Financial Intermediation, House Prices, and the Welfare Effects of the U.S. Great Recession

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This paper

- The effects of the housing wealth drop in the U.S. Great Recession (GR) on welfare of leveraged and un-leveraged households

- Quantitative question(s):
  1. who lost more?
  2. redistribution between agents?
  3. what role for the leveraging/de-leveraging cycle?

- Measurement tool is a dynamic general equilibrium model: heterogeneous households - endowment economy - endogenous collateral constraint

- Financial intermediation shock: loosening/tightening lending standards drive aggregate change in supply of credit and leverage

Motivation 1

- Between 2001 and 2007 mortgage debt expanded in real terms by 59%
- Outstanding mortgage loans over housing value rose despite the 19% increase in housing value
- Borrowers lost more housing wealth $(q \cdot h)$ than savers:

Status in 2007	savers	borrowers
$\Delta_{07,09}(qh)$	-9.2%	-16.6%

- Borrowers' loss in housing wealth is increasing in leverage

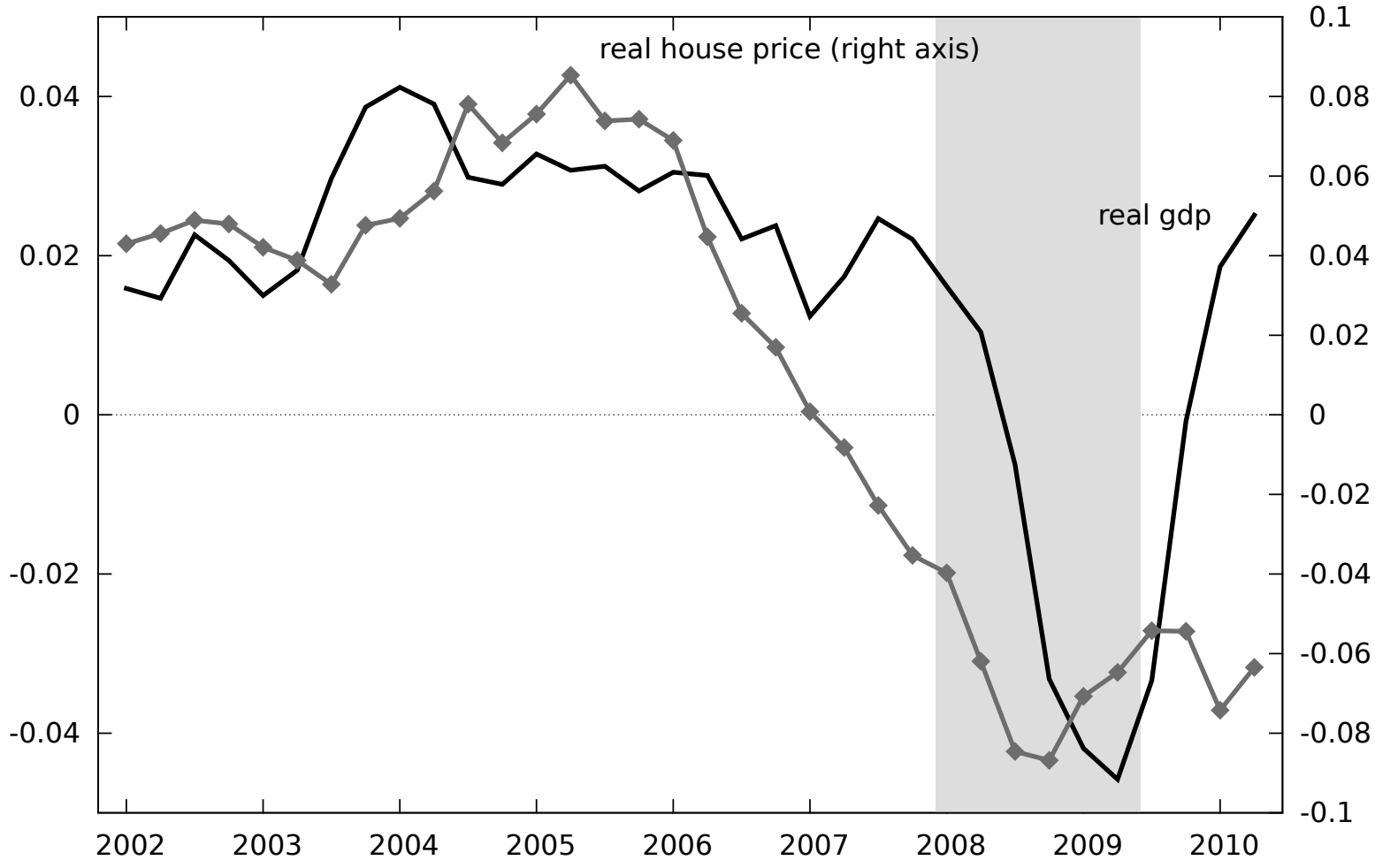
$\frac{\text{Debt}}{\text{housing wealth}}$ in 2007	$< 43\%$	43 - 67%	$>67\%$
$\Delta_{07,09}(qh)$	-12.9%	-16.5%	-23.5 %

