Wall Street or Main Street: Who to Bail Out?

David Zarruk Valencia

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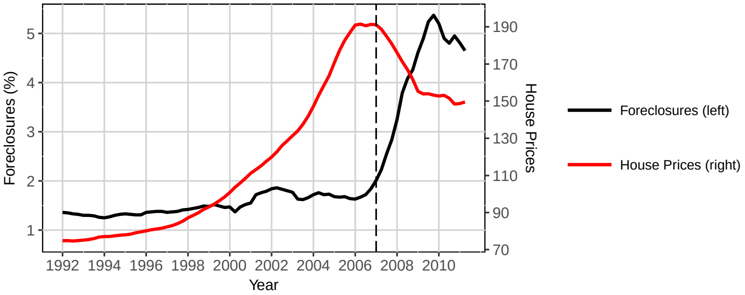
The Great Recession

- **Mortgage crisis:** decrease in house prices ⇒ increase in mortgage default/foreclosures



- Increase in foreclosures generated large losses to mortgage holders
- Threatened solvency of financial system

Question

- What is the government policy that maximizes household welfare subject to preserving banks' solvency during mortgage crises?

  1. **Bailouts** to banks to cover losses
  2. **Subsidies to households** to prevent additional foreclosures

- Emergency Economic Stabilization Act - 2008:

  1. **Bailouts** (TARP): $60 billion (CBO)
  2. **Subsidies to households** (HAMP): $75 billion

Trade-Off

The optimality of subsidies vs. bailouts is determined by 2 frictions:

1. Dead-weight loss on foreclosures of 20% (Campbell et al., 2011)
   - Prior to default households disinvest in the house
   - Vandalism and deterioration during vacancy
   - **Bailout policy** will pay dead-weight loss

2. Unobservable idiosyncratic house price component ($10\% - 14\%$ std):
   - Government does not observe decision to default
   - **Subsidy policy** $\Rightarrow$ additional 11% strategic default (Mayer et al., 2014)
   - If taxation is distortionary, this has welfare consequences

I Abstract From...

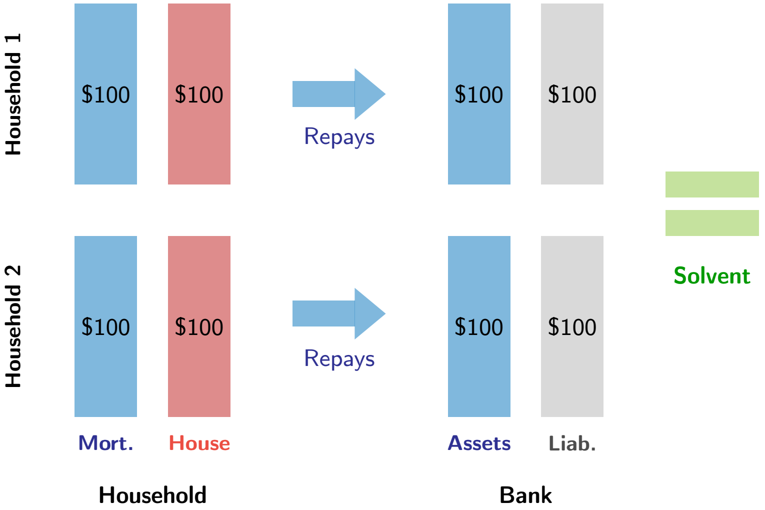
- **Moral Hazard:**

  "Trying to mete out punishment to perpetrators ... by letting major forms (banks) fail ... can pour gasoline on the fire ... the truly moral thing to do during a raging financial inferno is to put it out."

  Tim Geithner (President of NY Fed, 2009):

- **Price externality:**
  - Effect seems low: -1% on prices of houses $< 0.1m$
  - Including it reinforces results

Trade-Off



Household 1
$100
$100
Repays
$100
$100
Household 2
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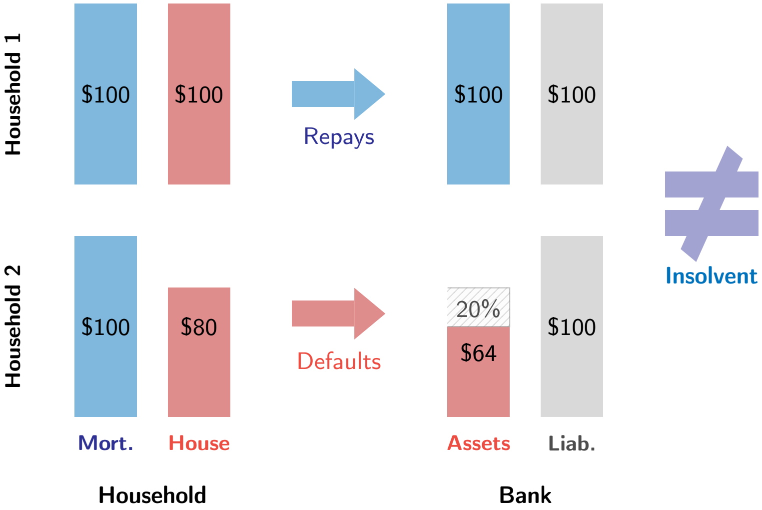
$100
Repays
$100
$100
Solvent
Mort.
House
Assets
Liab.
Household
Bank

