Regulation and Trade in Secondary Mortgage Markets

Salomon Garcia

University of Minnesota

September 26, 2019

Motivation

- Mortgage originators sell, or securitize, in the secondary mortgage market close to 70% of all mortgage loans.
  - Volume of sales in secondary market is volatile, sometimes collapses
- Adverse selection. Asymmetric information about default risk.
  - Theory: adverse selection can lead to market collapses.
- Concern for policymakers, government mandate: provide affordable and stable mortgage credit to households.

Questions:

- What policies can avoid secondary market collapses, and stabilize mortgage credit supply?
- What are the welfare implications for households?

What I do

Develop a quantitative model of financial intermediation and securitization.

- borrowers and lenders face exogenous income and default risk.
- add secondary market for loans

    i) heterogeneous lending technology: reallocation of resources.
    ii) lender's priv info: loan's default risk. Adverse selection.

- government policy: provide a subsidy to investors in the secondary market.

Calibrate model to match key moments of the U.S. mortgage market.

- model performance: simulate great recession.

Evaluate policy interventions in secondary market.

- changes in subsidy and in taxes.

Results

Model accounts for 2/3 of collapse of secondary market during great recession.

- Feed in default rate and income shocks observed in 2006-10:

  volume of sales and volume of new issuance in the primary market fall by 30% (45% in the data).

Welfare gains of increasing a subsidy to investors in the secondary market.

- Subsidy increases volume of sales. Market collapses are less frequent.
- Borrowers' welfare: +0.21%, lower interest rates but pay higher taxes.
- Lenders' welfare: +3.01%, lower losses from default and adverse selection.

Related Literature

Quantitative:

- Credit Cycles: Ivashina, Sharfstein(2010), Calem, Covas, Wu(2013), Landvoigt (2016).

  Contribution: Endogenous SM. Role: efficient reallocation of resources.

- Policy: Elenev, Landvoigt, Van Nieuwerburgh (2016). Gette, Zechetto (2015). Jeske, Krueger and Mitman (2013).

  Contribution: Role of policy in the presence of adverse selection.

Theory:

- Chari, Shourideh, Zetlin-Jones (2014). Kurlat(2013). Guerrieri, Shimer (2013). Caramp (JMP2017), Neuhan(JMP2016).

  Contribution: Connect dynamics of SM to primary origination market.

Outline

1. Model
2. Calibration
3. Policy

Model: environment

- Infinite horizon
- Agents:
  - borrower, representative
  - lenders, continuum
- Markets:

  i) lending market
  ii) secondary market for loans

Model: borrower

Representative borrower

- preferences: $U^B(C_t, H_t)$
- impatient: $\beta^B < \beta^L$
- assets:

  H_t, housing stock
  B_t, mortgage debt (long-term)

Exogenous aggregate processes

- Y_t, income endowment
- λ_t, default rate
- $\{\lambda_t, Y_t\} \sim$ joint stochastic process: first order Markov

Model: lenders

- preferences: $u(c_t^j) = \log(c_t^j)$
- assets: b_t^j, loan portfolio. $\quad B_t = \int b_t^j d\Gamma(b,z)$

Exogenous processes

- lending technology: $z_t^j \sim$ i.i.d, $[\underline{z}, \overline{z}]$, cdf $F(z)$
- agg default: fraction λ_t of b_t^j with prob 1

Loans

- b_t^j: <u>current</u>, fraction ϕ matures every t
- n_t^j: <u>new loans</u>, lender j issues n_t^j at gross cost, $n_t^j z_t^j$

Model: lenders

- preferences: $u(c_t^j) = \log(c_t^j)$
- assets: b_t^j, loan portfolio. $B_t = \int b_t^j d\Gamma(b, z)$

Exogenous processes

- lending technology: $z_t^j \sim \text{i.i.d}, [\underline{z}, \overline{z}]$, cdf $F(z)$
- agg default: fraction λ_t of b_t^j with prob 1

Loans

- b_t^j: current, fraction ϕ matures every t
- n_t^j: new loans, lender j issues n_t^j at gross cost, $n_t^j z_t^j$

Private information

- lender knows which of its current loans b_t^j are affected by λ_t.
- lending productivity z_t^j.