(source: 2001 and 2007-2009 Panel SCF)

▸ households balance sheet

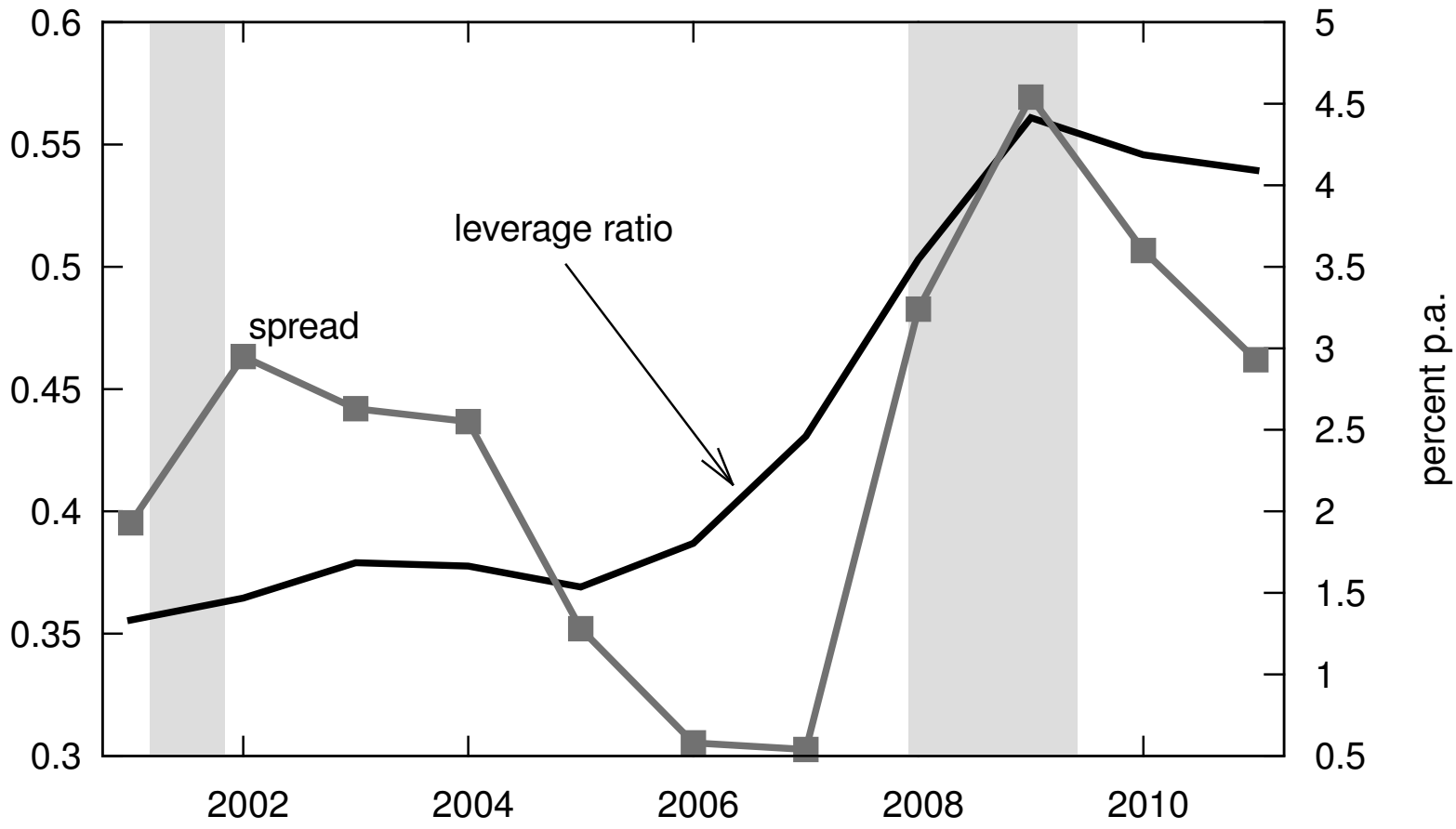
Motivation 2

House price and aggregate income move together



Motivation 3

Aggregate leverage and financial intermediation



Our exercise

- Calibrate the model both from micro and macro data
- Simulate the US economy in the period 2005-2009: contemporaneous negative realization of income and spreads that follows a period of positive realization
- Exogenous aggregate income shock: in the GR explain the 75% drop in house prices and capture the observed corr(GDP,HP)
- Financial intermediation generate a spread between interest rates: decreasing (increasing) spreads generate a leveraging (de-leveraging)

The model economy

- Two type of households: Borrowers and Savers, different time discount factors $\beta_s > \beta_b$
- Savers unconstrained, borrowers are subject to collateral constraint
- Competitive and risk neutral financial intermediaries
- Income and intermediation shocks follow exogenous Markov process

Financial intermediaries

Intermediaries collect savings and transform them into loans to maximize profits:

