Housing Finance, Boom-Bust Episodes, and the Macroeconomy

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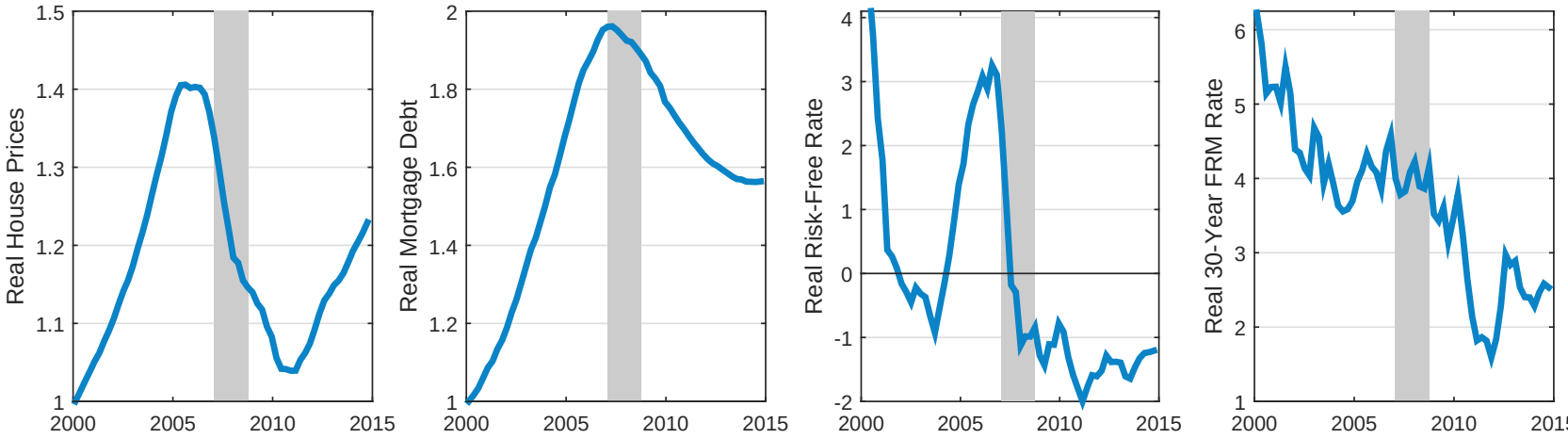
Motivation

- According to IMF data, house prices have been soaring globally since the late 90s until the global financial crisis (GFC).
- After the GFC prices have continued to grow at a fast pace (i.e. two digit growth in 2017 for countries such as Canada, China, New Zealand, Hong Kong, and single digit U.S. India, Norway)
- These global housing booms share common features.
  - Extended period of credit expansions, lower mortgage borrowing costs alongside a low return to safe assets.
  - House prices are not driven by rent growth.
  - House prices are growing more than income.

HOUSING MARKETS AND CREDIT IN THE U.S.

- During the Great Depression, the housing market collapsed as homeowners could not rollover their short-term low LTV loans due to the failure of local banks.
- The introduction of high LTV long-term mortgages and nationwide credit were important drivers of the postwar housing boom (Chambers, Garriga, and Schlagenhauf 2012).
- 2000s boom was fueled by a credit expansion and declining cost of borrowing.



QUESTIONS AND METHODOLOGY

Question: *How do credit and mortgage arrangements impact the dynamics of housing and the macroeconomy?*

- Construct a quantitative macro model with extensive and intensive margins for housing and mortgage borrowing.
- Analyze the role of credit vs. income-productivity applied to the 2000s housing boom-bust.
- Assess the **aggregate** and **cross-sectional** implications of mortgage structure.
- Evaluate the impact of macroprudential policies targeted at mortgage design.

TAKEAWAYS

- **Anatomy of the boom:** credit booms have a bigger impact on housing and consumption than does income growth.
- **Asymmetric macro effects:** consumption responds more strongly to house price movements during the bust than during the boom.
- **Mortgage Structure**
  - *Refinancing and Equity Extraction:* the ability to refinance and extract equity substantially magnifies housing booms and the spillovers to consumption.
  - *Mortgage Duration:* long-term debt mitigates rollover risk and has a substantial impact on foreclosure, ownership, and consumption dynamics.
- **Macroprudential Regulations:** Tighter LTV constraints blunt the boom and mitigate the bust. PTI constraints are not as effective at reducing endogenous fragility, but they increase homeownership during the boom.

Model Summary

Households

- Preferences $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, c_{h,t})$. Own $h \in \mathcal{H}$ with $c_h = h$ or consume apartment space $c_h = a \in [0, \bar{a}]$, $\bar{a} \leq \underline{h}$. Labor efficiency $e \cdot s$ with cdf $F(e)$ and transitions $\pi_s(s'|s)$.

Technology

- Consumption $Y_c = z_c N_c$. New housing $Y_h = F_h(\overline{L}, S_h, N_h)$. Apartments produced using linear, reversible technology.

Long-Term, Defaultable Mortgage Debt

- Extensive vs. intensive margins of credit. FRMs vs. ARMs.
- Long-term contracts with default, prepayment, and the ability to extract equity.

Decentralized Housing Market

- Search frictions endogenize housing illiquidity.

Household Portfolio Choice

New buyers/homeowners who refinance:

$$V^R_{own}(y,(\bar{r}_m,m),h,s,0) = \max_{m',b',c\geq 0} u(c,h) + \beta \mathbb{E}\left[(W_{own}+R_{sell})(y',(r_m,m'),h,s',0)\right]$$

subject to

$$c + \gamma p(h) + q_b b' + m \leq y + q^0_m((r_m,m'),b',h,s)m'$$

$$q^0_m((r_m,m'),b',h,s)m' \leq \vartheta p(h)$$

$$y' = we's' + b'$$

Homeowners who make a regular payment:

$$V^C_{own}(y,(\bar{r}_m,m),h,s,0) = \max_{l,b',c\geq 0} u(c,h) + \beta \mathbb{E}\left[(W_{own}+R_{sell})(y',(\bar{r}_m,m'),h,s',0)\right]$$

subject to

$$c + \gamma p(h) + q_b b' + l \leq y$$

$$l \geq \frac{\bar{r}_m}{1+\bar{r}_m} m$$

$$m' = (m-l)(1+\bar{r}_m)$$

$$y' = we's' + b'$$

MORTGAGE FINANCING

- Key features: endogenous default premia, prepayment, equity extraction through costly refinancing.
- For ARMs, $\bar{r}_m = r_m$ adjusts every period.
- Mortgage prices satisfy the recursive relationship:

