

Mortgage Debt, Consumption, and Illiquid Housing Markets in the Great Recession

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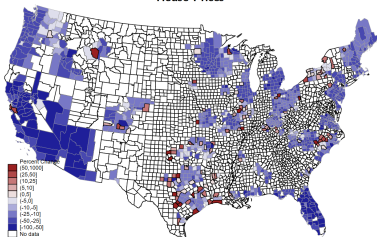
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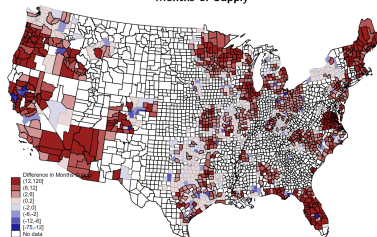
INTRODUCTION

- Deterioration in housing and macroeconomy 2006 – 2011.

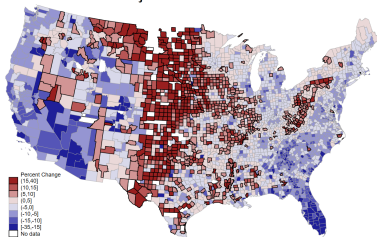
House Prices



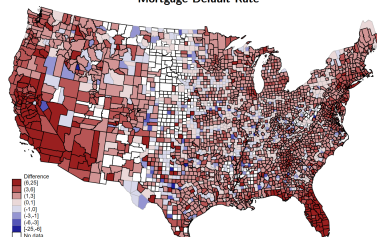
Months of Supply



Adjusted Gross Income



Mortgage Default Rate



LONGER TERM AGENDA

1. What drives housing (especially prices)?

- ▶ Fundamentals (growth, demographics, preferences)
- ▶ Expectations
- ▶ Credit
- ▶ Liquidity

$$P_t = \underbrace{R_t}_{\text{fundamentals}} + \underbrace{\mathbb{E}}_{\text{expectations}} \left\{ \Gamma_{t,t+1} \underbrace{[1 - \tau(\Omega)]}_{\text{liquidity}} P_{t+1} \right\} + \underbrace{\mu_t \theta P_t}_{\text{credit}}$$

2. How does housing impact the macroeconomy?

- ▶ Spillovers to consumption and investment.
- ▶ Fragility of the financial sector.

3. What are the policy implications?

- ▶ Macroprudential regulations.
- ▶ Transmission of monetary and fiscal policy.

TODAY'S TALK

We develop a quantitative macro-housing model with endogenous liquidity and default to address three questions:

1. What were the drivers of the housing bust?

- ▶ Earnings skewness shocks (higher left tail risk) and tightening lending standards primarily to blame.
- ▶ Productivity shocks and Fed tightening play little role.

2. What are the key channels of macroeconomic transmission from the housing market?

- ▶ Balance sheet effects minor in traditional macro models.
- ▶ Here: endogenous illiquidity + balance sheet depth amplify housing decline and transmission to consumption.

3. How effective were mortgage rate interventions?

- ▶ Post-2008 lower mortgage rates boosted house prices and consumption by repairing balance sheets.

MODEL SUMMARY: I

Households

- ▶ Preferences $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t, c_{ht})$ over consumption c_t and housing services c_{ht} .
- ▶ Segmented owner and rental markets: own $h_t \in \mathcal{H}$ with $c_{ht} = h_t$ or rent apartment space $c_{ht} = a_t \in [0, \bar{a}]$; $\bar{a} \leq \underline{h}$.
- ▶ Income shocks $e_t \cdot z_t$ drawn from $F(e_t)$ and $\pi_z(z_{t+1}|z_t)$.

Technology

- ▶ Goods production $Y_{ct} = Z_t N_{ct} = C_t + S_{ht} + \frac{1}{A} C_{at} + \Omega_t$.
- ▶ Linear, reversible technology for producing apartment space \Rightarrow rents $p_a = 1/A$ are purely supply-determined.
- ▶ New owner-occupied housing $Y_{ht} = F_h(\bar{L}, S_{ht}, N_{ht})$.

MODEL SUMMARY: II

Housing Market Frictions: search-induced trading delays.

Endogenous housing liquidity.

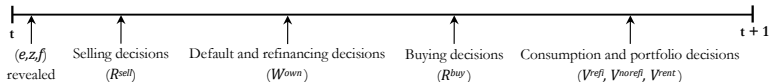
- ▶ Search by price (sellers p_t^{list} , buyers p_t^{bid}) and house type h .
- ▶ Sellers face a trade-off between price and their probability $\eta_t^{sell}(\cdot)$ of a successful transaction. Analogous for buyers.
- ▶ Probabilities $\eta_t^{sell}(p_t^{list}, h; \Phi_t)$ and $\eta_t^{buy}(p_t^{bid}, h; \Phi_t)$ depend on choices and aggregate conditions, including heterogeneity.

▶ Search Details

Banking Sector: issues bonds for saving; mortgages.

- ▶ Long-term: no forced deleveraging if house prices drop.
- ▶ Fixed interest rate.
- ▶ Refinance to extract equity (houses as ATMs) or cut rate.
- ▶ Default and prepayment risks priced in at origination.
- ▶ Banks actively manage foreclosure inventories.

HOUSEHOLD TIMELINE



- ▶ State $(y_t, (\bar{r}, m_t), h_t, z_t, f_t)$ for owners; renters (y_t, z_t, f_t) .
 - ▶ Cash at hand $y_t = w_t e_t z_t + b_t$, mortgage rate \bar{r} and balance m_t , housing h_t , persistent shock z_t , credit flag f_t .
- ▶ First owners decide whether to sell; non-sellers decide whether to default.
- ▶ Then non-owners decide whether to buy.
- ▶ Lastly, consumption and portfolio choice decisions.