$$\max_{D_t, S_t} \qquad R_{D,t} D_t - R_t S_t$$

subject to the constraint

$$D_t \leq \theta_t S_t \qquad \theta_t \in (0, 1] \; \forall \; t$$

Competitive financial intermediation sector implies:

$$\frac{R_{D,t}}{R_t} = \frac{1}{\theta_t}$$

Households

- Borrowers

$$\max \qquad U_b = E_0 \sum_{t=0}^{\infty} \beta_b^t \left\{ u(c_{b,t}, h_{b,t}) \right\}$$

subject to

$$c_{b,t} + q_t h_{b,t} + d_t \leq y_t + q_t h_{b,t-1} + R_{D,t-1} d_{t-1} + \Upsilon_t$$

collateral constraint

$$R_{D,t} d_t + m E_t(q_{t+1}) h_{b,t} \geq 0$$

$$d_t \leq 0$$

- Savers analogous, with budget constraint

$$c_{s,t} + q_t h_{s,t} + s_t \leq y_t + q_t h_{s,t-1} + R_{t-1} s_{t-1} + \Upsilon_t$$

▸ Optimality conditions

Wealth recursive equilibrium

- Define relative wealth share of borrowers:

$$\omega_{b,t} = \frac{R_{D,t-1} d_{b,t-1} + q_t h_{b,t-1}}{q_t}$$

- Wealth distribution across agents summarized by one number:

$$\Omega = (\omega_b, 1 - \omega_b), \qquad \omega_b \in [0, 1]$$

- Solve for an equilibrium where prices and allocations are time invariant functions of the exogenous shocks and the borrowers' wealth share