Trade-Off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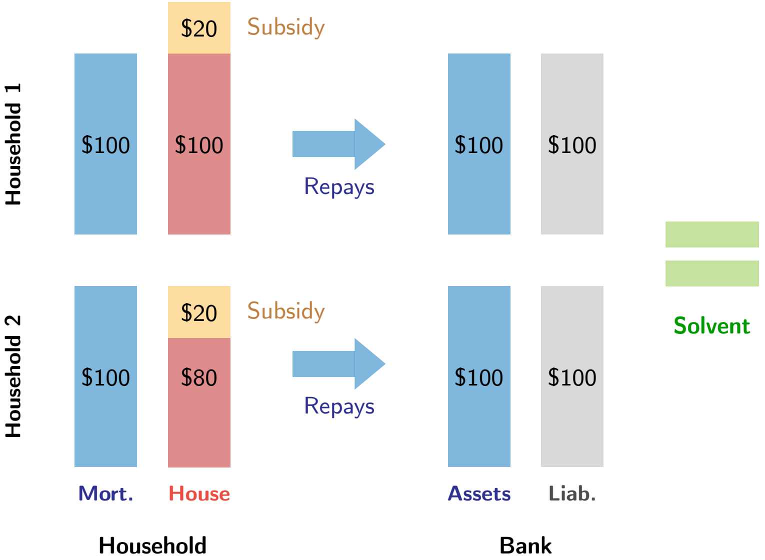
Trade-Off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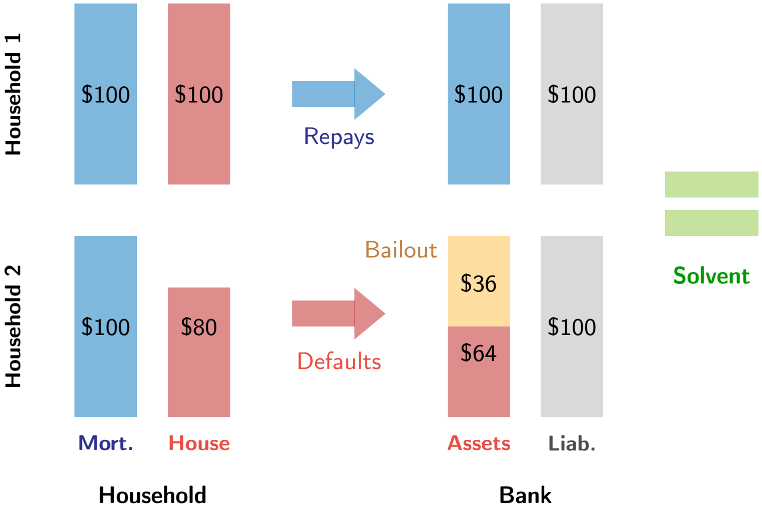
Trade-Off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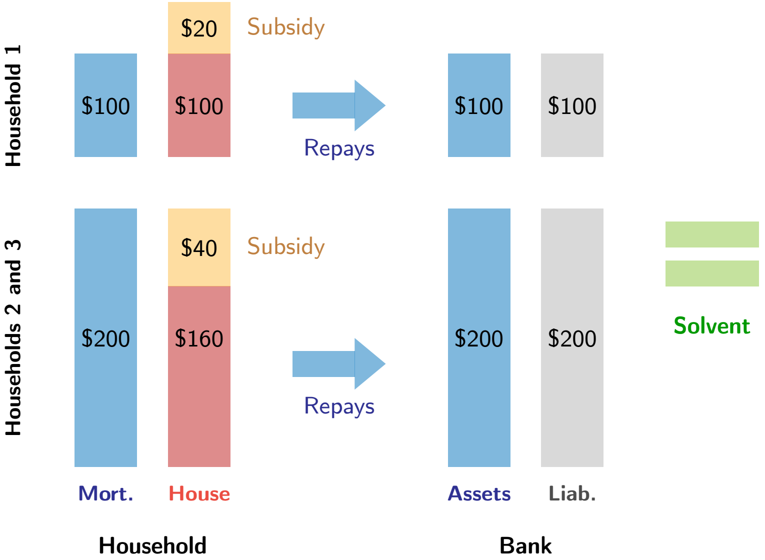
Trade-Off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$100
Repays
$100
$100
Households 2 and 3
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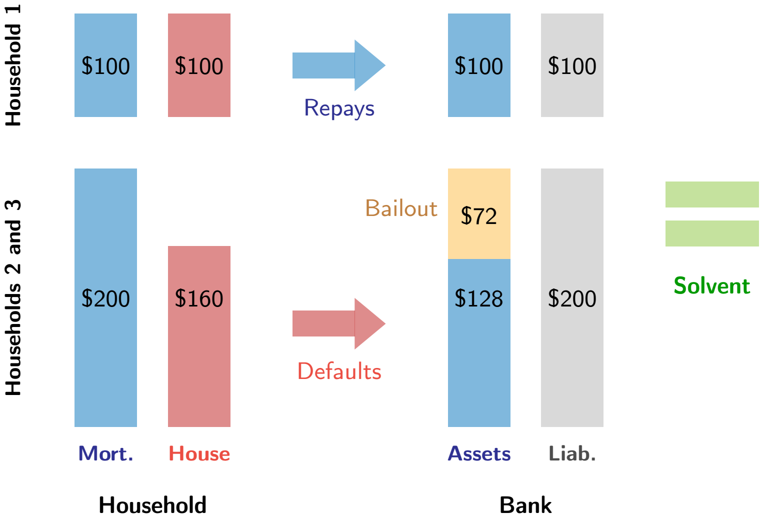
Subsidy
$200
$160
Repays
$200
$200
Solvent
Mort.
House
Assets
Liab.
Household
Bank

Trade-Off


Household 1
$100
$100
Repays
$100
$100
Households 2 and 3
$200
$160
Defaults
Bailout
$72
$128
$200
Solvent
Mort.
House
Assets
Liab.
Household
Bank

Preview of Results

1. In the data:
   - "Strategic default" is 11%:
     - Distortion given by Frisch elasticity is small
     - Not necessarily bad - can be welfare improving
   - Dead-weight loss of 20% is large
   - $\Rightarrow$ Subsidies outweigh bailouts!
2. Expanding HAMP to prevent *all* foreclosures and eliminating TARP:
   - Welfare improvement of $+$**0.2%** in consumption terms
3. Implementing HAMP with better "eligibility" (first best):
   - Welfare improvement of $+$**0.4%**
4. Expanding TARP and eliminating HAMP:
   - Welfare improvement of $-$**0.8%**