$$q_m^0((\bar{r}_m, m'), b', h, s)m' = \frac{1}{(1+\zeta)(1+r_m)}\mathbb{E}\left\{\overbrace{\eta_s(\theta_s(p_s', h))m'}^{\text{sell + repay}} + \overbrace{[1-\eta_s(\theta_s(p_s', h))]}^{\text{no sale (do not try/fail)}}\right.$$

$$\times\left[d'\left(\underbrace{\varphi \min\left\{J_{REO}(h), m'\right\}}_{\text{default + repossession}} + \underbrace{(1-\varphi)}_{\text{no repossession}}\underbrace{(1+\zeta)q_m^0((\bar{r}_m, m'), b'', h, s')m'}_{\text{continuation value with } m'}\right)\right.$$

$$\left.\left.+(1-d')\left\{m'\mathbf{1}_{[\text{Refi}]} + \mathbf{1}_{[\text{No Refi}]}\left(\underbrace{l}_{\text{payment}} + \underbrace{(1+\zeta)q_m^0((\bar{r}_m, m''), b'', h, s')m''}_{\text{continuation with } m'' = (m' - l)(1+\bar{r}_m)}\right)\right\}\right]\right\}$$

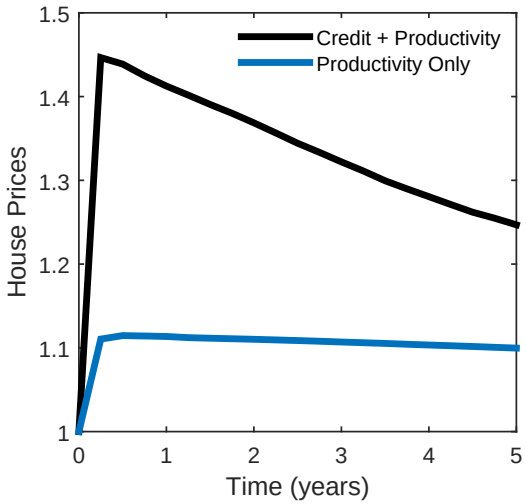
CALIBRATION

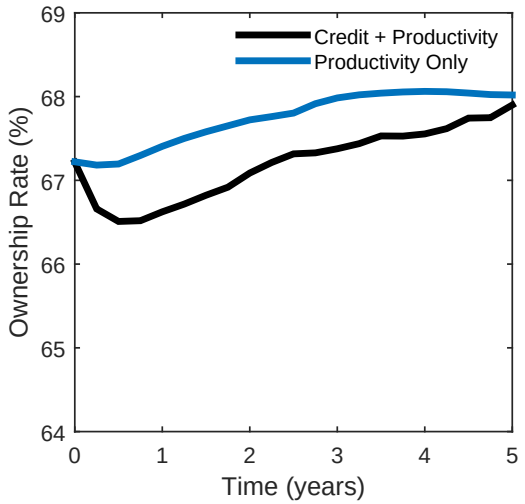
- Calibrate the economy to the late 1990s.
- Important to match the LTV distribution (especially the right tail), homeownership rate, and foreclosures.

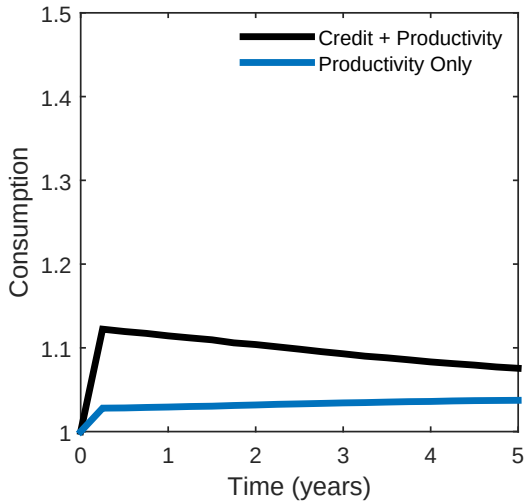
Description	Parameter	Value	Target	Model	Source/Reason
Homeownership Rate	$\bar{a}$	2.005	67.0%	67.2%	Census
Housing Wealth (Owners)	ω	0.8177	2.49	2.49	1998 SCF
Median Borrower LTV			62.90%	65.51%	1998 SCF
Borrowers with $LTV \geq 70\%$			40.00%	43.43%	1998 SCF
Borrowers with $LTV \geq 80\%$	β	0.9657	25.0%	24.2%	1998 SCF
Borrowers with $LTV \geq 90\%$			14.50%	11.27%	1998 SCF
Borrowers with $LTV \geq 95\%$			9.20%	7.97%	1998 SCF
Median Owner Liq. Assets/Earn			0.16	0.15	1998 SCF
Foreclosure Starts (Annual)	γ_s	0.6550	1.60%	1.87%	Nat'l Delinquency Survey