BORROWING, SAVING, AND CONSUMPTION

New originations ($m_{t+1} > m_t$ or to lower rate $r_{t+1} < \bar{r}$):

$$V_t^{own,0}(y_t, h, z_t) = \max_{m_{t+1}, b_{t+1}, c_t} u(c_t, h) + \beta \mathbb{E} \left[\begin{array}{l} W_{t+1}^{own,0}(y_{t+1}, (r_{t+1}, m_{t+1}), h, z_{t+1}) \\ + R_{t+1}^{sell,0}(y_{t+1}, (r_{t+1}, m_{t+1}), h, z_{t+1}) \end{array} \right]$$

subject to

$$c_t + \gamma p_t h + b_{t+1}/(1 + i_{t+1}) \leq y_t + \underbrace{q_t((r_{t+1}, m_{t+1}), b_{t+1}, h, z_t) m_{t+1}}_{=1+r_{t+1}+\text{default premium}}$$

$$q_t((r_{t+1}, m_{t+1}), b_{t+1}, h, z_t) m_{t+1} \leq \vartheta p_t h$$

Owners making a regular payment ($m_{t+1} \leq m_t$, \bar{r} unchanged):

$$V_t^{amort}(y_t, (\bar{r}, m_t), h, z_t) = \max_{b_{t+1}, l_t, c_t} u(c_t, h) + \beta \mathbb{E} \left[\begin{array}{l} W_{t+1}^{own,0}(y_{t+1}, (\bar{r}, m_{t+1}), h, z_{t+1}) \\ + R_{t+1}^{sell,0}(y_{t+1}, (\bar{r}, m_{t+1}), h, z_{t+1}) \end{array} \right]$$

subject to

$$c_t + \gamma p_t h + b_{t+1}/(1 + i_{t+1}) + l_t \leq y_t$$

$$\frac{\bar{r}}{1 + \bar{r}} m_t \leq l_t \leq m_t$$

$$m_{t+1} = (m_t - l_t)(1 + \bar{r})$$

BUYING AND SELLING HOUSES

- The option value of trying to sell is

$$R_t^{sell,0}(y_t, (\bar{r}, m_t), h, z_t) = \max\{0, \max_{p_t^{list} \geq 0} \eta_t^{sell}(p_t^{list}, h) [V_t^{rent,0}(y_t + p_t^{list} - m_t, z_t) + R_t^{buy,0}(y_t + p_t^{list} - m_t, z_t) - W_t^{own,0}(y_t, (\bar{r}, m_t), h, z_t)] + [1 - \eta_t^{sell}(p_t^{list}, h)](-\xi)\}$$

subject to

$$p_t^{list} \geq m_t - y_t$$

- The option value of searching for a house is

$$R_t^{buy,0}(y_t, z_t) = \max\{0, \max_{\substack{h_t \in H, \\ p_t^{bid} \leq y_t - y}} \eta_t^{buy}(p_t^{bid}, h_t) [V_t^{own,0}(y_t - p_t^{bid}, h_t, z_t) - V_t^{rent,0}(y_t, z_t)]\}$$

MORTGAGE PRICING

- ▶ Key features: fixed rates, default, prepayment, refinancing.
- ▶ Housing illiquidity endogenously affects default premia.

$$\begin{aligned}
 (1 + \zeta)q_t((\bar{r}, m_{t+1}), b_{t+1}, h, z_t) &= \frac{1}{1 + r_{t+1}} \mathbb{E} \left\{ \underbrace{\eta_{t+1}^{\text{sell}}}_{\text{sell, repay}} + \underbrace{(1 - \eta_{t+1}^{\text{sell}})}_{\text{no house sale}} \left[\underbrace{d_{t+1}^*}_{\text{default}} \varphi \min \left\{ 1, \frac{J_{t+1}^{\text{REO}}(h)}{m_{t+1}} \right\} \right]_{\text{foreclosure recovery ratio}} \right\} \\
 &+ \underbrace{d_{t+1}^* (1 - \varphi) (1 + \zeta) q_{t+1}^{\text{delinq}}}_{\text{continuation value of delinquency}} + (1 - d_{t+1}^*) \left\{ \underbrace{\mathbf{1}_{[\text{Refi}, t+1]} + \mathbf{1}_{[\text{No Refi}, t+1]}}_{\text{repay in full}} \left(\frac{l_{t+1}^* + (1 + \zeta) q_{t+1}^{\text{cont}} m_{t+2}^*}{m_{t+1}} \right) \right\}_{\text{payment + continuation value}}
 \end{aligned}$$

such that

$$\eta_{t+1}^{\text{sell}} \equiv \eta_s(\theta_s(p_{t+1}^{\text{list}*}, h; p_{t+1})) \text{ (probability of house sale)}$$

$$q_{t+1}^{\text{delinq}} \equiv q_{t+1}((\bar{r}, m_{t+1}), b_{t+2}^{\text{delinq}*}, h, z_{t+1}) \text{ (mark-to-market price for delinquent } m_{t+1})$$

$$q_{t+1}^{\text{cont}} \equiv q_{t+1}((\bar{r}, m_{t+2}^*), b_{t+2}^*, h, z_{t+1}) \text{ (mark-to-market price for updated } m_{t+2}^*)$$

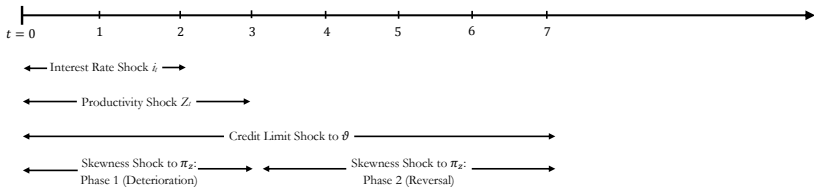
$$m_{t+2}^* = (m_{t+1} - l_{t+1}^*)(1 + \bar{r}) \text{ (endogenous amortization)}$$

CALIBRATION

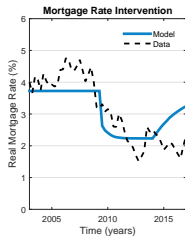
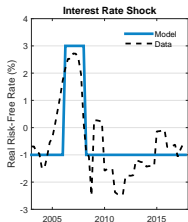
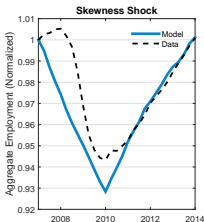
- ▶ Calibrate the economy to the mid-2000s.
- ▶ Important to match households' balance sheets (especially the LTV distribution).

Description	Target	Model	Source/Reason
Homeownership Rate	69.2%	69.2%	Census
Mean Net Worth	2.83	2.84	2007 SCF
Housing Wealth (Owners)	3.97	3.97	2007 SCF
Borrowers with $LTV \geq 80\%$	20.6%	26.5%	2007 SCF
Borrowers with $LTV \geq 90\%$	10.8%	10.7%	2007 SCF
Borrowers with $LTV \geq 95\%$	6.7%	6.0%	2007 SCF
Mean Owner Liquid Assets	1.19	1.53	2007 SCF
Median Owner Liquid Assets	0.23	0.27	2007 SCF
Months of Supply	4.90	4.89	Nat'l Assoc of Realtors
Foreclosure Starts	1.50%	1.25%	Delinquency Survey

DRIVERS OF THE HOUSING BUST



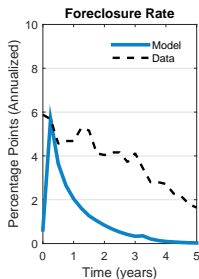
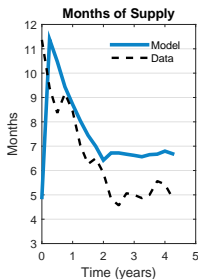
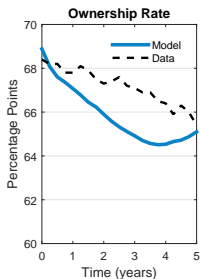
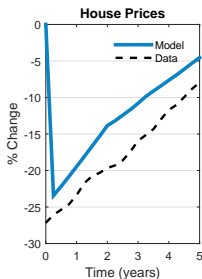
- ▶ The skewness shocks increase downside earnings risk.
- ▶ Calibrated to match path of aggregate employment.
- ▶ Interest rates follow a smoothed version of the data.



