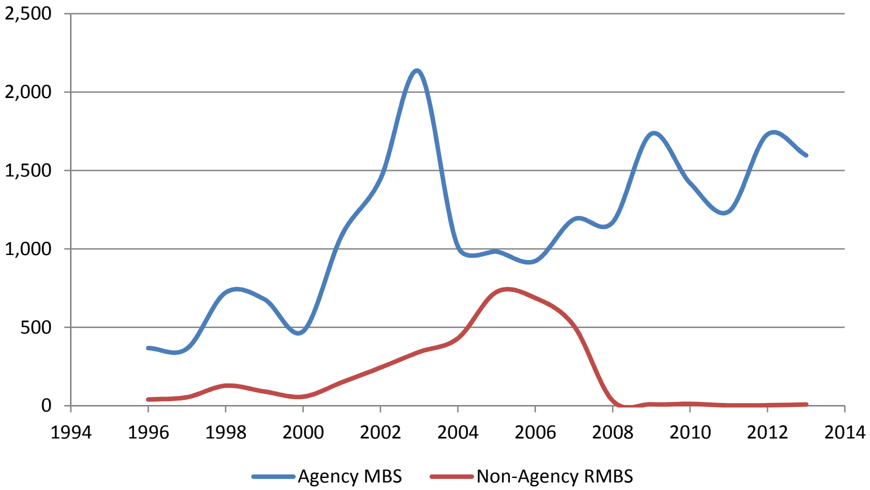


Takeaways

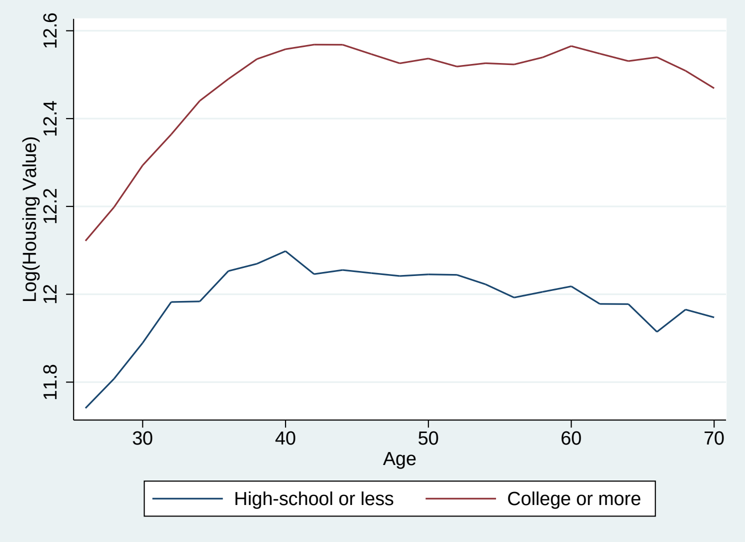
- SAMs can be welfare-enhancing
- Uptake can be positive even if they don't receive the liquidity benefits of the GSEs
- Uptake depends on expectations on house-price growth, contract design
- Defaults can go up if not everyone chooses a SAM

Figure: Agency and Non-Agency MBS Issuance (USD Billions)



Back

Age profile of house value—2005 homeowners



Evidence on within-market movers

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

	(1) All ages	(2) Age<45	(3) Age≥45
Moved from within	0.0047*	0.0458***	-0.0488***
	(0.0026)	(0.0032)	(0.0041)
Moved from outside	0.0105***	0.0561***	-0.0379***
	(0.0027)	(0.0034)	(0.0041)
N	2,439,293	685,580	1,753,713

Back