▸ Full Calibration Details

Anatomy of the Housing Boom







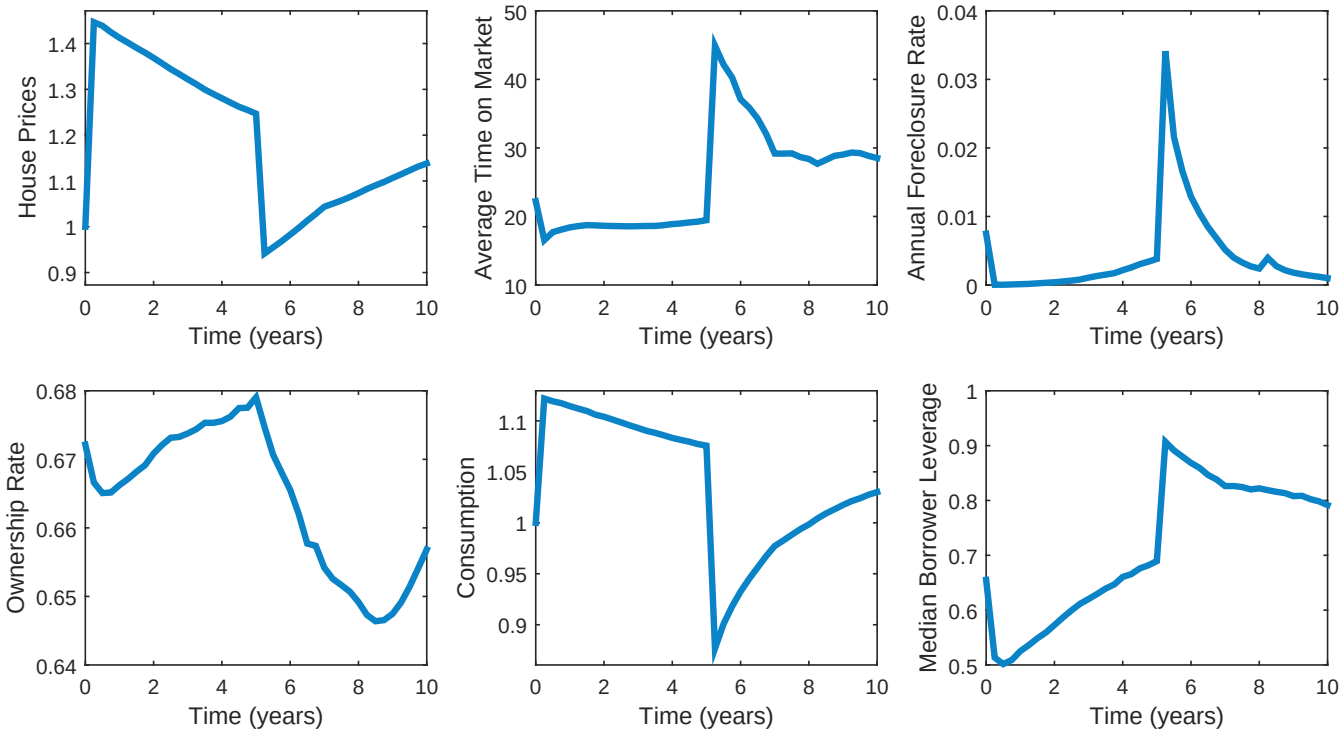
- Credit booms are much larger than productivity booms.
- Consumption increases much more during a credit boom, partly because of housing as an ATM.
- The credit boom has a minimal impact on the ownership rate because of the equilibrium increase in house prices.

Credit and the "New Narrative"

	Low Income	Middle Income	High Income
Average Borrower LTV			
Pre-Boom	59.3%	61.3%	70.3%
Productivity Only	56.4%	58.9%	57.1%
Productivity + Credit	60.9%	65.8%	69.3%
Δ*Credit*	+4.5%	+6.9%	+12.2%
*High-LTV Share**			
Pre-Boom	13.9%	14.6%	36.3%
Productivity + Credit	16.7%	22.7%	31.1%
Consumption Change			
Productivity Only	4.8%	4.2%	1.3%
Productivity + Credit	6.0%	11.7%	13.3%
Δ*Credit*	+1.2%	+7.5%	+12.0%

- Broad-based increase in borrowing and consumption from the credit expansion.
- Ownership shifts toward larger houses (13% move up with productivity alone vs. 22% when credit also expands).

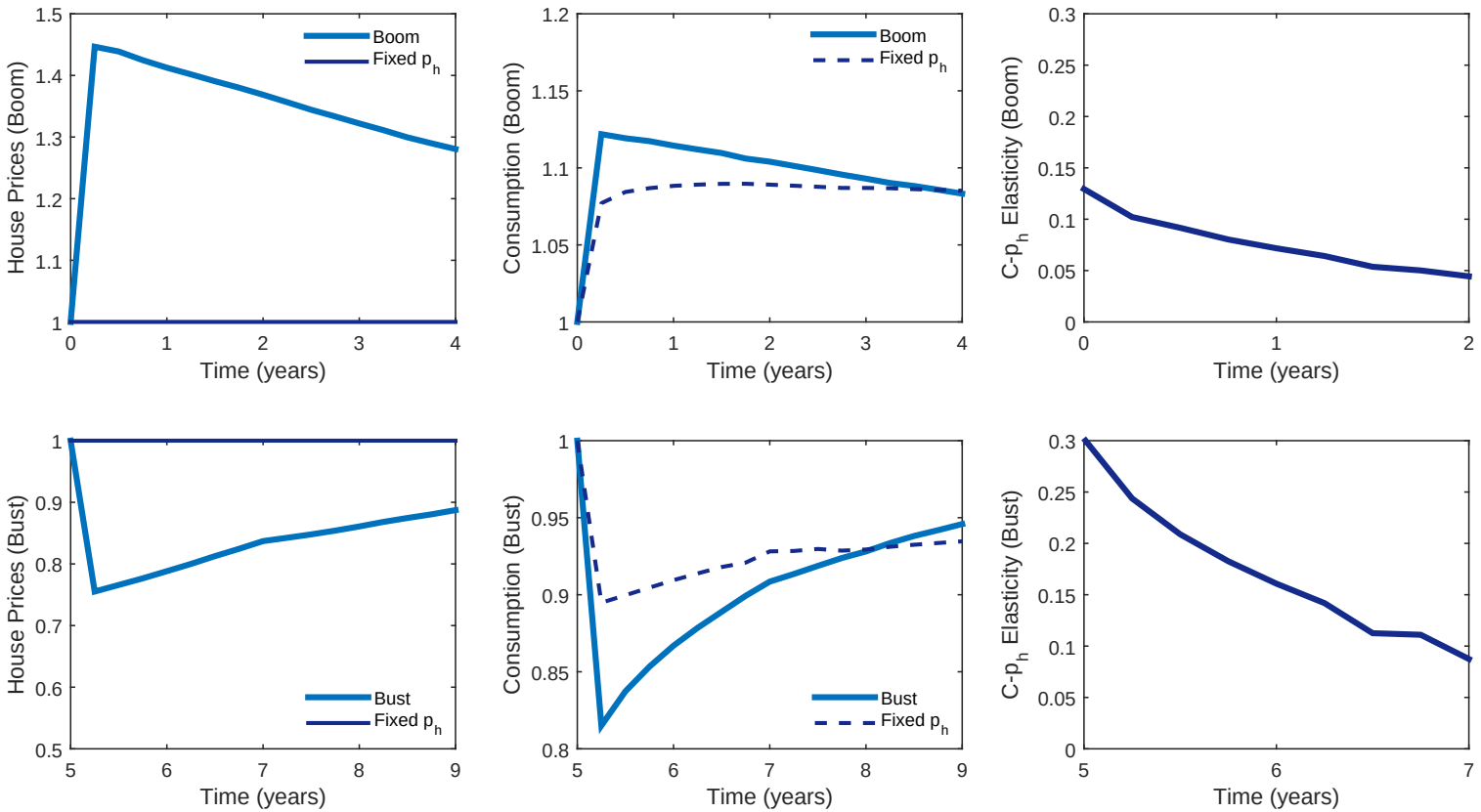
THE BOOM, BUST, AND RECOVERY



	$\Delta\text{Prices}_{boom}$	ΔC_{boom}	Own_{boom}	$\Delta\text{Prices}_{bust}$	ΔC_{bust}	Own_{bust}
Model	+44.6%	+12.2%	68.1%	−24.5%	−18.5%	64.3%
Data	+41.9%	+5.1%	69.2%	−25.9%	−15.0%	64.2%

- Downside labor market uncertainty and tighter credit are key to generating the bust.