DRIVERS OF THE HOUSING BUST

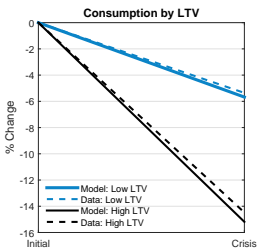
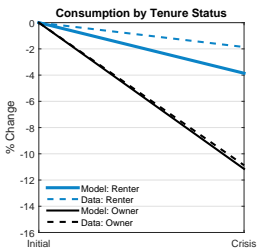
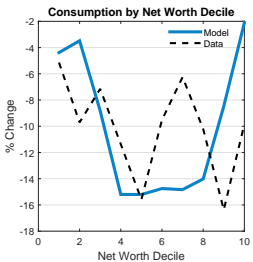
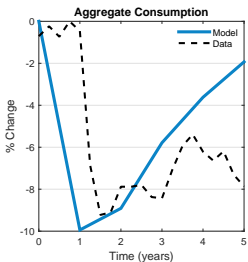
- The model replicates the severity of the housing crash.

	Δ House Prices	Δ Ownership	Δ Months Supply	Δ Foreclosures
Model	-23.4%	-2.8pp	+6.5 months	+5.1pp
Data	-25.7%	-3.6pp	+6.0 months	+4.2pp



DRIVERS OF THE HOUSING BUST

► The dynamics of consumption match the data.



DRIVERS OF THE HOUSING BUST

- Shocks to earnings skewness and credit are important.

	Baseline	Exclude*	Alone**	Impact Bounds
<i>Skewness Shock</i>				
ΔHouse Prices	-23.4%	-14.8%	-11.6%	[-11.6%, -8.6%]
ΔOwnership	-2.8pp	+1.2pp	-3.1pp	[-4.0pp, -3.1pp]
ΔMonths Supply	+6.5m	+3.0m	+1.3m	[+1.3m, +3.5m]
ΔForeclosures	+5.1pp	+1.1pp	+0.2pp	[+0.2pp, +4.0pp]
ΔConsumption	-9.9%	-6.3%	-2.8%	[-3.6%, -2.8%]
<i>Credit Shock</i>				
ΔHouse Prices	-23.4%	-19.1%	-5.6%	[-5.6%, -4.3%]
ΔOwnership	-2.8pp	-3.0pp	+0.9pp	[+0.2pp, +0.9pp]
ΔMonths Supply	+6.5m	+3.5m	+0.3m	[+0.3m, +3.0m]
ΔForeclosures	+5.1pp	+2.3pp	-0.2pp	[-0.2pp, +2.8pp]
ΔConsumption	-9.9%	-7.0%	-2.2%	[-2.9%, -2.2%]

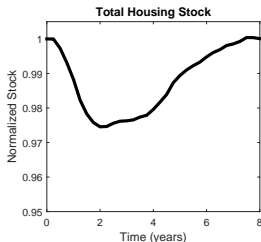
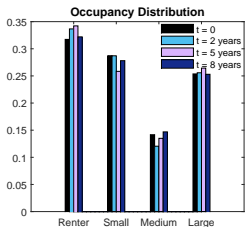
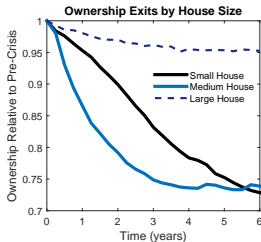
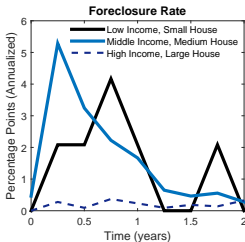
DRIVERS OF THE HOUSING BUST

- ▶ Productivity shocks and Fed tightening play little role.

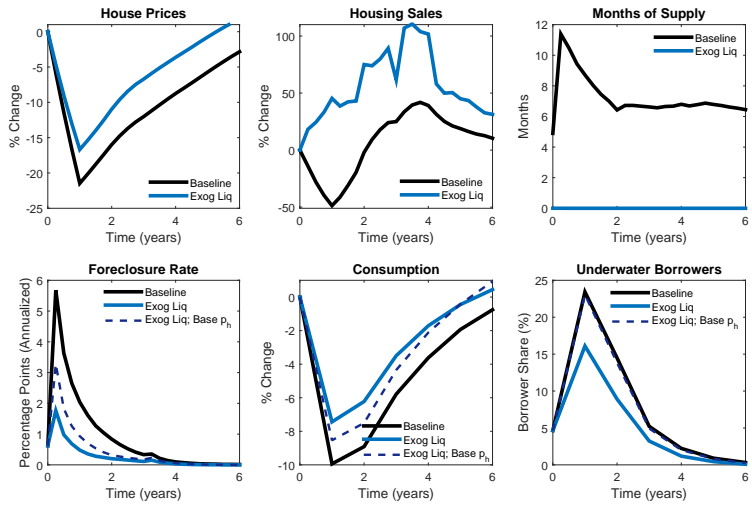
	Baseline	Exclude*	Alone**	Impact Bounds
<i>Productivity Shock</i>				
ΔHouse Prices	-23.4%	-21.6%	-1.9%	[-1.9%, -1.8%]
ΔOwnership	-2.8pp	-2.9pp	+0.7pp	[+0.1pp, +0.7pp]
ΔMonths Supply	+6.5m	+5.5m	+0.5m	[+0.5m, +1.0m]
ΔForeclosures	+5.1pp	+3.6pp	-0.4pp	[-0.4pp, +1.5pp]
ΔConsumption	-9.9%	-8.0%	-1.0%	[-1.9%, -1.0%]
<i>Interest Rate Shock</i>				
ΔHouse Prices	-23.4%	-20.2%	-3.7%	[-3.7%, -3.2%]
ΔOwnership	-2.8pp	-2.9pp	+0.5pp	[+0.1pp, +0.5pp]
ΔMonths Supply	+6.5m	+4.8m	+0.5m	[+0.5m, +1.7m]
ΔForeclosures	+5.1pp	+4.4pp	-0.4pp	[-0.4pp, +0.7pp]
ΔConsumption	-9.9%	-8.7%	-2.0%	[-2.0%, -1.2%]

THE CRISIS AND THE “NEW NARRATIVE”

- The crisis is not confined to low income owners.