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Agents - Overview

1. Households
   - Overlapping generations, heterogeneous agents
   - Long term mortgages to finance housing
2. Mortgage originators
   - Zero profits loan by loan
3. Production firms
   - Linear technology, perfect competition
4. Government:
   - In steady state: social security
   - During crises: bailouts, mortgage subsidies and labor taxes
   - Maximizes welfare, subject to ex-post solvency of banks

Demographics + Preferences

- Overlapping generations, identical newborn households
- Live up to $T = 30$ periods with exogenous survival probability π_t
- Every period, cohort size $\left(1 + \sum_{t=1}^{T} \prod_{i=1}^{t} \pi_i\right)^{-1}$ enters economy
- Lifetime utility:

$$\mathbb{E}_0 \sum_{j=1}^{T} \beta^{j-1} \pi_j \left[\frac{\left(\psi \mathbf{c_{t+j}^t}^{\kappa} + (1-\psi) \mathbf{s_{t+j}^t}^{\kappa}\right)^{\frac{1-\sigma}{\kappa}}}{1-\sigma} - \theta_l \frac{\mathbf{l_{t+j}^t}^{1+\eta}}{1+\eta} \right]$$

$\mathbf{c_{t+j}^t}$: consumption, $\mathbf{s_{t+j}^t}$: housing services, $\mathbf{l_{t+j}^t}$: labor

Income Dynamics

- Working age households: $(1-\tau^j_{ss}-\tau^j_G)we\bar{e}_t l$
  1. After-tax market wage: $(1-\tau^j_{ss}-\tau^j_G)w$
  2. Non-insurable idiosyncratic component: e

$$\log(e') = \rho \log(e) + \sigma_\epsilon \epsilon, \qquad \epsilon \sim N(0,1)$$

  3. Deterministic age-specific productivity: $\bar{e}_t$

- Retired households: b
- Owns production + mortgage origination firms (zero-profit)

Housing

- Fixed supply $\bar{H}$
- Own h at a price P_h^j:
  - Evolution: $P_h^{j+1}(1-\delta_i)h \quad \delta_i \sim U[-\underline{\delta}, \bar{\delta}], \qquad i \in [0,1]$
  - δ_i partially observable:
    - Government observes $\tilde{\delta}_i = \delta_i$ with probability $1-p$
    - Government observes $\tilde{\delta}_i \in \Delta \backslash \{\delta_i\}$ with probability p
  - Every period household hires labor to "reconstruct" depreciation: $\delta_i h$
  - Production function of housing: $f_h(L) = AL$
- Rent s at a price q^j
- No owner occupied housing
- Can own and rent at same time (Jeske et al., 2013)
  - $h > s$: net owner
  - $h < s$: net renter

Financial Assets

- One-period risk-free bonds: $a' \geq 0$ at exogenous interest rate r_f^j
- Housing is financed with mortgages m'
- A mortgage m' with collateral h' and price $P_m^j(t, e, a', h', m')$:
  - Delivers $P_m^j(t, e, a', h', m')m'$ on first period
  - Requires payments equal to m' every period
  - Debt disappears every period with probability ρ
  - Proportional cost F on mortgage issuance/refinancing
  - Loan-to-value restriction at origination:

$$\left(\sum_{j=t}^{T} \left[\Pi_{i=t}^{j} \pi_i \right] \left[\frac{\rho}{1+r} \right]^{j-t} \right) m'/P_h h' < LTV$$

  - Default implies losing collateral h'

Household's Problem

- Heterogeneity across: age (t), productivity (e), savings (a), housing (h), mortgage debt (m) and depreciation (δ)
- State variables: $\mathbf{s} := (t, e, a, h, m, \delta)$
- Choice variables: default/keep/refinance, c, h, s, a, l
- Every period household solves:

$$V(\mathbf{s}) = \max_{c,s,h',a',m',l} \{V^{keep}(\mathbf{s}), V^{def}(\mathbf{s}), V^{ref}(\mathbf{s})\}$$

- V^{keep} is value function for keeping current mortgage Keep
- V^{def} is value function for default Default
- V^{ref} is value function for refinancing mortgage Refinance

Firms

1. Production
    - Linear technology: $f(L) = A \cdot L$
    - $w = A$
    - Perfect competition
2. Mortgage originators
    - Access to funds at equilibrium rate r_f
    - Perfect competition
    - $P_m(j, e, a', H', m')$ determined by zero expected profit loan-by-loan

Mortgage Pricing Function

$$P_m(t, e, a', h', m'; \Omega, \Theta)m' = \left(\frac{\pi_t \rho}{1 + r_f}\right) \mathbb{E}_{e', \delta'} \Bigg[\underbrace{d(\mathbf{s}'; \Omega, \Theta)\left[(1 - \Psi)P_h(1 - \delta')h' - \delta' P_h h'\right]}_{\text{Default}} +$$

$$\underbrace{s(\mathbf{s}'; \Omega, \Theta)\left(\sum_{j=t+1}^{T}\left[\Pi_{i=t+1}^{j}\pi_i\right]\left(\frac{\rho}{1 + r}\right)^{j-(t+1)}\right)m'}_{\text{Refinance}} +$$

$$\underbrace{(1 - d(\mathbf{s}'; \Omega, \Theta))(1 - s(\mathbf{s}'; \Omega, \Theta))(m' + P_m(t + 1, e', a'', h', m'; \Omega', \Theta')m')}_{\text{Keep mortgage}} \Bigg]$$

Government's Problem

- Government subsidizes mortgage refinancing at lump-sum τ:

$$\tau : \{1, \ldots, T\} \times \mathcal{E} \times \mathcal{A} \times \mathcal{H} \times \mathcal{M} \times \tilde{\Delta} \to [0, 1]$$