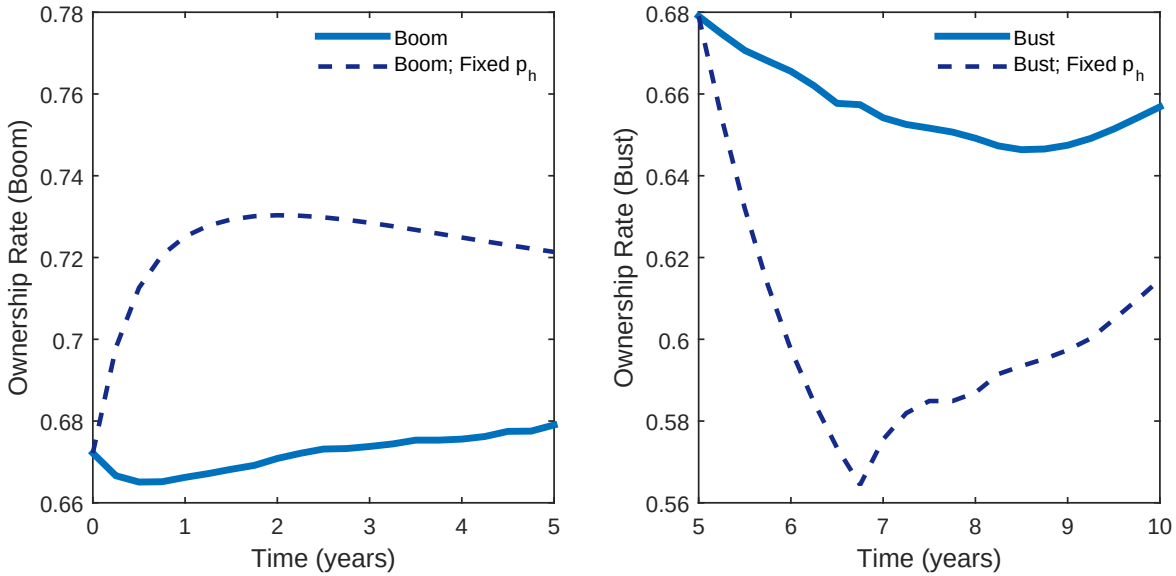
ASYMMETRIC BALANCE SHEET EFFECTS



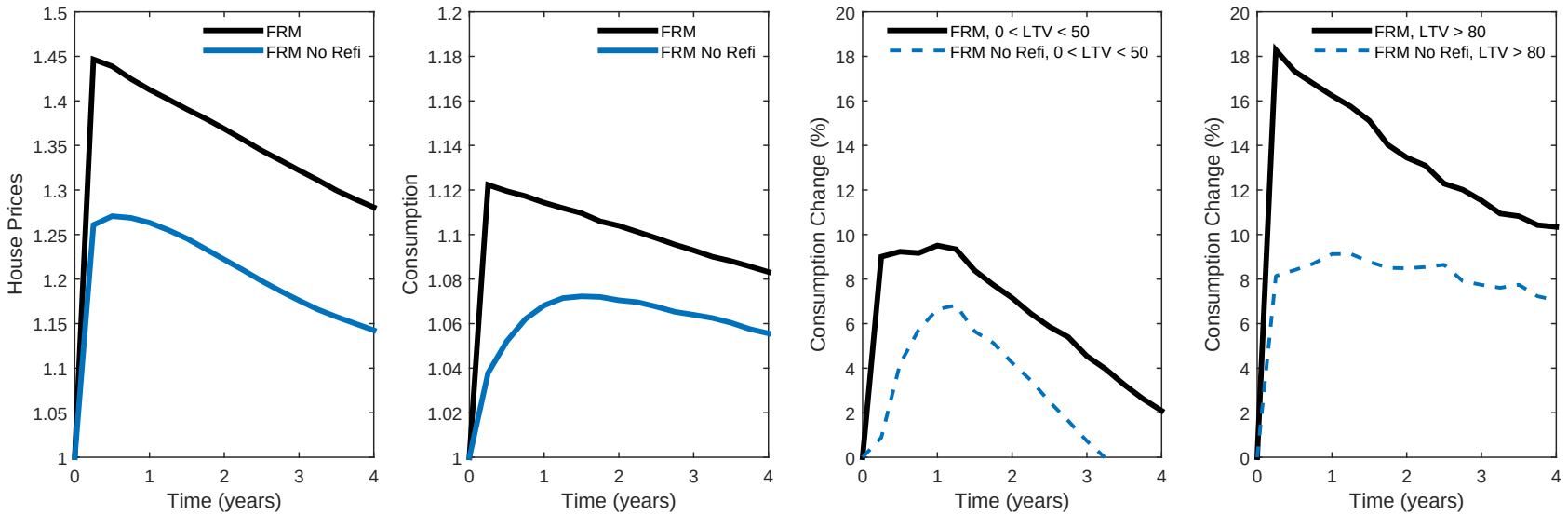
- Consumption dynamics are driven largely by the ability to withdraw equity from the household balance sheet.
- Debt overhang in the bust makes balance sheet effects much larger than during the boom.

Asymmetric Homeownership Dynamics

- The credit channel is highly nonlinear because of the foreclosure double trigger.
- Also, fluctuations in housing liquidity are asymmetric.
- Models without an extensive margin (own vs. rent, default vs. pay) miss this channel.