▸ CE ▸ CM

Calibration of key parameters to SCF data

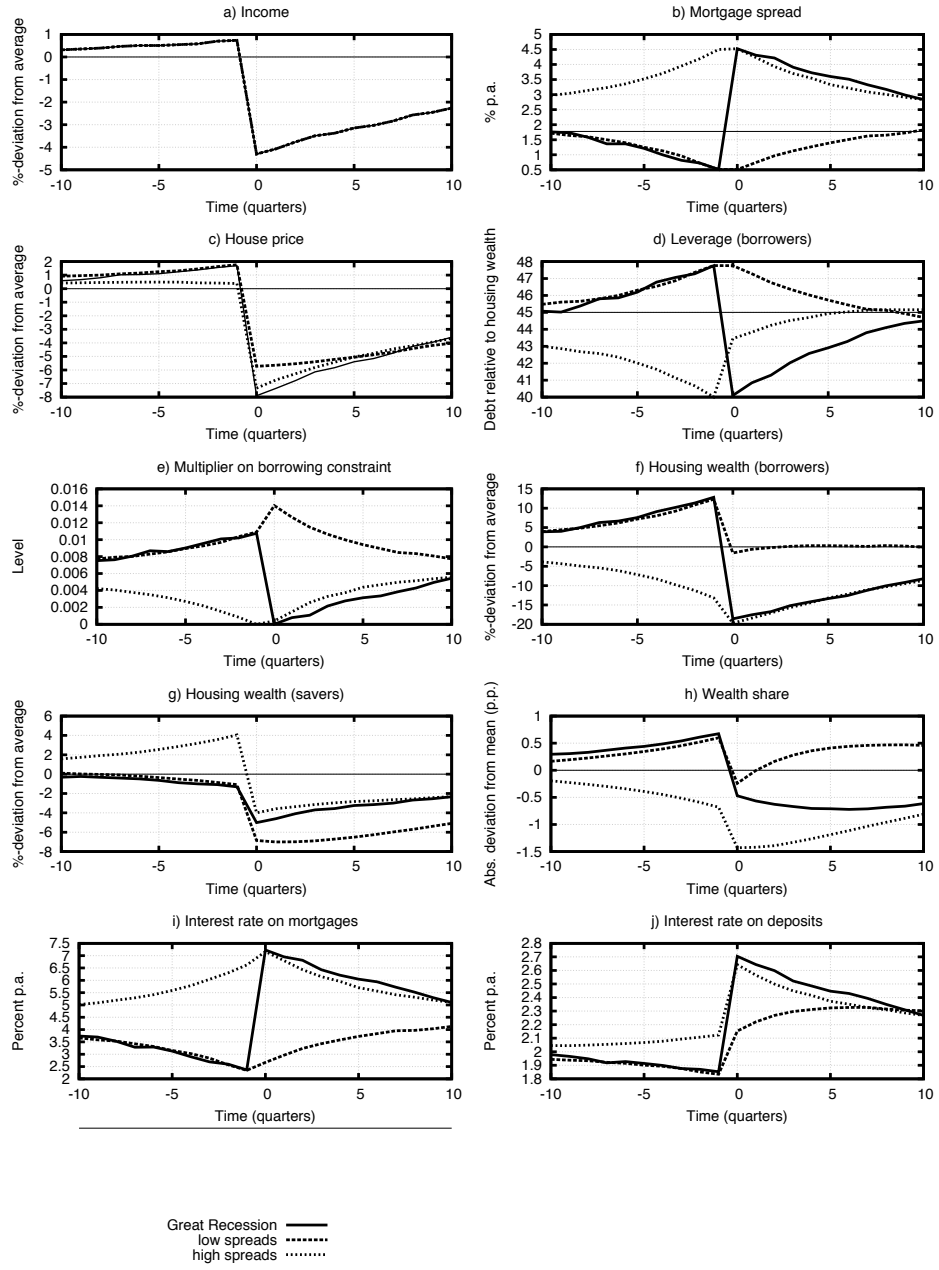
Parameter	Value	Model	Data	Source/Target
Preferences				
γ	2			Benchmark value from literature
ρ	0			Benchmark value from literature
ϕ	0.95	196%	196%	Average housing value over GDP (annualized) 1998 - 2009
Population Parameters				
β_s	0.98	2%	2%	Average real interest rate 1980 - 2009
β_b	0.935	11.7%	11.3%	Borrowers' financial wealth share (SCFaverage 1998-2009)
m	0.49	45%	44.4%	Borrowers' leverage ratio (SCF average between 1998-2009)
n_b	0.42	42%	42%	Share of borrowers (SCF average 1998-2009)

▸ uf ▸ shocks

Quantitative Exercise

- Go along the equilibrium path and select all recessions where financial intermediation and income are high in $t-1$ and low in t
- Construct event window: averages over all recessions matching the above criteria
- Effect on house prices, leverage and wealth
- Estimate welfare consequences for borrowers and savers
- Study two counter-factual scenarios:
  1. What would have happened if spreads would have remained low during recession (no de-leveraging)?
  2. What if leverage would have been low already previous to the recession (no leveraging up)?