Model: secondary market

Anonymous and centralized market

- lenders can trade current outstanding $(1-\phi)b_t^j$.
- p_t: competitive (pooling) price.
- trading decisions:

$$
\begin{aligned}
s_{G_t}^j &\in [0,\ (1-\phi)b_t^j(1-\lambda_t)] \\
s_{B_t}^j &\in [0,\ (1-\phi)b_t^j\lambda_t] \\
d_t^j &\geq 0, \text{ purchases}
\end{aligned}
$$

- μ_t, adverse selection discount:

$$\mu_t = \frac{S_{B_t}}{S_{B_t} + S_{G_t}}$$

Debt accumulation

$$b_{t+1}^j = (1-\phi)b_t^j(1-\lambda_t) - s_{G_t}^j + n_t^j + (1-\mu_t)d_t^j - 0((1-\phi)b_t^j\lambda_t - s_{B_t}^j)$$

Model: government

- exogenous policy
- balances budget every period

Policy instruments

- τ, subsidy to buyers in the secondary market.
- γ, fee (tax) on originators.
- T^B, lump sum transfer to borrowers.

Lender's problem

$$V^L(z,b;X) = \max_{\{c,b',n,d,s_B,s_G\}} \log c + \beta^L \mathbb{E}_{z',X'|X} V^L(z',b';X)$$

$$\begin{aligned}
c + nz(q+\gamma) + pd(1-\tau) &\leq (1-\lambda)\phi b + p(s_G + s_B) \\
b' &= (1-\lambda)(1-\phi)b - s_G + n + (1-\mu)d \\
s_G &\in [0,\ (1-\phi)(1-\lambda)b] \\
s_B &\in [0,\ (1-\phi)\lambda b] \\
& d \geq 0, \quad n \geq 0
\end{aligned}$$

- Aggregate states: $X = \{B, H, \Gamma; \lambda, Y\}$

Lender's problem

$$V^L(z,b;X) = \max_{\{c,b',n,d,s_B,s_G\}} \log c + \beta^L \mathbb{E}_{z',X'|X} V^L(z',b';X)$$

$$\begin{aligned}
c + nz(q+\gamma) + pd(1-\tau) &\leq (1-\lambda)\phi b + p(s_G + s_B) \\
b' &= (1-\lambda)(1-\phi)b - s_G + n + (1-\mu)d \\
s_G &\in [0,\ (1-\phi)(1-\lambda)b] \\
s_B &\in [0,\ (1-\phi)\lambda b] \\
& d \geq 0, \quad n \geq 0
\end{aligned}$$

- Aggregate states: $X = \{B, H, \Gamma; \lambda, Y\}$

Lender's problem

$$V^L(z,b;X) = \max_{\{c,b',n,d,s_B,s_G\}} \log c + \beta^L \mathbb{E}_{z',X'|X} V^L(z',b';X)$$

$$\begin{aligned} c + nz(q+\gamma) + pd(1-\tau) &\leq (1-\lambda)\phi b + p(s_G + s_B) \\ b' &= (1-\lambda)(1-\phi)b - s_G + n + (1-\mu)d \\ s_G &\in [0,\ (1-\phi)(1-\lambda)b] \\ s_B &\in [0,\ (1-\phi)\lambda b] \\ & d \geq 0, \quad n \geq 0 \end{aligned}$$

- Aggregate states: $X = \{B, H, \Gamma; \lambda, Y\}$

Lender's problem

$$V^L(z,b;X) \quad = \quad \max_{\{c,b',n,d,s_B,s_G\}} \log c + \beta^L \mathbb{E}_{z',X'|X} V^L(z',b';X)$$

$$\begin{aligned} c + nz(q+\gamma) + pd(1-\tau) &\leq (1-\lambda)\phi b + p(s_G + s_B) \\ b' &= (1-\lambda)(1-\phi)b - s_G + n + (1-\mu)d \\ s_G &\in [0,\ (1-\phi)(1-\lambda)b] \\ s_B &\in [0,\ (1-\phi)\lambda b] \\ & d \geq 0, \quad n \geq 0 \end{aligned}$$