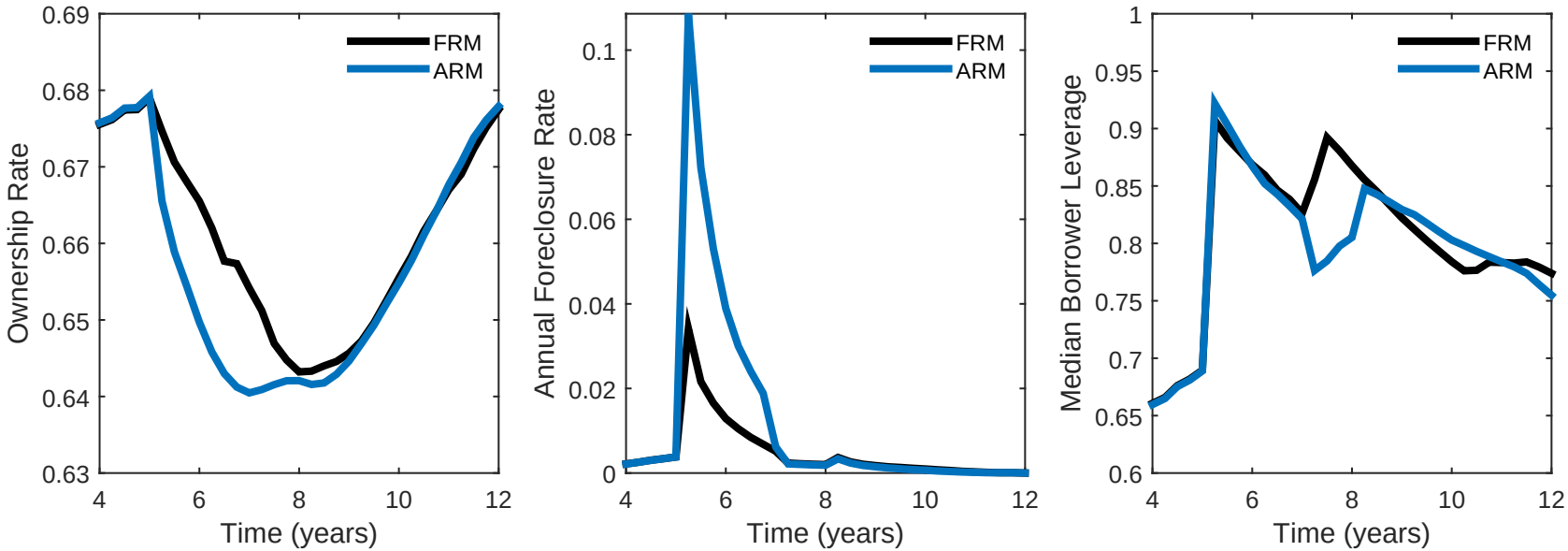


EQUITY EXTRACTION AND REFINANCING



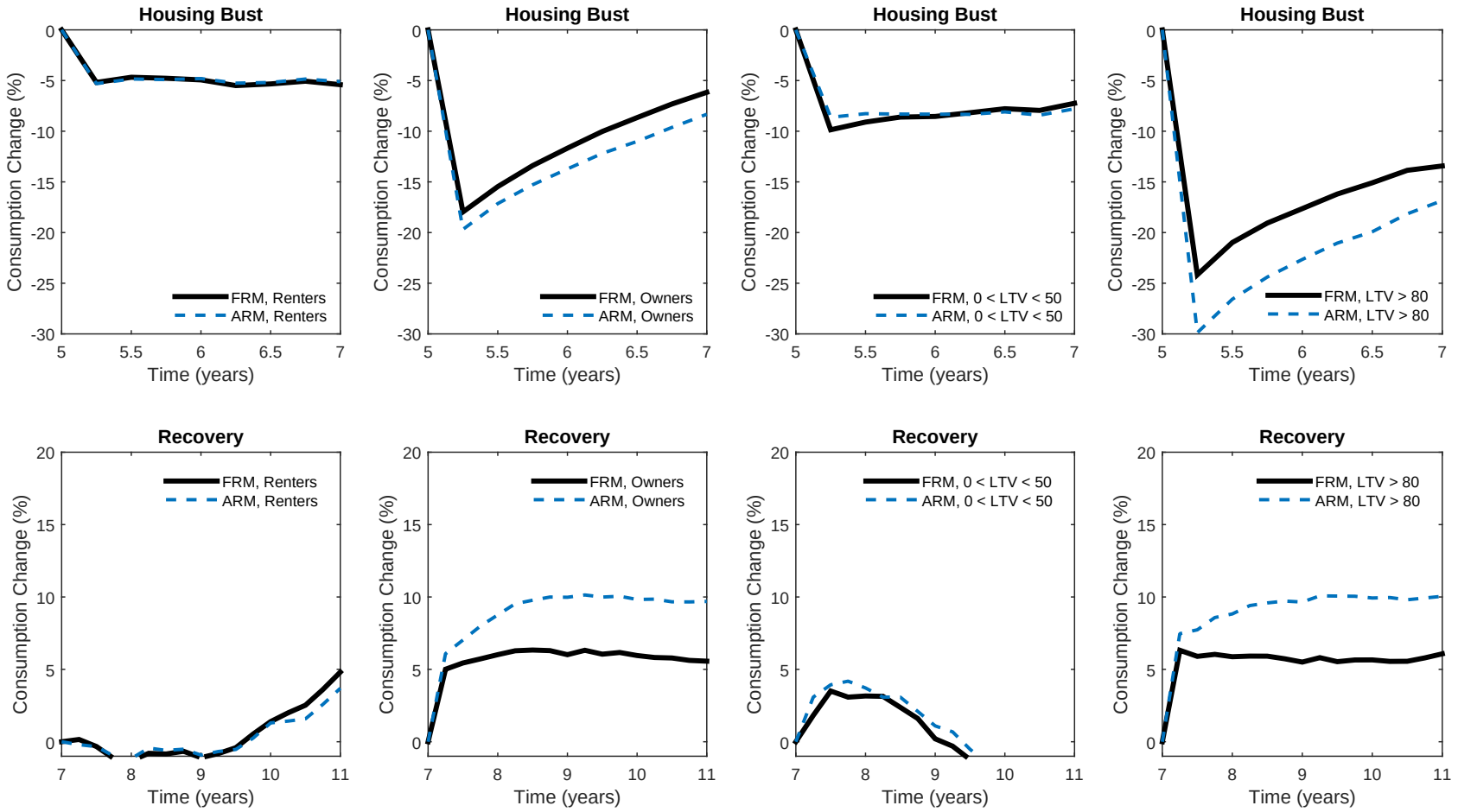
- Without the ability to refinance, the house price boom is 40% smaller and exhibits less overshooting.
- When houses can't be used as ATMs, the spillover to consumption is smaller and more gradual.
- The difference in consumption dynamics is most stark for highly leveraged owners.