THE IMPORTANCE OF ENDOGENOUS LIQUIDITY



► Magnifies the \uparrow in foreclosures, the \downarrow in p and C , and is needed for the sales collapse.

THE LIQUIDITY-ADJUSTED DOUBLE TRIGGER

$$\Delta \text{DefaultRate}_{06-10}^i = \beta_0 + \beta_1 \% \Delta \text{HNW}_{06-10}^i + \beta_2 \Delta \text{Illiquidity}_{05-08}^i$$

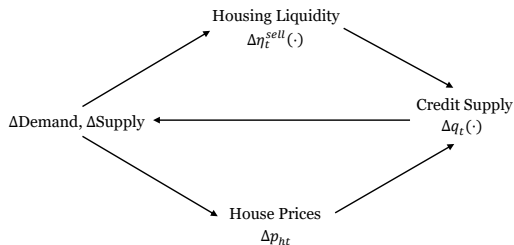
	(1)	(2)
	$\Delta \text{Default}$	$\Delta \text{Default}$
$\% \Delta \text{Prices} \times \frac{H_{06}}{NW_{06}}$	-0.131*** (0.005)	-0.140*** (0.005)
$\Delta \text{Months Supply}$	0.125*** (0.009)	
$\Delta \text{Time on Market}$		0.027*** (0.002)
Constant	0.891*** (0.105)	0.872*** (0.110)
N	1021	935
R^2	0.540	0.545

- ▶ Measure the effect of falling prices *and* rising illiquidity.
- ▶ Each additional month of time on the market is associated with a 0.81 percentage point rise in default.

ENDOGENOUS LIQUIDITY: AMPLIFICATION

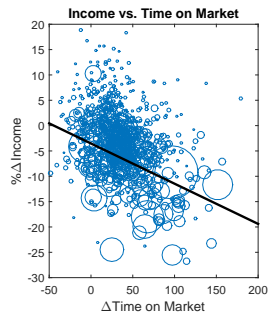
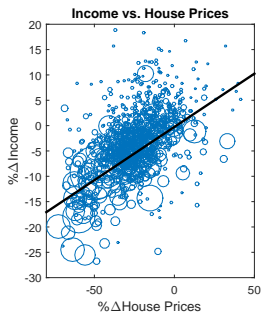
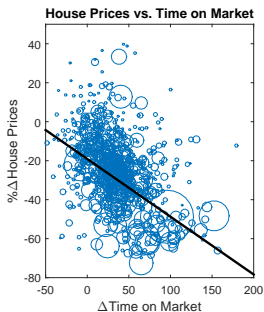
	Baseline	Exogenous Liquidity	Amplification
Δ House Prices	-23.4%	-18.6%	25.8%
Δ Consumption	-9.9%	-7.4%	33.6%
Δ Foreclosures	+5.1pp	+1.1pp	343.5%

- ▶ Default probabilities and collateral values affect the supply of credit, i.e. the spread between $q_t(\cdot)$ and $\frac{1}{1+r}$.
- ▶ Changes in credit impact housing market conditions.



ENDOGENOUS LIQUIDITY: AMPLIFICATION

- ▶ Micro-data reveal a negative correlation between housing illiquidity and both house prices and income.
- ▶ Add housing illiquidity to Mian-Sufi regressions.



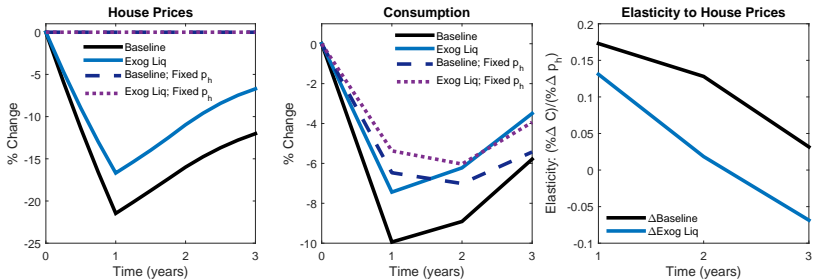
ENDOGENOUS LIQUIDITY: AMPLIFICATION

$$\% \Delta Y_{06-11}^i = \beta_0 + \beta_1 \% \Delta HNW_{06-11}^i + \beta_2 \Delta \text{Illiquidity}_{05-08}^i$$

	(1)	(2)	(3)	(4)	(5)	(6)
	% Δ AGI	% Δ AGI	% Δ AGI	% ΔE_{NT}	% ΔE_{NT}	% ΔE_{NT}
% Δ Prices $\times \frac{H_{06}}{NW_{06}}$	0.237*** (0.011)	0.202*** (0.012)	0.229*** (0.012)	0.118*** (0.023)	0.091*** (0.025)	0.090*** (0.026)
Δ Months Supply		-0.188*** (0.022)			-0.143*** (0.047)	
Δ Time on Market			-0.029*** (0.005)			-0.035*** (0.010)
Constant	-1.803*** (0.241)	-0.780*** (0.262)	-0.859*** (0.275)	-0.771 (0.494)	0.010 (0.553)	0.198 (0.575)
<i>N</i>	1023	1023	934	1023	1023	934
<i>R</i> ²	0.304	0.350	0.348	0.025	0.034	0.036

- The rise in months of supply during the crisis implies a 2 percentage point decline in AGI and more than a 1.5 percentage point drop in nontradable employment.

AGGREGATE SPILLOVERS



- ▶ Even with fixed prices, endogenous liquidity magnifies the consumption drop (by 20%) and is more persistent.
- ▶ \$30 decrease in AGI for every \$1,000 fall in house prices; \$31 for every one-day increase in selling delays.

$$\Delta AGI_{06-11}^i = \beta_0 + \beta_1 \Delta Prices_{06-11}^i + \beta_2 \Delta Illiquidity_{05-08}^i$$

BALANCE SHEET DEPTH

- Highly leveraged owners accounted for a disproportionate share of the aggregate consumption decline.