Benchmark results



Results

	Δq	$\Delta(qh_b)$	$\Delta(qh_s)$	$\Delta\omega_b$	λ_b	λ_s
Data	-11.05	-16.6	-9.2	?	?	?
On impact, relative to pre-recession peak						
Great Recession	-9.44	-27.83	-3.75	-1.14	-3.29	-1.12
Low spreads	-7.36	-12.36	-5.83	-0.84	-2.86	-1.21
High spreads	-7.69	-7.51	-7.73	-0.75	-2.81	-1.21

Comment on benchmark

- Great Recession hurts borrowers more than savers

- Income shocks drive house prices
- Shocks to financial intermediation main driver behind household leveraging/de-leveraging (occasionally binding constraint)

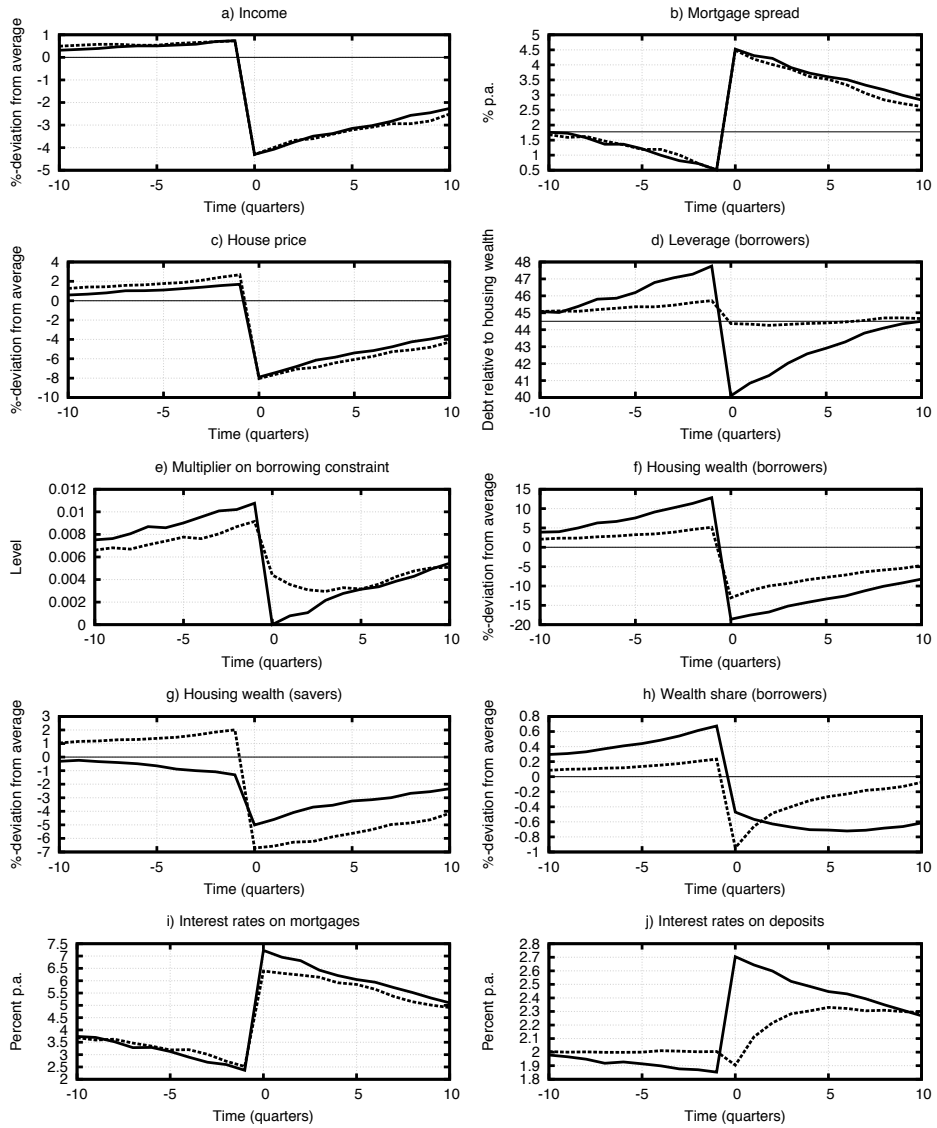
- Borrowers loose from leveraging/de-leveraging cycle:
  1. Counterfactual 1: with low spreads before and during recession, borrowers loose 13 percent less, savers more
  2. Counterfactual 2: the lower the leverage ex-ante the smaller borrowers loss