Fixed-Rate vs. Adjustable Rate Mortgages



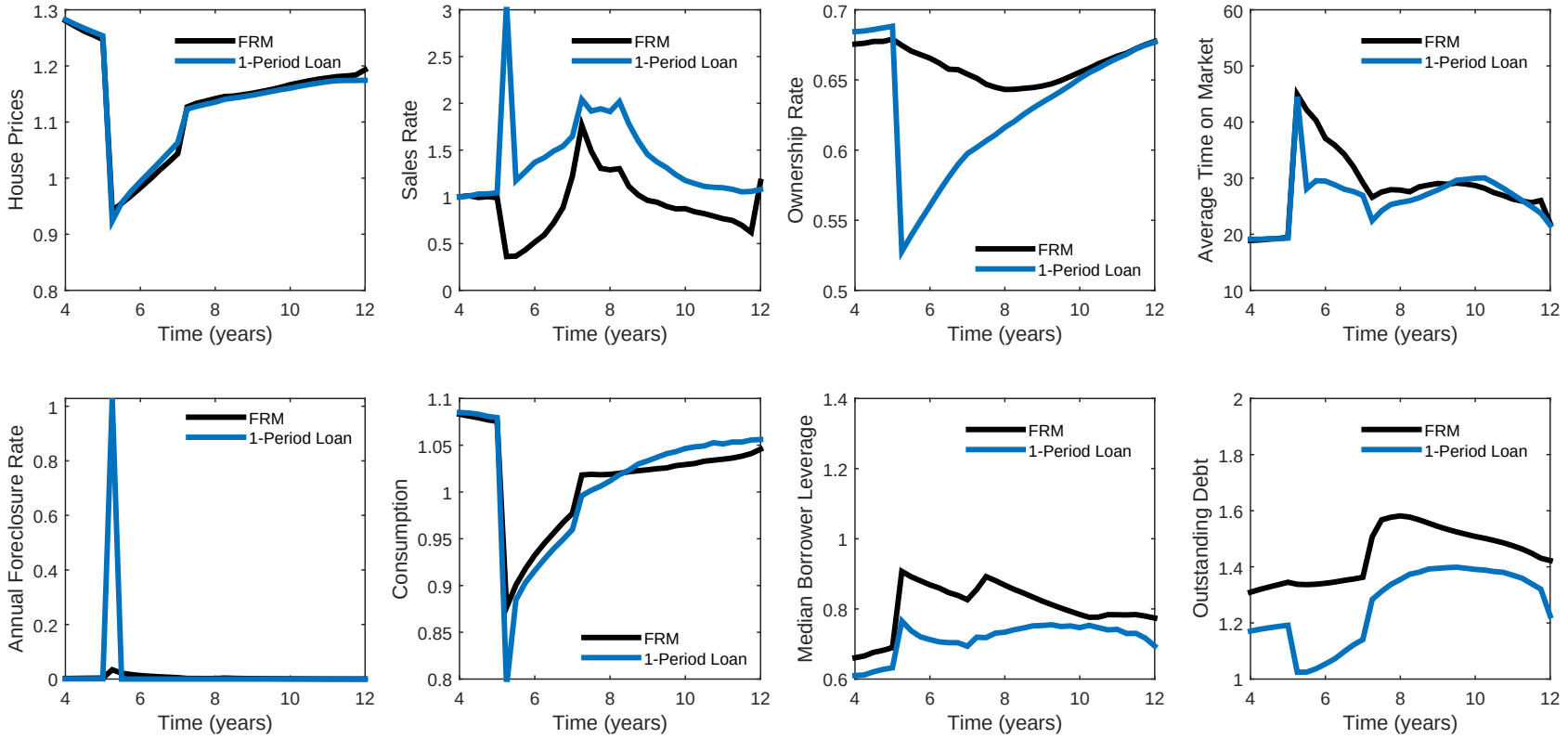
- FRMs and ARMs exhibit the same house price boom as long as refinancing is possible. Without refinancing, the ARM boom is 30% and the FRM boom is 27%.
- The ARM economy is more sensitive to interest rate movements during the bust and recovery.

FIXED-RATE VS. ADJUSTABLE RATE MORTGAGES



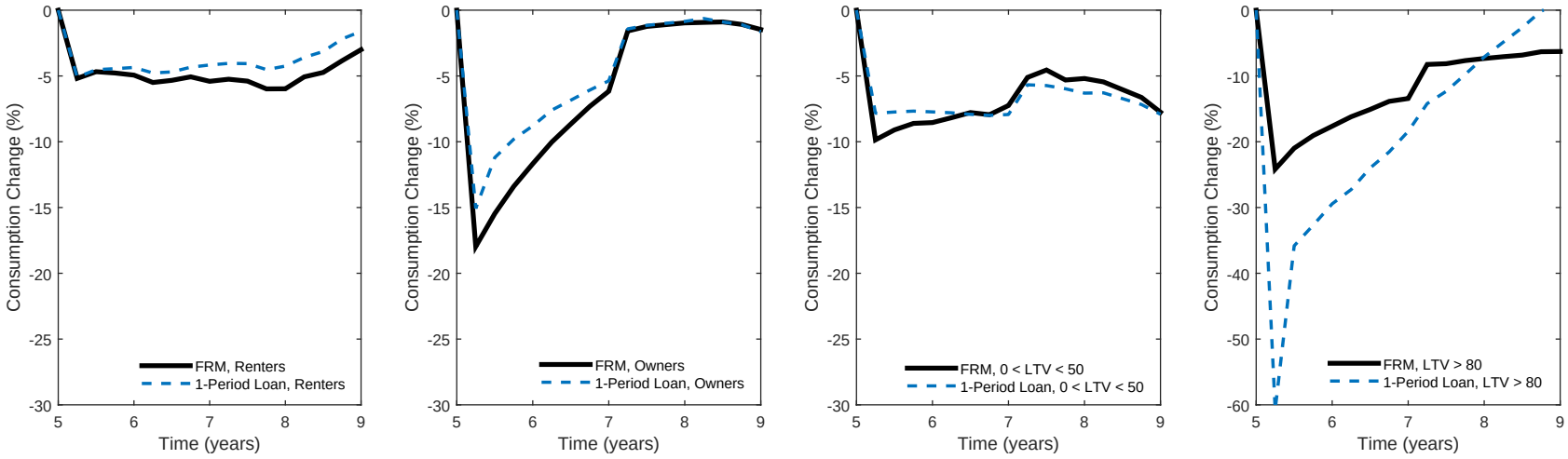
- Consumption is more sensitive to interest rates in the ARM economy, particularly among highly leveraged owners.