- Subsidy eligibility rule is:

$$\Gamma : \{1, \ldots, T\} \times \mathcal{E} \times \mathcal{A} \times \mathcal{H} \times \mathcal{M} \times \tilde{\Delta} \to \{0, 1\}$$

- Chooses subsidies $\tau(t, e, a, h, m, \tilde{\delta})$, eligibility rule $\Gamma(t, e, a, h, m, \tilde{\delta})$
- w.p. p, government gives subsidy to $\Gamma(\mathbf{s}) = 0$ and $\Gamma(\widetilde{\mathbf{s}}) = 1$
- Mistakes only made on δ but not on (t, e, a, h, m)

Government's Problem

- After ag. shock: subsidies τ, bailouts B, labor income taxes τ_G

$$\max_{\tau_M,\Gamma,B,\tau_G} \int_{\mathbf{s}'} V(\mathbf{s}';\tau_M,\Gamma,B,\tau_G)d\Phi_j(\mathbf{s}'), \quad \text{s.t.}$$

$$\int_{\mathbf{s}} P_m^{j-1}(t,e,a',h',m')m' \quad d\Phi_{j-1}(\mathbf{s}) = \qquad \text{(Ex-Post Solv.)}$$

$$\left(\frac{\pi_j\rho}{1+r_f^j}\right)\int_{\mathbf{s}'}\left[d(\mathbf{s}';\tau_M,\Gamma,B,\tau_G)P_h(1-\delta')(1-\Psi)\mathbf{H}'+\ldots\right]d\Phi_j(\mathbf{s}')+B$$

$$(1-p)\int_{\mathbf{s}'}\Gamma(\mathbf{s}')\tau(\mathbf{s}')F(\ldots)s(\cdot)d\Phi+p\int_{\mathbf{s}'}(1-\Gamma(\mathbf{s}'))\tau(\mathbf{s}')F(\ldots)s(\cdot)d\Phi+\ldots$$

$$\ldots+B=A \qquad \text{(Bud. Bal. } j\text{)}$$

$$Ar_f^i = \underbrace{\int \tau_G e\bar{e}_j w\mathbf{l}(\cdot)d\Phi_i}_{\text{Taxes}} \qquad \text{(Bud. Bal. } i>j\text{)}$$

Equilibrium

A stationary recursive competitive equilibrium are a value function V and policy functions for household, a pricing function $P_m(\cdot)$ for mortgages, a price for rental housing q, a price for new housing P_h and a distribution Φ such that:

1. Households optimize — Household's problem
2. Financial firms optimize (zero-profit condition for P_m) — Firms's problem
3. Markets clear — Market clearing
   - 3.1 Rental housing
   - 3.2 Owned housing
   - 3.3 Bonds
   - 3.4 Goods
4. Government's budget balance — Govs budget balance
5. Law of motion for aggregate distributions Φ_t

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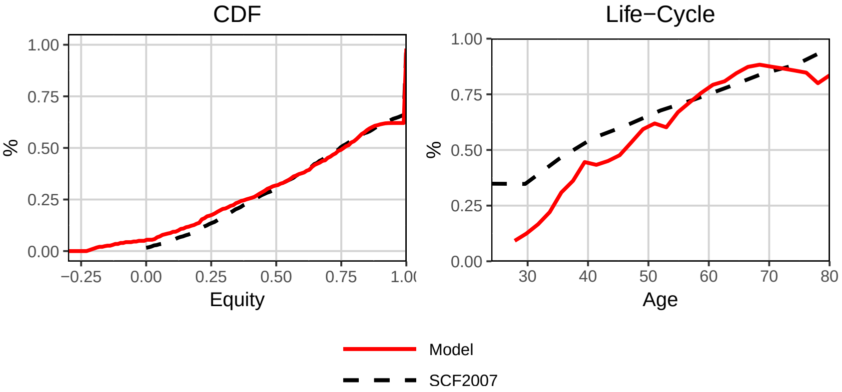
	Value	Source	Function
Pref.			
σ κ η θ_l	2 -0.1 0.5 5	IES: 0.5 Fernandez-Villaverde et al. (2011) Keane and Rogerson (2015) Average Labor = 0.4	$\frac{(\psi c^{\kappa}+(1-\psi)h^{\kappa})^{\frac{1-\sigma}{\kappa}}}{1-\sigma}$ $-\theta_l \frac{l^{1+\eta}}{1+\eta}$
Demog.			
T π_t	30 -	Maximum age: 80 Actuarial Life Tables	
Income			
λ_ϵ σ_ϵ $\bar{e}_t$	0.95 0.22 -	Storesletten et al. (2004) Storesletten et al. (2004) Hansen (1993)	$\log(e_{t+1}) =$ $\lambda_\epsilon \log(e_t) + \sigma_\epsilon \epsilon_{t+1}$
Financ.			
ρ F Ψ	0.92 0.015 0.22	Mortgage dur. 25 yrs Hurst and Stafford (2004) Pennington-Cross (2006)	

Endogenously Calibrated

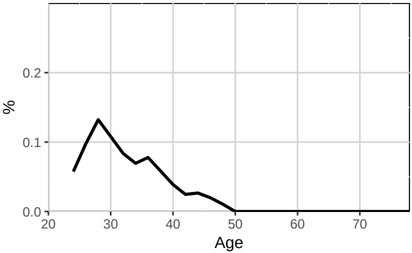
Parameter	Value	Variable	Data	Model
		Targeted Moments		
$\bar{\delta}$	0.119	Default rate	2.96%	2.5 %
$\underline{\delta}$	-0.345	Ownership rate	65.5%	65.6 %
ψ	0.84	Rent/Cons expenditures	14.1%	14.3 %
		Untargeted Moments		
		Std. Dev. Idiosyncratic Comp.	$10 - 14.5\%$	13.4 %
		Average home equity	62%	64.3 %
		Average size (sq ft.): owned/rented	1.51	1.52

Equity Distribution



- Misses left tail of distribution
- Agents start with zero assets + zero housing