- Aggregate states: $X = \{B, H, \Gamma; \lambda, Y\}$

Lender's problem

$$V^L(z, b; X) = \max_{\{c, b', n, d, s_B, s_G\}} \log c + \beta^L \mathbb{E}_{z', X'|X} V^L(z', b'; X)$$

$$\begin{aligned}
c + nz(q + \gamma) + pd(1 - \tau) &\leq (1 - \lambda)\phi b + p(s_G + s_B) \\
b' &= (1 - \lambda)(1 - \phi)b - s_G + n + (1 - \mu)d \\
s_G &\in [0,\ (1 - \phi)(1 - \lambda)b] \\
s_B &\in [0,\ (1 - \phi)\lambda b] \\
& d \geq 0, \quad n \geq 0
\end{aligned}$$

- Aggregate states: $X = \{B, H, \Gamma; \lambda, Y\}$

Lender's problem

$$V^L(z, b; X) \quad = \quad \max_{\{c, b', n, d, s_B, s_G\}} \log c + \beta^L \mathbb{E}_{z', X'|X} V^L(z', b'; X)$$

$$\begin{aligned}
c + nz(q+\gamma) + pd(1-\tau) \quad &\leq \quad (1-\lambda)\phi b + p(s_G + s_B) \\
b' \quad &= \quad (1-\lambda)(1-\phi)b - s_G + n + (1-\mu)d \\
s_G \quad &\in \quad [0,\ (1-\phi)(1-\lambda)b] \\
s_B \quad &\in \quad [0,\ (1-\phi)\lambda b] \\
& \quad\quad d \geq 0, \quad n \geq 0
\end{aligned}$$

- Aggregate states: $X = \{B, H, \Gamma; \lambda, Y\}$

Lender's problem

$$V^L(z,b;X) = \max_{\{c,b',n,d,s_B,s_G\}} \log c + \beta^L \mathbb{E}_{z',X'|X} V^L(z',b';X)$$

$$\begin{aligned}
c + nz(q+\gamma) + pd(1-\tau) &\leq (1-\lambda)\phi b + p(s_G + s_B) \\
b' &= (1-\lambda)(1-\phi)b - s_G + n + (1-\mu)d \\
\boldsymbol{s_G} &\in [0,\ (1-\phi)(1-\lambda)b] \\
\boldsymbol{s_B} &\in [0,\ (1-\phi)\lambda b] \\
& \boldsymbol{d} \geq 0, \quad \boldsymbol{n} \geq 0
\end{aligned}$$

- Aggregate states: $X = \{B, H, \Gamma; \lambda, Y\}$

Borrower's problem

$$V^B(b,h;X) = \max_{\{c,n,h'\}} u(c,h) + \beta^B \mathbb{E}_{X'|X} V^B(b',h';X')$$

$$\begin{aligned} c + h' - (1-\lambda)(1-\delta)h &\leq y - (1-\lambda)\phi b + qn - T^B \\ b' &= (1-\lambda)(1-\phi)b + n \\ b' &\leq \pi h' \\ &\text{given} \quad b_0, h_0 \end{aligned}$$

- Aggregate states: $X = \{B, H, \Gamma; \lambda, Y\}$

Recursive Competitive Equilibrium

A RCE given gov policy $\{\tau, \gamma, T^B\}$, consists of: prices $\{q(X), p(X)\}$; adverse selection discount $\{\mu(X)\}$; a law of motion $\Gamma'(X)$ and transition density $\Pi(X'|X)$, and policy functions: $\{C, N, B', H'\}^B$; $\{c, n, d, s_G, s_B\}^L_{j\in J}$ s.t.:

1. borrowers and lenders optimize.
2. the discounted price q clears the **credit market**:

$$N(q, p; X) = \int n(q, p; X) d\Gamma$$

3. whenever $p > 0$ the **secondary market** clears:

$$\begin{aligned} D(p, q; X) &= S(p, q; X) \\ \mu(X) &= S_B(X)/S(X) \end{aligned}$$

4. gov budget constraint holds:

$$\gamma N(X) + T^B = \tau p D(X)$$

5. resource constraint holds:

$$C^B + C^L + H' - (1-\delta)(1-\lambda)H = Y + q \int (z-1) n \, d\Gamma$$

Model

Set up

Characterization

- lenders' trading and lending decisions.