MORTGAGE DURATION AND ROLLOVER RISK



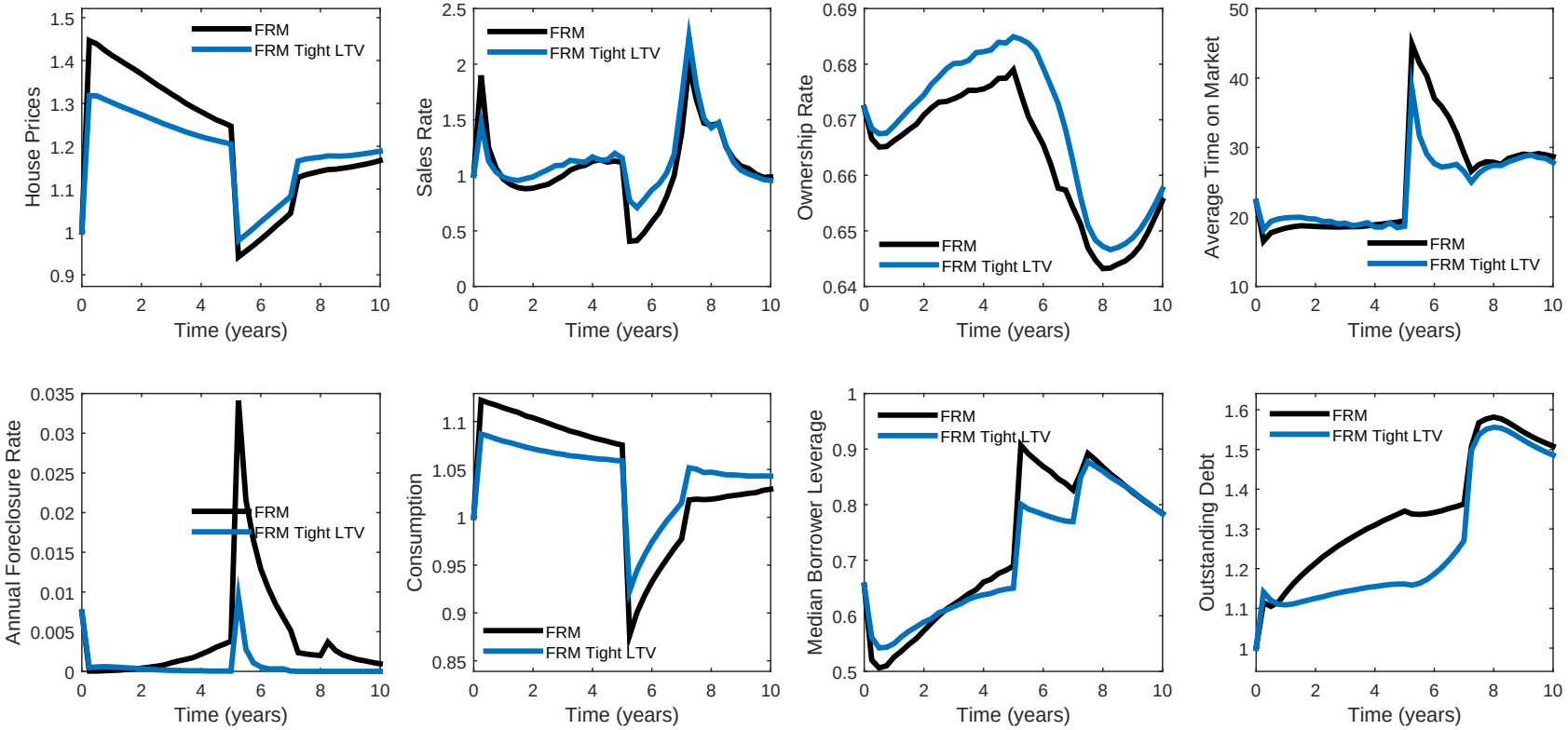
- Mortgage duration has almost no impact on housing dynamics during the boom.
- During the bust, house prices are unaffected but ownership, foreclosures, and consumption respond more severely.