Introducing adjustment costs

- Housing is much more volatile than the data (this comes from the spread shock)

- We propose a solution with ad-hoc adjustment cost:
  1. Functional form: $q_t \frac{\eta}{2}(h_{i,t} - \bar{h}_i)^2$
  2. No need to introduce another state variable
  3. η assumed to be the same for savers and borrowers and calibrated to match the 9% drop for savers

Adjustment costs



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	Δq	$\Delta(qh_b)$	$\Delta(qh_s)$	$\Delta\omega_b$	λ_b	λ_s
Data	-11.05	-16.6	-9.2	?	?	?
On impact, relative to pre-recession peak						
Great Recession	-10.44	-17.31	-8.54	-1.18	-3.09	-1.14
Low spreads	-7.03	-10.35	-6.11	-0.76	-2.76	-1.22
High spreads	-7.18	-9.62	-6.55	-0.75	-2.75	-1.22

Comments on adjustment costs results

- Good side - better match with the data
  1. Volatility of housing
  2. Quantitatively the house price drop (more powerful spread shock)

- Bad side:
  1. Constraint (virtually always binds)
  2. Initial distribution has no effect on wealth and welfare

Other checks

- Always binding: it reacts similarly to a model with adjustment cost but leverage constant

- Risk Aversion: the higher the risk aversion the higher the equilibrium house price drop

- Elasticity of substitution: increase the volatility of housing demand

Conclusion

- We quantify the size of welfare losses associated to housing wealth drop

- Using a simple model of borrowers and savers with financial intermediation shocks and occasionally binding collateral constraint, we find that
  - welfare loss of Great Recession larger for borrowers
  - high leverage makes welfare cost more sensitive to house price shocks
  - non-linearity is virtually absent in model with adjustment costs

▸ literature

Thanks a lot for your attention!

Back-up Slides

Households Balance Sheet

$$W = qh + RS + R_D D \qquad S \geq 0, \quad D \leq 0$$

- Define net savings: $NS = RS + R_D D$
- RS=savings bonds + directly held bonds + the cash value of life insurance + certificates of deposits + quasi-liquid retirement accounts + all other types of transaction accounts
- $R_D D$=debt secured by primary residence + the debt secured by other residential property + credit card debt + other forms of debt

$\Rightarrow$ savers: $NS > 0$

$\Rightarrow$ borrowers: $NS < 0$

$\Rightarrow$ spread: R_D/R

$\Rightarrow$ borrowers' wealth share $\omega_b = \frac{qh_b + RS_b + R_D D_b}{q}$

Savers are older (59 vs 47) - higher income - similar years of education - same cars - more equity

▸ SCF data

Households' optimality conditions

- Savers:

$$u_c(c_{s,t}, h_{s,t}) = \beta_s E_t[u_c(c_{s,t+1}, h_{s,t+1})]R_t$$

$$u_c(c_{s,t}, h_{s,t}) = \frac{1}{q_t} u_h(c_{s,t}, h_{s,t}) + \beta_s E_t[\frac{q_{t+1}}{q_t} u_c(c_{s,t+1}, h_{s,t+1})]$$