Properties

Characterization

Proposition 1

1. There exists at least one pair of functions $\{p(X), q(X)\}$ that satisfies market clearing conditions, with $p(X) \geq 0$, and $q(X) > 0$ for all X.
2. For lenders, trading and lending decisions are functions of two cut-offs: $\{\hat{z}, \frac{\hat{z}}{1-\mu(\hat{z})}\}$, where $\hat{z} = \frac{p(X)}{q(X)}$.

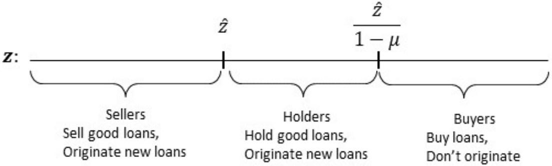
Characterization: lenders' decisions

$\{c, b', s_B, s_G, d, n\}$

1. $\{c, b'\}$: constant fraction of wealth.
2. $\{s_B, s_G, d, n\}$ corner solutions according to cut-offs: $\{\hat{z},\ \frac{\hat{z}}{1-\mu}\}$.
   - $p > 0$: all lenders sell bad loans $s_B = \lambda(1-\phi)b$

then:

- $z < \hat{z}$: seller $\{s_G > 0,\ d = 0,\ n > 0\}$
- $z > \frac{\hat{z}}{1-\mu}$: buyer $\{s_G = 0,\ d > 0,\ n = 0\}$
- $z \in [\hat{z}, \frac{\hat{z}}{1-\mu}]$: holders $\{s_G = 0,\ d = 0,\ n > 0\}$



Model

Set up

Characterization

Properties

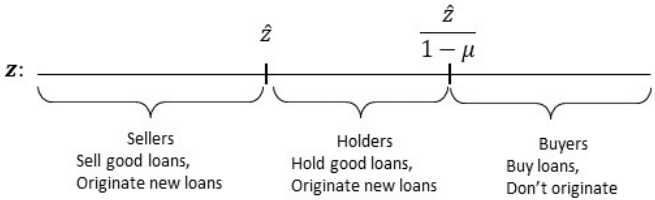
- Fluctuations in default rate induce fluctuations in volume of sales, and the volume of lending.
- Comparative statics in a deterministic setting.

Model's properties: secondary market

Proposition 2. An increase in default rate, λ, leads to:

Secondary Market:

- higher fraction of bad loans sold.
- higher fraction of holders.

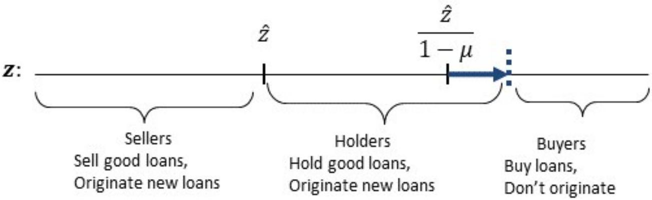


Model's properties: secondary market

Proposition 2. An <u>increase</u> in default rate, λ, leads to:

Secondary Market:

- higher fraction of bad loans sold.
- higher fraction of holders.

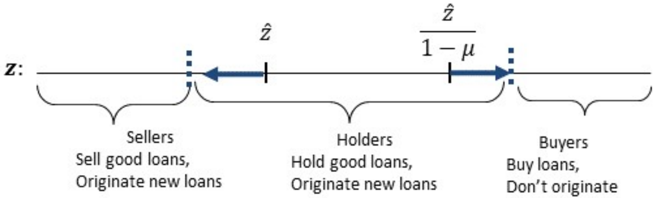


Model's properties: secondary market

Proposition 2. An <u>increase</u> in default rate, λ, leads to:

Secondary Market:

- higher fraction of bad loans sold.
- higher fraction of holders.