MORTGAGE DURATION AND ROLLOVER RISK



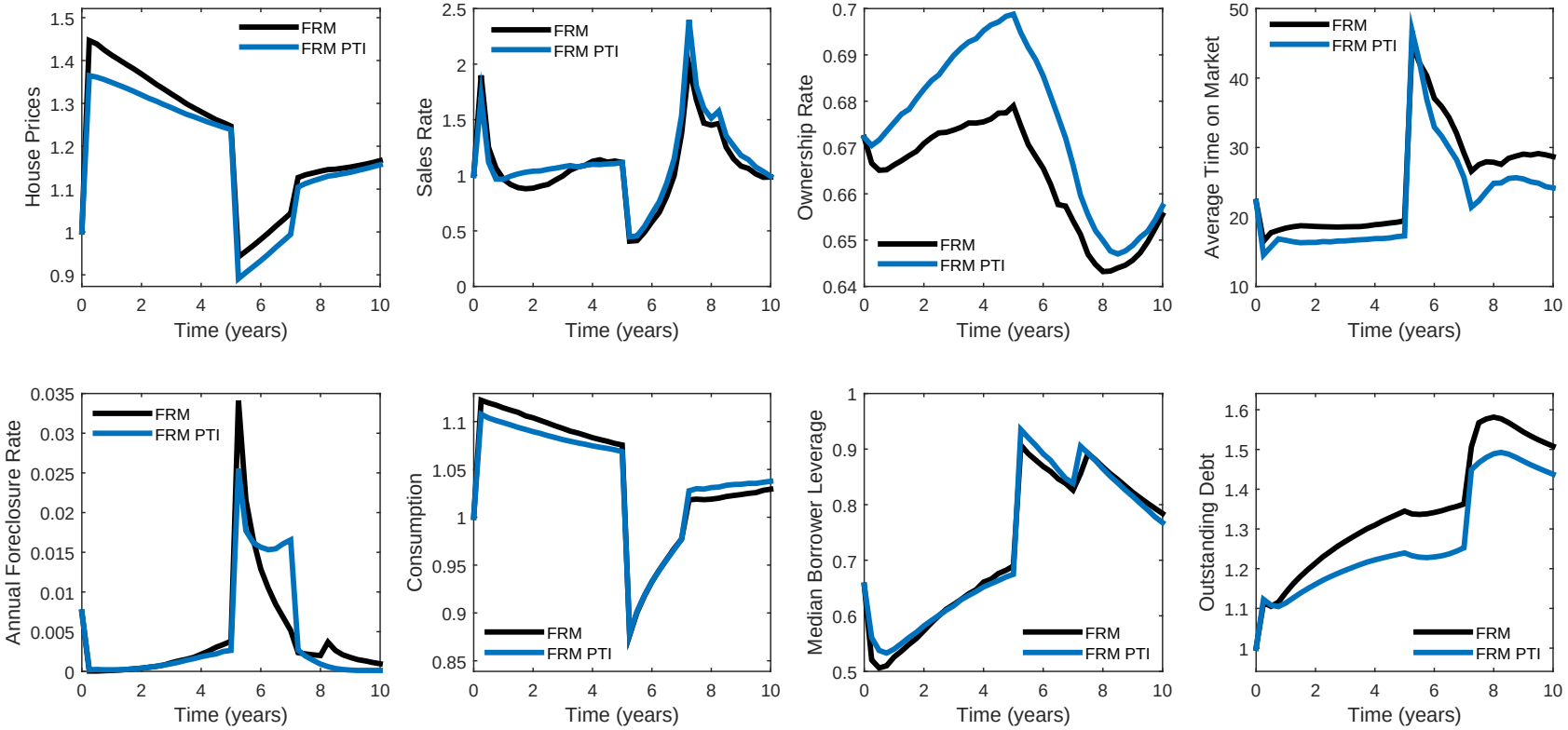
- For homeowners with equity, there is little rollover risk during the bust.
- Highly leveraged owners experience a consumption disaster with short-term debt.

MACROPRUDENTIAL POLICY: LTV CAPS



- LTV caps substantially shrink the size of housing booms without crowding out homeownership.
- They also decrease the endogenous fragility of the economy and reduce the size of busts.

Macroprudential Policy: PTI Caps



- PTI caps are less effective at reducing house price booms but have an even larger positive impact on ownership.
- However, PTI limits do not reduce endogenous fragility and can exacerbate house price declines during a bust.

Conclusions

- Credit booms are significantly larger than productivity booms.
- The transmission of house prices to consumption is stronger during busts when equity extraction becomes more difficult.
- More heavily-indebted economies are more fragile with respect to negative shocks.
- Mortgage design has significant aggregate and cross-sectional effects, particularly during busts.

THE MODEL: FRICTIONAL HOUSING MARKET

- Importance of endogenous housing liquidity explored in Garriga and Hedlund (2016).
- Sellers choose list price p_s and sell w/prob $\eta_s(\theta_s(p_s, h))$.
- Dynamic sorting problem simplified by brokers $\Rightarrow$ block recursivity: θ_s, θ_b do not depend directly on distribution Φ.

$$\eta_s(\theta_s(p_s, h; \Phi)) = \left(\frac{p(\Phi)h - p_s}{\kappa_s h}\right)^{\frac{\gamma_s}{1-\gamma_s}} \quad \eta_b(\theta_b(p_b, h; \Phi)) = \left(\frac{p_b - p(\Phi)h}{\kappa_b h}\right)^{\frac{\gamma_b}{1-\gamma_b}}$$

- Equilibrium determination of sufficient statistic $p(\Phi)$:

$$\int h^* \eta_b(\theta_b(p_b^*, h^*; p)) d\Phi_{rent} = \underbrace{Y_h(p)}_{\text{new housing}} + \underbrace{S_{REO}(p)}_{\text{REO housing}} + \underbrace{\int h \eta_s(\theta_s(p_s^*, h; p)) d\Phi_{own}}_{\text{sold by owner}}$$

Back to Seller's Problem

Calibration I

- Calibrate the economy to match the cross-section of leverage in 1998, plus other key housing statistics.

Description	Parameter	Value	Source/Reason
	Independent Parameters		
Autocorrelation	ρ	0.952	Storesletten et al (2004)
SD of Persistent Shock	σ_ϵ	0.17	Storesletten et al (2004)
SD of Transitory Shock	σ_e	0.49	Storesletten et al (2004)
IES	ν	0.13	Flavin and Nakagawa (2008)
Risk Aversion	σ	2	Standard
Structure Share	α_S	30%	Favilukis et al. (2016)
Land Share	α_L	33%	Lincoln Inst Land Policy
Holding Costs	η	0.7%	Moody's
Depreciation (Annual)	δ_h	1.4%	BEA
Rent-Price Ratio (Annual)	r_h	5%	Sommer et al. (2013)
Risk-Free Rate (Annual)	r	1.0%	Federal Reserve Board
Servicing Cost (Annual)	ϕ	3.1%	3.2% Real Mortgage Rate
Mortgage Origination Cost	ζ	0.4%	FHFA
Maximum LTV	ϑ	125%	Fannie Mae
Prob. of Repossession	φ	0.5	2008 OCC Mortgage Metrics
Credit Flag Persistence	λ_f	0.9500	Fannie Mae

Calibration II

Description	Parameter	Value	Target	Model	Source/Reason
Jointly Determined Parameters					
Homeownership Rate	$\bar{a}$	2.005	67.0%	67.2%	Census
Starter House Value	h_1	2.4250	1.75	1.75	American Housing Survey
Housing Wealth (Owners)	ω	0.8177	2.49	2.49	1998 SCF
Borrowers with $LTV \geq 80\%$	β	0.9657	25.0%	24.2%	1998 SCF
Months of Supply*	ξ	0.0016	5.40	5.42	Nat'l Assoc of Realtors
Avg. Buyer Search (Weeks)	γ_b	0.0940	10.00	9.95	Nat'l Assoc of Realtors
Maximum Bid Premium	κ_b	0.0171	2.5%	2.5%	Gruber and Martin (2003)
Maximum List Discount	κ_s	0.1029	15%	15%	RealtyTrac
Foreclosure Discount	χ	0.0980	21%	21%	Pennington-Cross (2006)
Foreclosure Starts (Annual)	γ_s	0.6550	1.60%	1.87%	Nat'l Delinquency Survey
Model Fit					
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