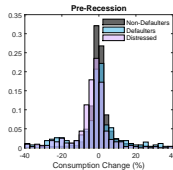
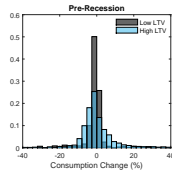
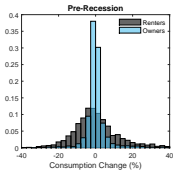
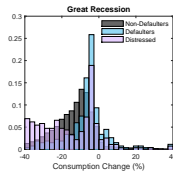
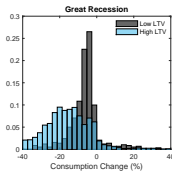
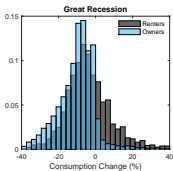
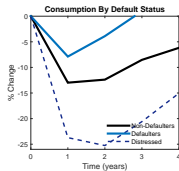
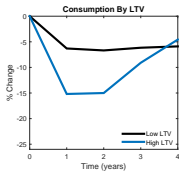
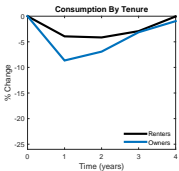
	Renters	Owners	Low LTV	High LTV
<i>Model</i>				
Pre-Crisis Share	16.0%	84.0%	18.9%	19.0%
Share of Decline	6.2%	93.8%	5.4%	28.9%
<i>Data</i>				
Pre-Crisis Share	23.9%	76.1%	13.4%	13.2%
Share of Decline	5.1%	94.9%	8.4%	22.3%

BALANCE SHEET DEPTH: GROSS VS. NET POSITIONS

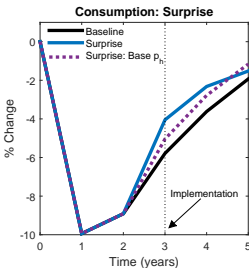
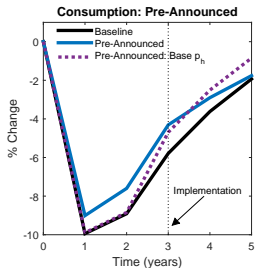
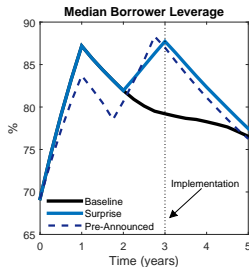
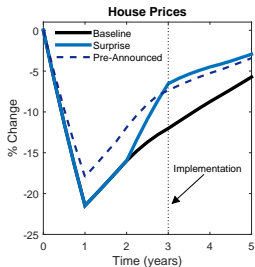
- ▶ Highly leveraged owners experience much larger drop in consumption than renters with similar net worth but shallower and more liquid balance sheets.
- ▶ Balance sheets affect higher order movements also. Owner consumption growth distribution shifts down and fans to the left during the housing bust.

	<i>Low NW–By Tenure</i>		<i>Medium NW–Owners</i>		<i>High NW–Owners</i>	
	Renters	Owners	Small h	Medium h	Medium h	Large h
<i>Model</i>						
Δ Consumption	–5.1%	–16.0%	–11.8%	–22.3%	–5.7%	–8.9%
Pre-Crisis LTV	—	84.8%	65.2%	82.3%	31.5%	58.8%
<i>Data</i>						
Δ Consumption	–5.5%	–13.4%	–7.4%	–30.8%	–1.8%	–7.3%
Pre-Crisis LTV	—	80.9%	75.4%	93.6%	40.1%	55.0%

BALANCE SHEET DEPTH: HIGHER ORDER MOMENTS



THE POWER OF MORTGAGE RATE REDUCTIONS



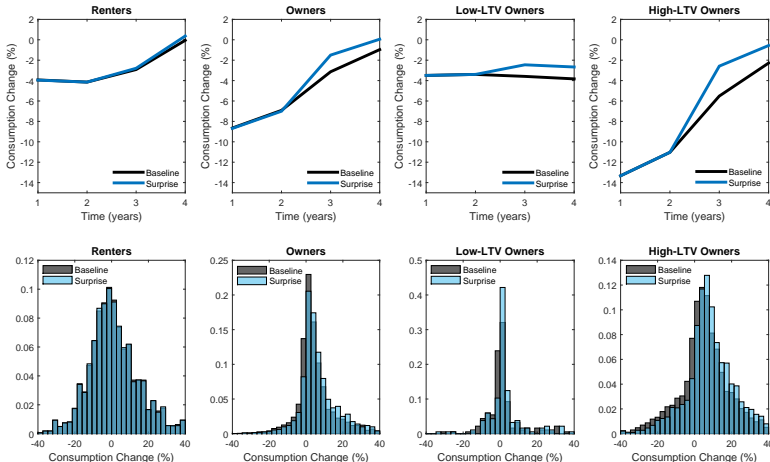
THE POWER OF MORTGAGE RATE REDUCTIONS

- ▶ Consumption responds to lower mortgage rates because of, cash flow effects, intertemporal substitution, and balance sheet repair.
- ▶ The majority (59%) of the consumption boost comes from balance sheet repair caused by the equilibrium improvement in house prices.

	<i>House Prices</i>		<i>Consumption</i>	
	Change	Recovery	Change	Recovery
<i>Surprise</i>				
Fixed Prices	—	—	+0.7pp	12.9%
Equilibrium	+5.3pp	47.2%	+1.7pp	30.0%
<i>Pre-Announced</i>				
Fixed Prices	—	—	+1.1pp	18.9%
Equilibrium	+4.4pp	39.6%	+1.5pp	25.5%

RATE REDUCTIONS AND HETEROGENEITY

- ▶ Highly leveraged owners experience a 2.9 percentage point increase in consumption compared to only 1.2 percentage points for less indebted owners.

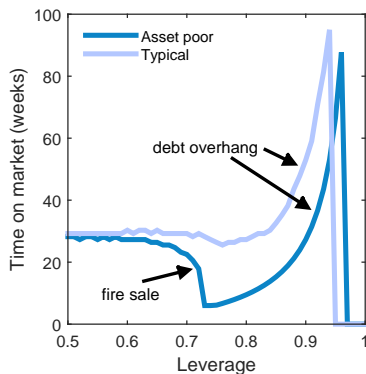
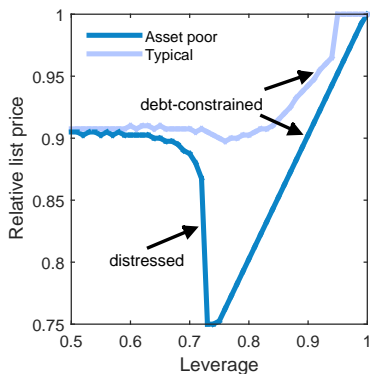


CONCLUSIONS

- ▶ Shocks to earnings skewness (higher left tail risk) and borrowing constraints needed to rationalize the bust.
- ▶ Higher foreclosure activity from the liquidity-adjusted double trigger induces liquidity spirals that amplify the drop in house prices and consumption.
- ▶ Endogenous liquidity needed to generate sales drop.
- ▶ Balance sheet depth (i.e. gross rather than net positions) critically shapes transmission of housing to consumption.
- ▶ Lowering mortgage rates accelerates the recovery in house prices and consumption primarily through balance sheet repair rather than intertemporal substitution.