Default in Steady State



- Young households (25-35 yrs)
- Negative idiosyncratic price shock (high δ)
  - Poor households that cannot pay
  - Wealthy households that can cover issuance cost of new mortgage later
- Only 31% of households underwater default:
  - Fixed cost of mortgage issuance F
  - Fixed contracts $\Rightarrow$ households in "bad shape" prefer to stick to contract

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One-Time Shock

- Shocks last for three periods:

  1. Loan-To-Value at origination set $\leq 65\%$ - Boz and Mendoza (2014) (downpayment of 35%)
     - Fraction of banks on *Willingness to Lend Survey* that tightened credit standards increased from 0% to 50%
  2. Labor income shock - Glover et al. (2014):

Age group	**Per capita earnings**
$20-29$	-12.8%
$30-39$	-11.1%
$40-49$	-8.8%
$50-59$	-9.6%
$60-69$	-4.4%
$70+$	$+0.3\%$

HAMP vs TARP: The Great Recession

- Eligibility conditions for HAMP:
  1. Payments-to-income $\geq 31\%$
  2. Delinquent or in danger of falling behind on mortgage payments
  3. Collateral has to be owner-occupied and primary residence
  4. Single-family, 1-4 units, unmodified first-lien mortgage $\leq \$730K$
  5. Originated before Jan. 1st, 2009
  6. Modification has to pass net present value test
- HAMP reduced payments-to-income to exactly 31% of monthly income
- Expenditures $135:
  1. HAMP expected cost: $75 billion (56%)
  2. TARP expected bailout: $60 billion (44%)

HAMP vs TARP: The Model

- Want to match policy that preserves solvency and transfers:
  1. 56% in mortgage refinancing subsidies (HAMP)
  2. 44% in bailouts to banks
- Such a policy subsidizes mortgage refinancing to:
  1. Households with payments-to-income $\geq$ 28%
  2. Choose to default
- Subsidies such that PTI in period of subsidy is reduced to exactly 28%

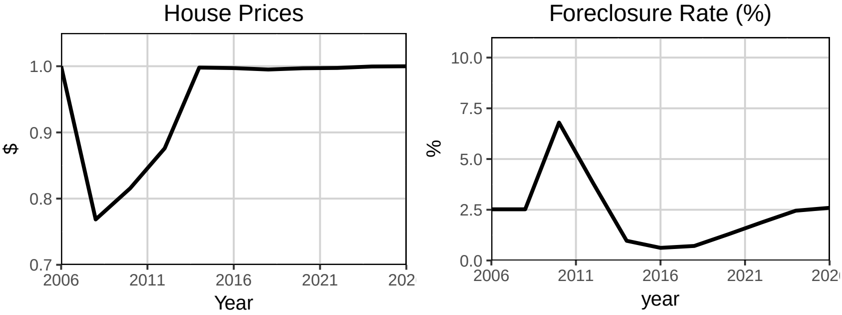
Information Friction

- Mayer et al. (2014)
- Settlement between Countrywide Fin. Corp. and Federal Government
- Offered modifications to seriously delinquent, subprime, first lien mort.
- Find **strategic default** of $10 - 11\%$
- In equilibrium, government subsidizes 11% of non-defaulters with:

$$\boxed{p = 1.6\%}$$

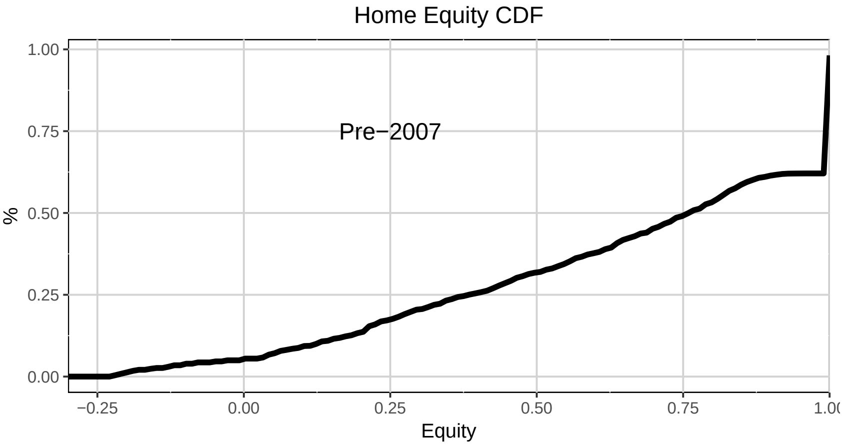
- Problem: point estimate!
- Upper bound - modifications were "unconstrained"

The Great Recession



- Initially foreclosures rise
- "High-risk" households default while "low-risk" keep mortgage
- After income shock ends, better composition of mortgage holders

The Great Recession



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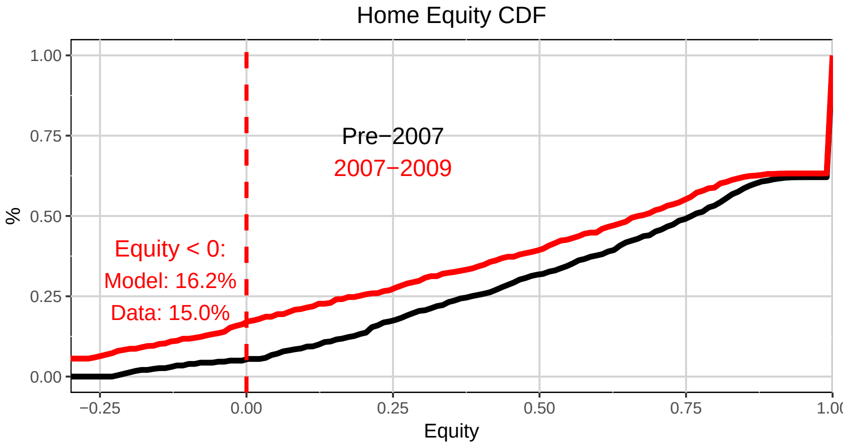