- Borrowers:

$$u_c(c_{b,t}, h_{b,t}) = \beta_b E_t[u_c(c_{b,t+1}, h_{b,t+1})R_{L,t}] + \psi_t R_{L,t}$$

$$u_c(c_{b,t}, h_{b,t}) =$$
$$\frac{1}{q_t} u_h(c_{b,t}, h_{b,t}) + \beta_b E_t \left[\frac{q_{t+1}}{q_t}(u_c(c_{b,t+1}, h_{b,t+1}) + \psi_t m)\right]$$

▸ Households

Competitive Equilibrium

Given a initial distribution of housing stock and initial shocks $\{y_0, \theta_0\}$, a financial market equilibrium for economy $\mathcal{E}$ is given by a collection of allocations $\{h_{s,t}, h_{b,t}, c_{s,t}, c_{b,t}, s_t, d_t, S_t, D_t\}_{t=0}^{\infty}$ and a collection of prices $\{q_t, R_{D,t}, R_t\}_{t=0}^{\infty}$, so that agents solve their respective maximization problems, and the following market clearing conditions hold:

- Housing market: $n_s h_{s,t} + n_b h_{b,t} = 1$
- Financial markets:
  1. Market for debt $D_t = -n_b d_t$
  2. Market for savings: $S_t = n_s s_t$
- Goods market: $\sum_{i=b,s} n_i c_{i,t} + (1 - \theta_t) S_t = y_t + \Upsilon_t$
  $\Rightarrow$ We set $\Upsilon_t \equiv (1 - \theta_t) S_t$

▸ Wealth Recursive

Computational method

- Compute an equilibrium where policy functions (prices and allocations) are time invariant functions of the state variables (exogenous shocks and the borrowers' wealth share)

- For each tuple consisting of wealth and exogenous shock, $\sigma = (w, z)$, we find policy functions $f(\sigma)$that satisfies equilibrium conditions

- Policy function iteration:
  1. Select a grid $\mathcal{W}$, an initial guess f^{init} and an error tolerance ϵ. Set $f^{prime} = f^{init}$
  2. For all $\sigma = (w, z)$, find the function $f(\sigma)$ that solves the equilibrium system of equations (and inequalities)
  3. Use the solution $f(\sigma)$ and the guess f^{prime} to update wealth tomorrow and interpolate f on the obtained values for wealth tomorrow
  4. Set $f^{prime} = f$ and repeat 2. and 3. unless $||f - f^{prime}|| < \epsilon$

▸ Wealth Recursive

Instantaneous Utility Function

$$u(c_{i,t}, h_{i,t}) = \frac{((\phi c_{i,t}^{\rho} + (1-\phi) h_{i,t}^{\rho})^{\frac{1}{\rho}})^{(1-\gamma)}}{1-\gamma}$$

▶ calibration

Calibration exogenous shocks

Parameter	Value	Model	Data	Source/Target
Intermediation shock				
π_H^θ	0.565		56.5%	Probability of low spreads during 1998-2009:II
ρ_θ	0.868	0.868	0.868	Autocorrelation of spreads during 1998-2009:II
θ_L	0.99578	4.5 %	4.5 %	high spread 4.5 percent p.a.
θ_H	0.995	0.5%	0.5 %	low spread 0.5 percent p.a.
Income shock				
π_H^y	0.85	15%	15%	Probability of recession 1980- 2009:II (NBER dates)
π_{LL}^y	0.95			Average duration of recession (NBER dates) 1980- 2009:II
y_L	0.9572	5%	5%	Peak to trough drop in GDP of 5 percent
y_H	1.0076			Normalization $E(y) = 1$