HOUSING SEARCH FRICTIONS: I

- ▶ At low leverage, list prices insensitive to mortgage debt.
- ▶ Distressed sellers with some equity cushion who cannot borrow on good terms set firesale price.
- ▶ Debt overhang for very high leverage \Rightarrow long delays.



HOUSING SEARCH FRICTIONS: II

- ▶ Sellers choose p_t^{list} ; sell w/prob $\eta_t^{sell} = \eta_s(\theta_s(p_t^{list}, h; \Phi_t))$.
- ▶ Buyers choose p_t^{bid} ; buy w/prob $\eta_t^{buy} = \eta_b(\theta_b(p_t^{bid}, h; \Phi_t))$.
- ▶ Dynamic sorting problem simplified by brokers $\Rightarrow \theta_{st}$ and θ_{bt} depend on $\Phi_t(\cdot)$ only through sufficient statistic p_t :

$$\begin{aligned} \kappa_b h_t &\geq \overbrace{\alpha_{bt}(\theta_{bt}(p_t^{bid}, h_t))}^{\text{prob of match}} \overbrace{(p_t^{bid} - p_t h_t)}^{\text{net revenue}} \\ \kappa_s h_t &\geq \overbrace{\alpha_{st}(\theta_{st}(p_t^{list}, h_t))}^{\text{prob of match}} \overbrace{(p_t h_t - p_t^{list})}^{\text{net revenue}} \end{aligned}$$

$$\Rightarrow \eta_t^{sell}(p_t^{list}, h) = \left(\frac{p_t h - p_t^{list}}{\kappa_s h} \right)^{\frac{\gamma_s}{1-\gamma_s}} \quad \eta_t^{buy}(p_t^{bid}, h) = \left(\frac{p_t^{bid} - p_t h}{\kappa_b h} \right)^{\frac{\gamma_b}{1-\gamma_b}}$$

- ▶ Equilibrium determination of sufficient statistic $p_t(\Phi_t)$:

$$\int h_i^* \eta_b(\theta_b(p_t^{bid*}, h_i^*; p_t)) d\Phi_t^{rent} = \overbrace{Y_{ht}(p_t)}^{\text{new housing}} + \overbrace{S_t^{REO}(p_t)}^{\text{REO housing}} + \overbrace{\int h \eta_s(\theta_s(p_t^{list*}, h; p_t)) d\Phi_t^{own}}^{\text{sold by owner}}$$

CALIBRATION I

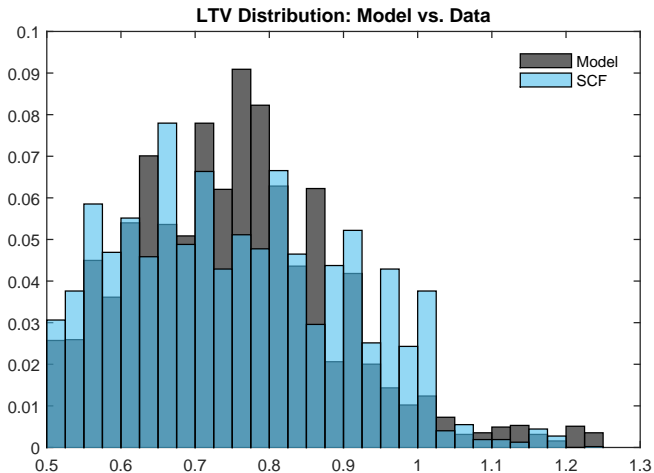
- Parametrize the economy to match key statistics from before the housing bust and Great Recession.

Description	Parameter	Value	Source/Reason
External 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)
Transition to Top 1%	$\pi_{3,4}$	0.0041	Kuhn and Ríos-Rull (2013)
Persistence of Top 1%	$\pi_{4,4}$	0.9	Kuhn and Ríos-Rull (2013)
Intratemp. Elas. of Subst.	ν	0.13	Flavin and Nakagawa (2008)
Risk Aversion	σ	2	Standard Value
Structures Share	α_S	30%	Favilukis et al (2017)
Land Share	α_L	33%	Lincoln Inst Land Policy
Taxes/Maintenance (Annual)	γ	2.8%	Moody's
Depreciation (Annual)	δ_h	1.4%	BEA
Rent-Price Ratio (Annual)	r_a	3.5%	Sommer et al (2013)
Risk-Free Rate (Annual)	r	-1.0%	Federal Reserve Board
Servicing Cost (Annual)	ϕ	3.6%	3.6% 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

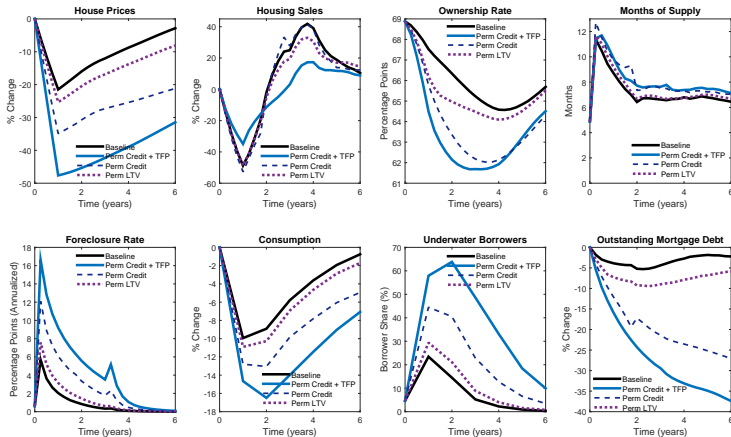
Description	Parameter	Value	Target	Model	Source/Reason
Jointly Determined Parameters					
Homeownership Rate	\bar{a}	2.7100	69.2%	69.2%	Census
Starter House Value	h_1	3.2840	2.75	2.75	Corbae and Quintin (2015)
Mean Net Worth	z_4/z_3	5.500	2.83	2.84	2007 SCF
Housing Wealth (Owners)	ω	0.8159	3.97	3.97	2007 SCF
Borrowers with $LTV \geq 90\%$	β	0.9737	10.8%	10.7%	2007 SCF
Months of Supply	ξ	0.0013	4.90	4.89	Nat'l Assoc of Realtors
Avg. Buyer Search (Weeks)	γ_b	0.0940	10.00	9.98	Nat'l Assoc of Realtors
Maximum Bid Premium	κ_b	0.0209	2.5%	2.5%	Gruber and Martin (2003)
Maximum List Discount	κ_s	0.1256	15%	15%	RealtyTrac
Foreclosure Discount	χ	0.1370	20%	20%	Pennington-Cross (2006)
Foreclosure Starts (Annual)	γ_s	0.6550	1.50%	1.25%	MBAA Delinquency Survey
Model Fit					
Borrowers with $LTV \geq 80\%$			20.6%	26.5%	2007 SCF
Borrowers with $LTV \geq 95\%$			6.7%	6.0%	2007 SCF
Mean Owner Liquid Assets			1.19	1.53	2007 SCF
Median Owner Liquid Assets			0.23	0.27	2007 SCF