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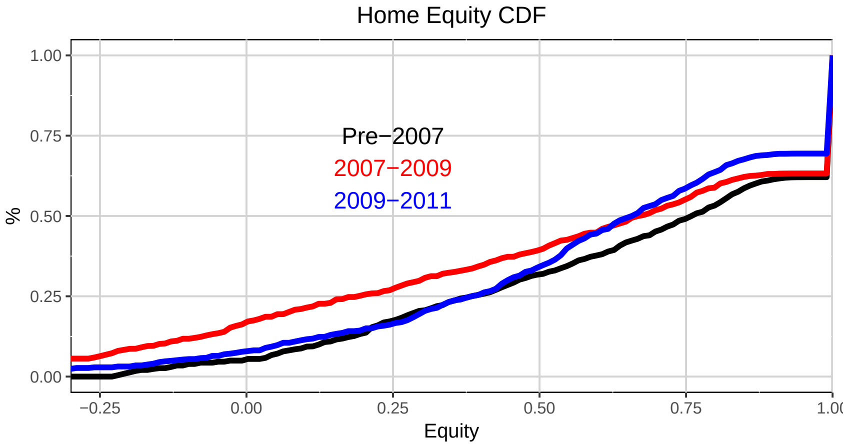

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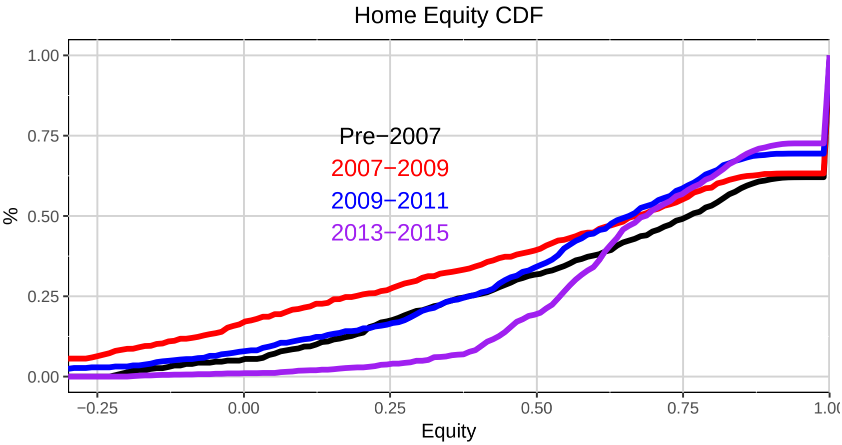

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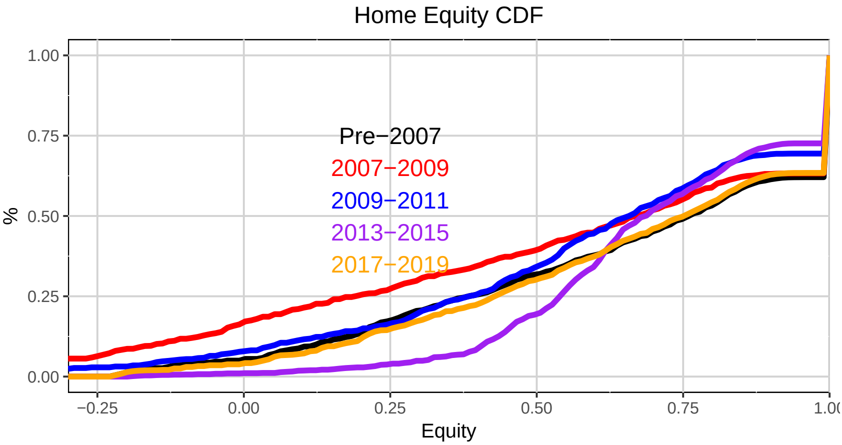

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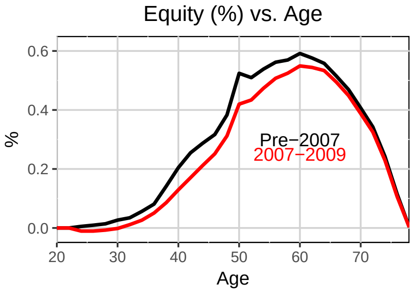
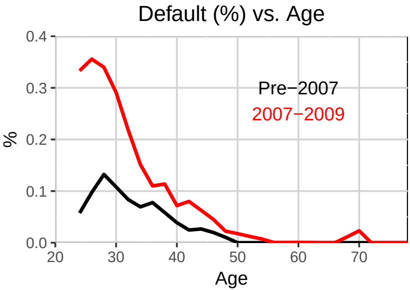




- Equity is low for young households
- $\Rightarrow$ crisis hits harder youngest home-owners
- Default concentrated on youngest

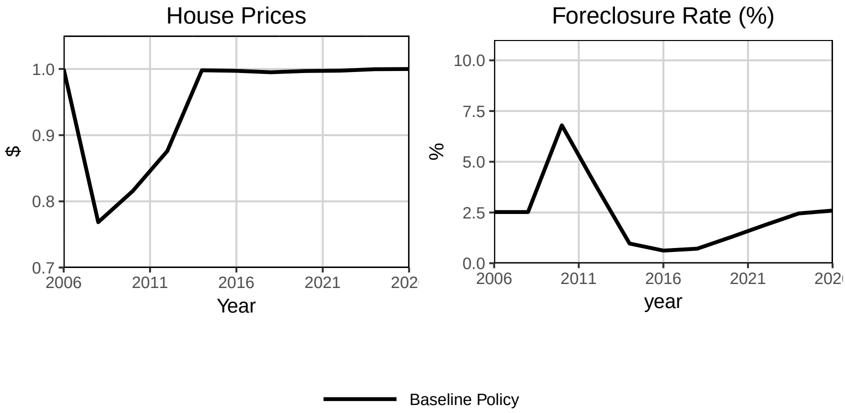
Counter-Factual Policy #1

- First best policy:
  - Default after shock highly concentrated on young
  - Subsidize only households that changed default decision after shock
  - Subsidy amount is sum of two components:
    - Amount given under HAMP
    - Amount decreasing on age
  - Increases welfare by $+0.4\%$
  - Decreases foreclosures to 4.9%
  - Small effect on house prices