▸ calibration

Related literature

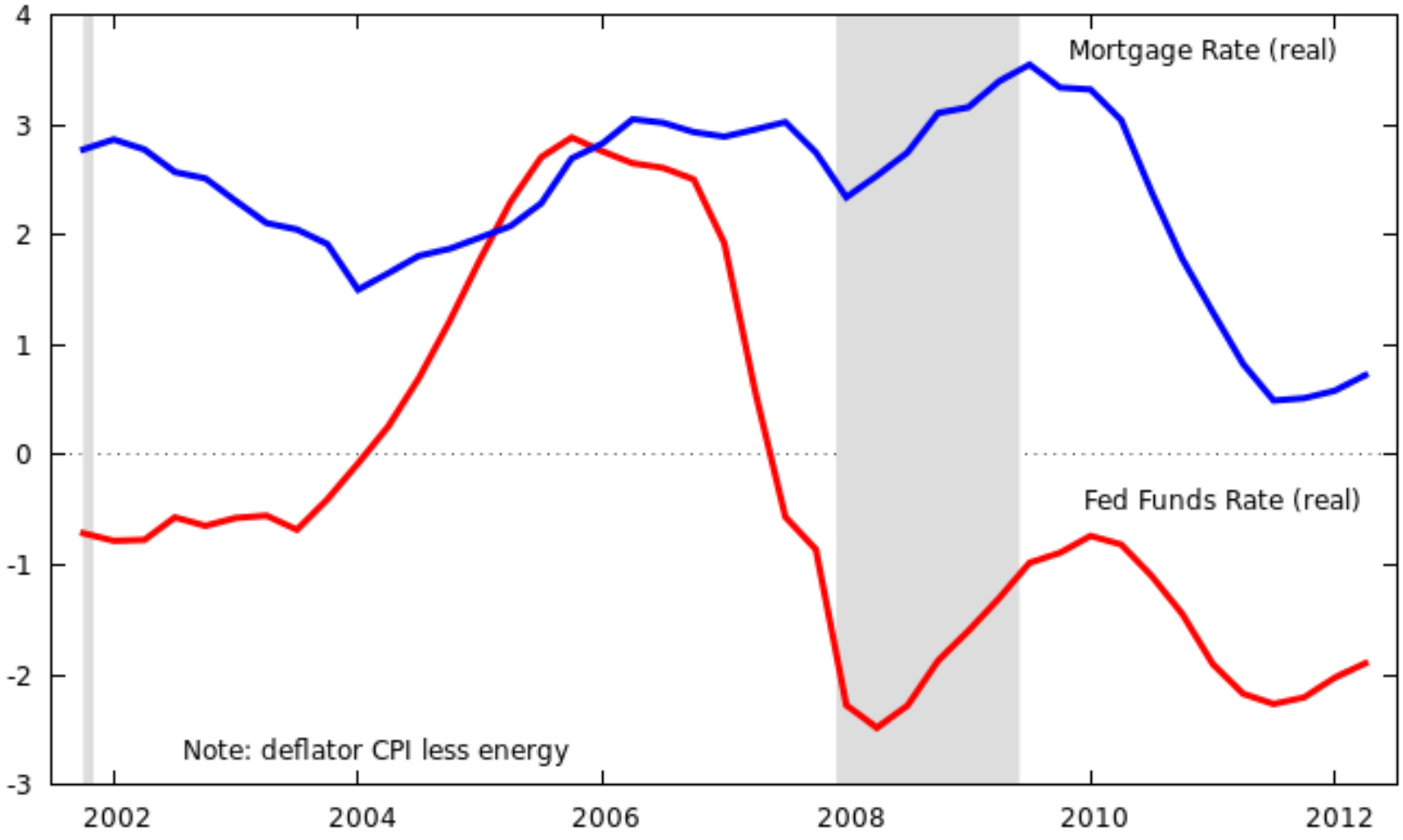
- Models with housing wealth and endogenous collateral constraint: Iacoviello (2005) and (2011); Iacoviello-Guerrieri L. (2012), Justiniano, Primiceri, and Tambalotti (2013) with occasionally binding collateral constraint

- Financial intermediation shocks: Cooper-Ejarque (2000); more recently credit spread shocks: Curdia-Woodford (2007) and Lorenzoni-Guerrieri V. (2012)

- Intergenerational distribution in the Great Recession: Glover et al. (2011) and Hur (2012)

▸ conclusions

Interest rates: data



▸ GR

Debt over housing wealth: aggregate data