CALIBRATION III



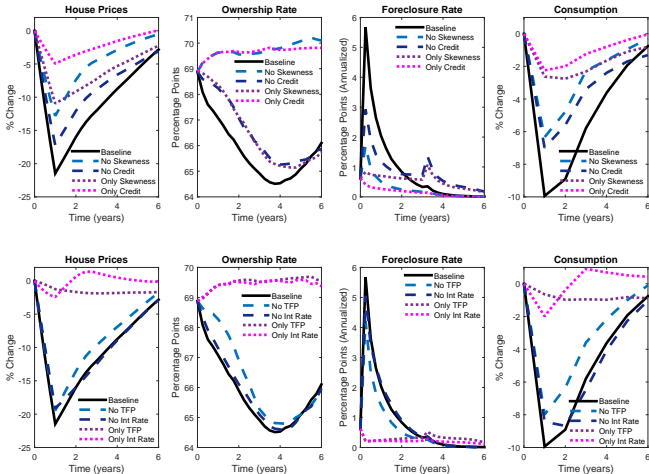
MAKING THE SHOCKS PERMANENT

- Expectations of terminal conditions matter for the crisis.



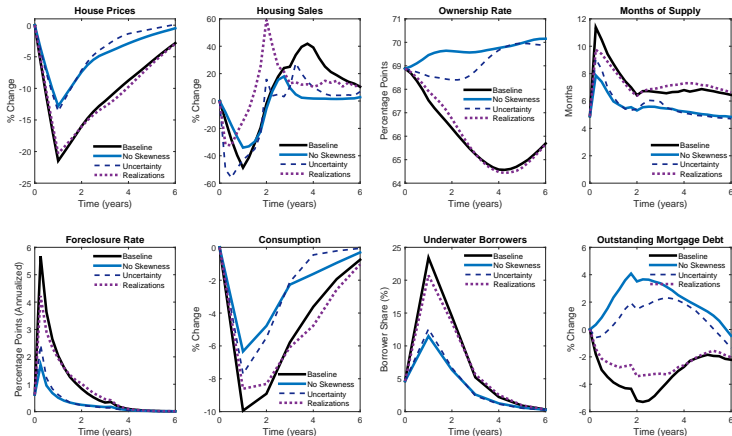
THE IMPORTANCE OF EARNINGS SKEWNESS SHOCKS

► Higher left tail risk necessary for homeownership decline.



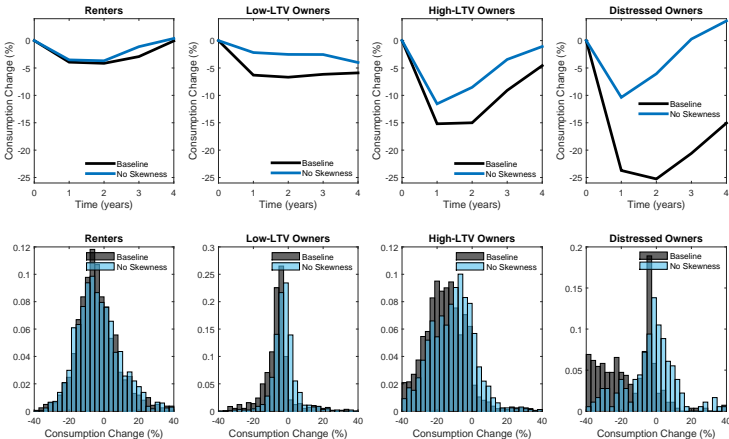
EARNINGS REALIZATIONS VS. UNCERTAINTY

- ▶ Bad earnings realizations have a larger effect, though uncertainty matters.



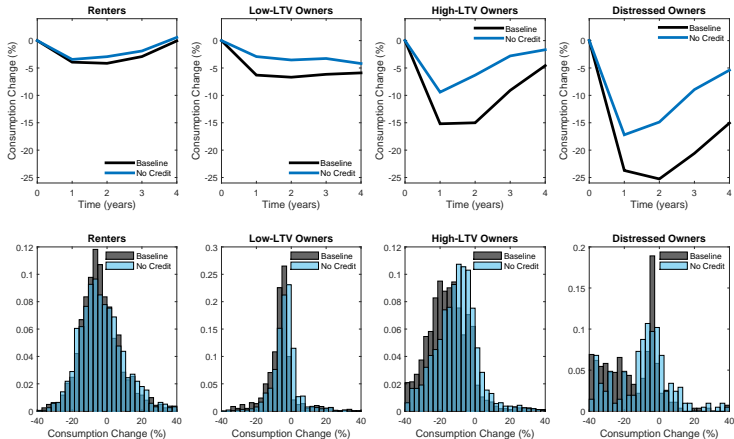
DISTRIBUTIONAL EFFECTS OF SKEWNESS SHOCKS

- ▶ Distressed owners are most affected by skewness shocks.



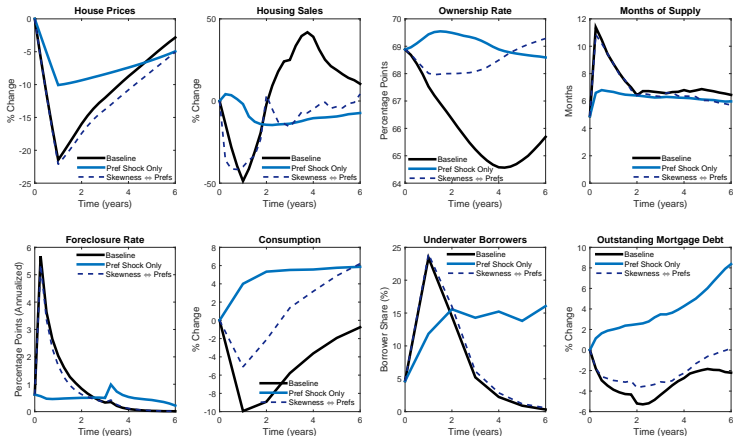
DISTRIBUTIONAL EFFECTS OF CREDIT SHOCKS

- ▶ High-LTV owners are most affected by tighter borrowing.