Counter-Factual Policy #2 and #3

- Expand HAMP as large as possible: subsidize to PTI$\geq$ 22.5%:
  1. Increases welfare by 0.2%
  2. Has a negligible effect on prices
  3. Decreases default by 3% between 2007-2009
- Bailout-only policy:
  1. Decreases welfare by 0.8%
  2. Has a negligible effect on prices
  3. Increases default by 3.4% between 2007-2009

The Great Recession



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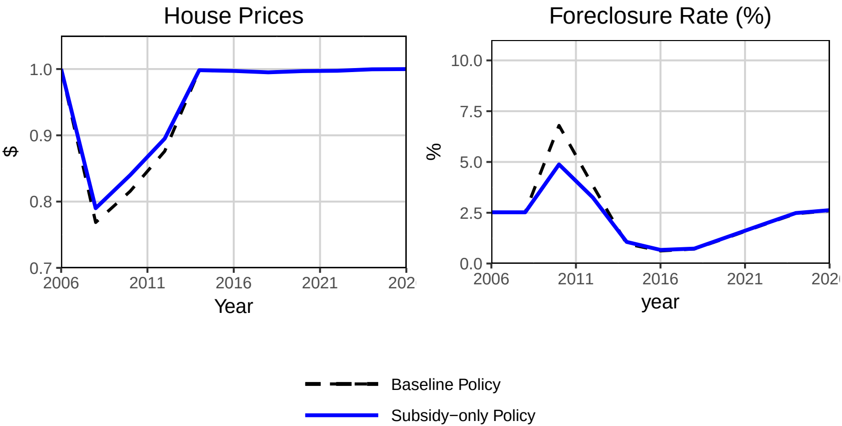

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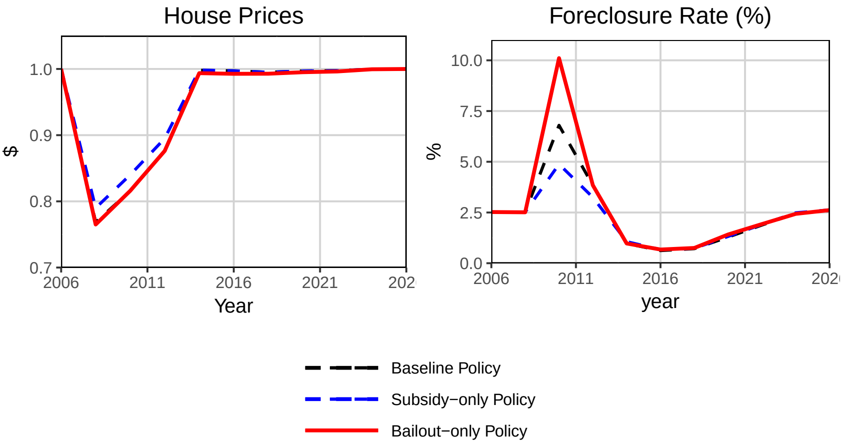

Concluding Remarks

- Cost of dead-weight loss outweighs cost of information friction
- $\Rightarrow$ Better to prevent foreclosures
- Expanding subsidy policies would have generated welfare improvements over bailout policies of $0.2\% - 0.4\%$
- Including foreclosure externality would make bailout policy even costlier
- Moral hazard can play in both directions, so effect is ambiguous

Thank you!

Computation

1. $\mathbf{t} = \mathbf{0}$: Start with guess $\mathbf{g^0}$ for policies and $\mathbf{P_m^0}$ for pricing functions

2. **Iteration t** :

   2.1 Given $\mathbf{g^t}$, perform value function iteration of P_m until convergence (cont. map. thm) to get $\mathbf{P_m^{t'}}$. Set:

   $$\mathbf{P_m^{t+1}} = \gamma \mathbf{P_m^t} + (1-\gamma)\mathbf{P_m^{t'}}$$

   2.2 Given $\mathbf{P_m^{t+1}}$, solve household's problem $(t = T, \ldots, 1)$ to get $\mathbf{g^{t+1}}$

   2.3 If $\left\| \mathbf{P_m^{t+1}} - \mathbf{P_m^t} \right\| < \epsilon$, stop. Otherwise, $\mathbf{t} = \mathbf{t} + \mathbf{1}$ and go to 2

3. If model and data moments match, stop. Otherwise, choose new parameters and repeat until convergence.

Household's Problem: Keep Mortgage

$$V^{keep}(t, e, a, h, m, \delta; \Omega, \Theta) = \max_{\substack{c,s,h',a' \geq 0 \\ l \in [0,1]}} u(c, s) + \pi_t \beta \mathbb{E}_{e'|e,\delta',m'} V(t+1, e', a', h, m', \delta'; \Omega', \Theta')$$

$$c + m + qs + P_a a' + \frac{\delta h w}{A} = (1 - \tau_l - \tau_{ss}) e \bar{e}_t w l + a + qh$$

$$m' = \begin{cases} m & \text{w.p.} \quad \rho \\ 0 & \text{w.p.} \quad 1 - \rho \end{cases}$$

$$\delta' \sim F_\delta(\delta'), \qquad e' \sim F_e(e'|e), \qquad \Omega' = G(\Omega), \qquad V^{keep}(T+1, \cdot) = 0$$