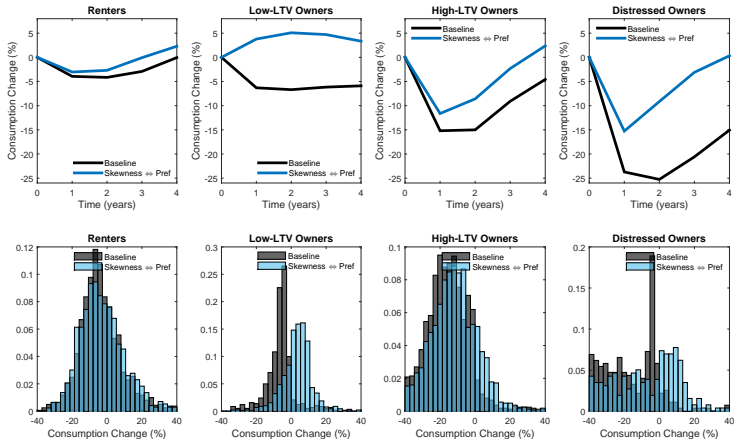
ALTERNATIVES: PREFERENCE SHOCKS

- ▶ Counterfactual homeownership and consumption dynamics.



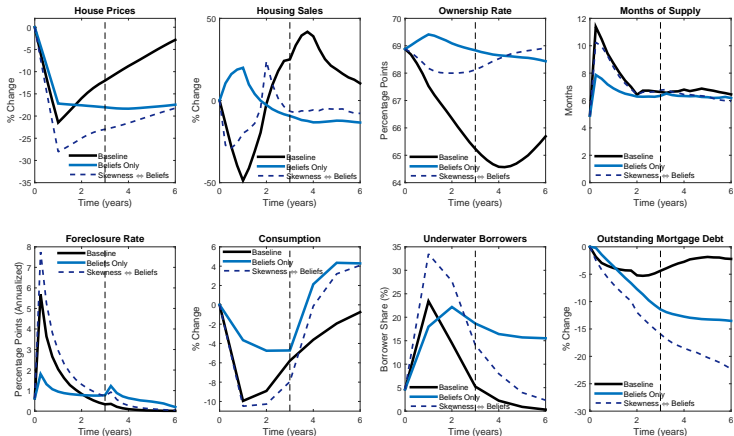
SWAPPING SKEWNESS WITH PREFERENCE SHOCKS

- ▶ Counterfactual consumption for low-LTV owners.



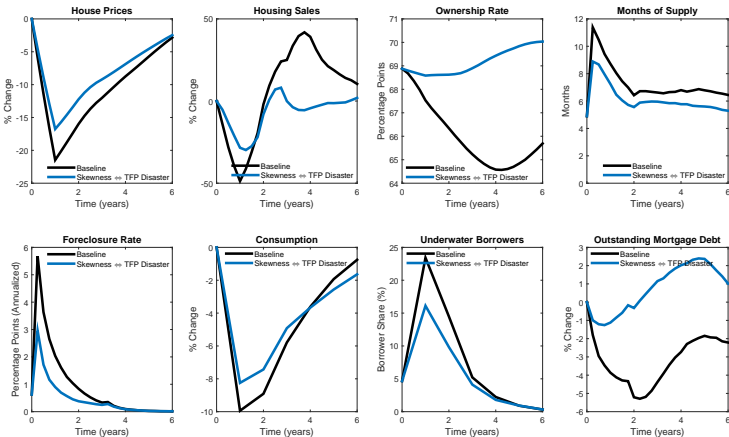
ALTERNATIVES: HOUSING PESSIMISM

- ▶ Counterfactual homeownership and debt dynamics.
- ▶ Bhutta (2015): debt decline due to fewer first-time buyers.



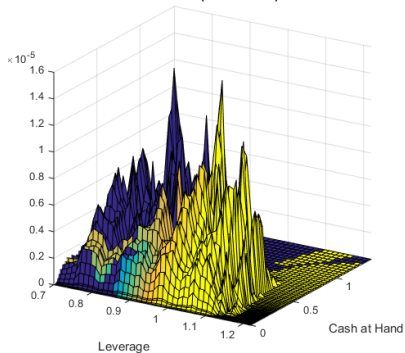
ALTERNATIVES: PRODUCTIVITY DISASTERS

- ▶ Insufficient volatility and counterfactual homeownership.

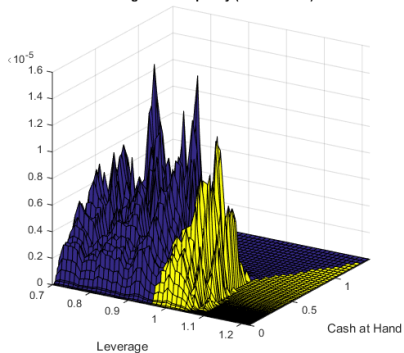


THE LIQUIDITY-ADJUSTED DOUBLE TRIGGER

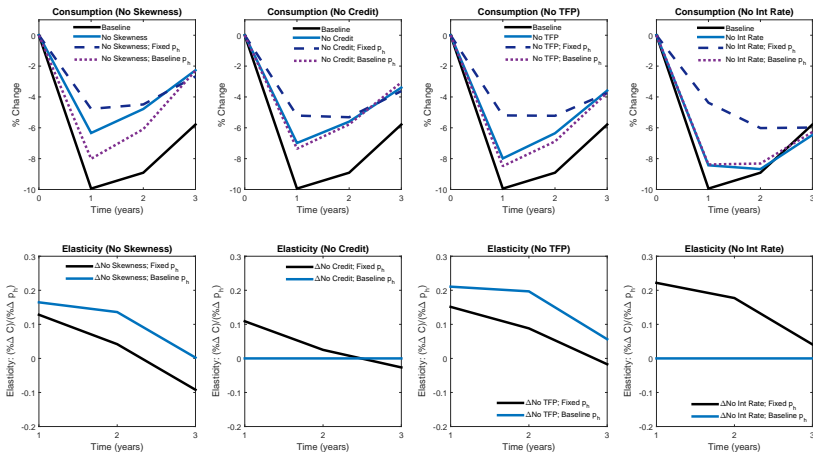
Baseline (Low Income)



Exogenous Illiquidity (Low Income)



NONLINEARITIES AND SHOCK DEPENDENCE



NONLINEARITIES AND SHOCK DEPENDENCE