Go to equilibrium

Household's Problem: Default

$$V^{def}(t,e,a,h,m,\delta;\Omega,\Theta) = \max_{\substack{c,s,h',a',m'\geq 0\\ l\in[0,1]}} u(c,s) + \pi_t \beta \mathbb{E}_{e'|e,\delta',m',\tilde{a}'} V(t+1,e',\tilde{a}',0,0,\delta';\Omega',\Theta')$$

$$c + qs + P_a a' = (1-\tau_l-\tau_{ss}) e\bar{e}_t wl + a$$

$$\delta' \sim F_\delta(\delta'), \qquad e' \sim F_e(e'|e), \qquad \Omega' = G(\Omega), \qquad V^{def}(T+1,\cdot) = 0$$

Go to equilibrium

Household's Problem: Refinance

$$\mathbb{E}_p V^{ref}(t,e,a,h,m,\delta;\Omega,\Theta) = (1-p)V^{ref,1-p}(t,e,a,h,m,\delta;\Omega,\Theta) + pV^{ref,p}(t,e,a,h,m,\delta;\Omega,\Theta)$$

Household's Problem: Refinance

$$V^{ref,1-p}(t,e,a,h,m,\delta;\cdot) = \max_{\substack{c,s,h',a',m'\geq 0 \\ l\in[0,1]}} u(c,s) + \pi_t \beta \mathbb{E}_{e'|e,\delta',\tilde{m}'} V(t+1,e',a',h',\tilde{m}',\delta';\cdot)$$

$$c + \left(\sum_{j=t}^{T} \left[\Pi_{i=t}^{j} \pi_i\right] \left(\frac{\rho}{1+r}\right)^{j-t}\right)(m + (1-\Gamma(\cdot)\tau(\cdot))Fm') + qs + P_h h' + P_a a' =$$

$$(1-\tau_l-\tau_{ss}) e\bar{e}_t wl + a + P_h h - \frac{\delta P_h h w}{A} + qh' + P_m(t,e,a',h',m';\cdot,\Theta)m'$$

$$\tilde{m}' = \begin{cases} m' & \text{w.p.} \quad \rho \\ 0 & \text{w.p.} \quad 1-\rho \end{cases} \qquad F = \begin{cases} F^{issue} & \text{if} \quad m=0, m'>0 \\ F^{ref} & \text{if} \quad m>0, m'>0 \\ 0 & \text{if} \quad m'=0 \end{cases}$$

$$\delta' \sim F_\delta(\delta'), \qquad e' \sim F_e(e'|e), \qquad \Omega' = G(\Omega), \qquad V^{ref}(T+1,\cdot) = 0$$

$$\left(\sum_{j=t}^{T} \left[\Pi_{i=t}^{j} \pi_i\right] \left[\frac{\rho}{1+r}\right]^{j-t}\right) m'/P_h h' < LTV$$

Household's Problem: Refinance

$$V^{ref,1-p}(t,e,a,h,m,\delta;\cdot) = \max_{\substack{c,s,h',a',m'\geq 0\\ l\in[0,1]}} u(c,s) + \pi_t \beta \mathbb{E}_{e'|e,\delta',\tilde{m}'} V(t+1,e',a',h',\tilde{m}',\delta';\cdot),$$

$$c + \left(\sum_{j=t}^{T}\left[\Pi_{i=t}^{j}\pi_i\right]\left(\frac{\rho}{1+r}\right)^{j-t}\right)(m + (1-(1-\Gamma(\cdot))\tau(\cdot))Fm') + qs + P_h h' + P_a a' =$$

$$(1-\tau_l-\tau_{ss})e\bar{e}_t wl + a + P_h h - \frac{\delta P_h hw}{A} + qh' + P_m(t,e,a',h',m';^{\bullet},\Theta)m'$$

$$\tilde{m}' = \begin{cases} m' & \text{w.p.} \quad \rho \\ 0 & \text{w.p.} \quad 1-\rho \end{cases} \qquad F = \begin{cases} F^{issue} & \text{if} \quad m=0, m'>0 \\ F^{ref} & \text{if} \quad m>0, m'>0 \\ 0 & \text{if} \quad m'=0 \end{cases}$$

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$$\left(\sum_{j=t}^{T}\left[\Pi_{i=t}^{j}\pi_i\right]\left[\frac{\rho}{1+r}\right]^{j-t}\right) m'/P_h h' < LTV$$

Go to equilibrium

Market Clearing Conditions

1. Rental markets clears:

$$\sum_{t=1}^{T} \int g_r(t, e, a, h^o, m, \delta_h) d\Phi_t = \sum_{t=1}^{T} \int g_h(t, e, a, h^o, m, \delta_h) d\Phi_t$$

2. Housing market clear:

$$\sum_{t=1}^{T} \int g_r(t, e, a, h^o, m, \delta_h) d\Phi_t = \bar{H}$$

Go to equilibrium

Government's Budget Balance

$$\underbrace{\int s\mathbf{m}(1-g_{default}(j,e,a,h^o,m,\delta))d\Phi}_{\text{Subsidies}} + \underbrace{B}_{\text{Bailout}} = \underbrace{\int \tau \mathbf{c} d\Phi}_{\text{Taxes}}$$

$$B = \sum_{t=1}^{T}\left(\frac{\pi_j \rho}{1+r_f}\right)\int\Bigg[\underbrace{g_{def}(\cdot)P_h(1-\delta'-\bar{\delta})\mathbf{H}'}_{\text{Default}} +$$

$$\underbrace{g_{repay}(\cdot)\left(\sum_{j=t+1}^{T}\left[\Pi_{i=t+1}^{j}\pi_i\right]\left(\frac{\rho}{1+r}\right)^{j-(t+1)}\right)(1-s)\mathbf{m}' +}_{\text{Renew mortgage}}$$

$$\underbrace{(1-g_{def}(\cdot))(1-g_{repay}(\cdot))(\mathbf{m}'+P_m(\cdot)\mathbf{m}')}_{\text{Keep mortgage}}\Bigg] - \mathbf{m}'P_m(\cdot)d\Phi$$

Go to equilibrium