Model's properties: secondary market

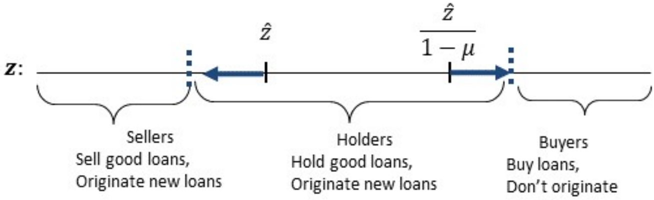
Proposition 2. An increase in default rate, λ, leads to:

Secondary Market:

- higher fraction of bad loans sold.
- higher fraction of holders.

Primary lending Market:

- Increase in lending from holders.
- Decrease in lending from sellers.

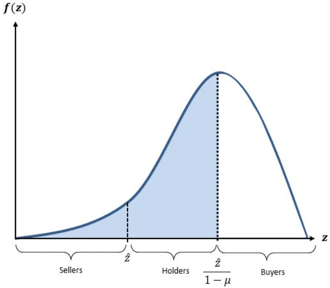


Outline

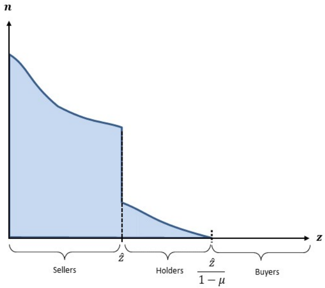
1. Model
2. Calibration
    - lenders, and policy
    - simulating great recession
3. Policy evaluation

Calibration: lenders

Description	param	value	target, period 90-06	**Data**	**Model**
tech: $F(z)$	α	4.2	mkt share top 10% inst. HMDA	0.89	0.84
shape	β	2.25	mean/med volume of loan issuance	1.01	0.96
location	lc	0.65	mortg spread, 30Y FRM real.	3.0%	3.1%
scale	sc	1.00	supp $[\underline{z}, \overline{z}] = [0.65,\ 1.65]$.		



Panel a. Beta distribution



Panel b. Volume of lending

Calibration: lenders and government

Description	param	value	target, period 90-06	**Data**	**Model**
Lenders					
disct factor	β^L	0.985	risk free rate.	1.52%	1.52%
life mortg pool	ϕ	0.30	avg maturity of mortg bond index.	3.7	3.7
Government					
orig fee	γ	0.007	Guarantee fee GSEs (bps)	20.0	20.0
subsidy	τ	0.6μ	GSEs market share of SM, 90-03		

- Borrowers
- Exogenous processes $\{\lambda, Y\}$
- Non-targeted moments

Taking stock

Model

- Fluctuations in default rate generate fluctuations in the volume of sales in the secondary market, and in the volume of lending.

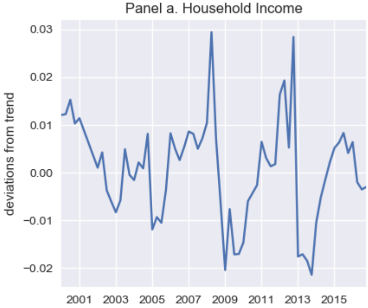
Model and calibration

- Changes in volume of lending from sellers dominate aggregate lending supply.
- Fluctuations are large because *sellers* do most of the lending in the economy.

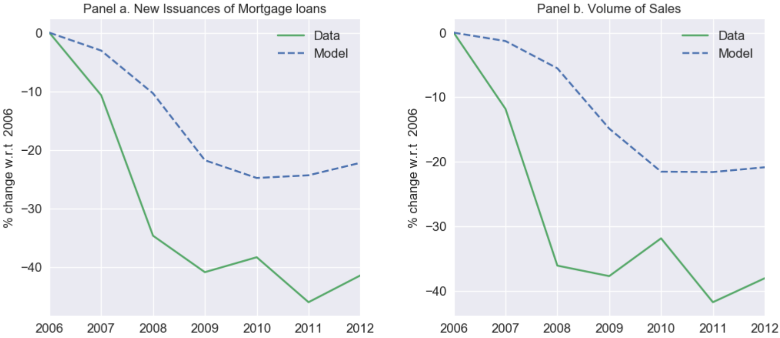
Outline

1. Model
2. Calibration
    - lenders, and policy
    - simulating the great recession
3. Policy evaluation

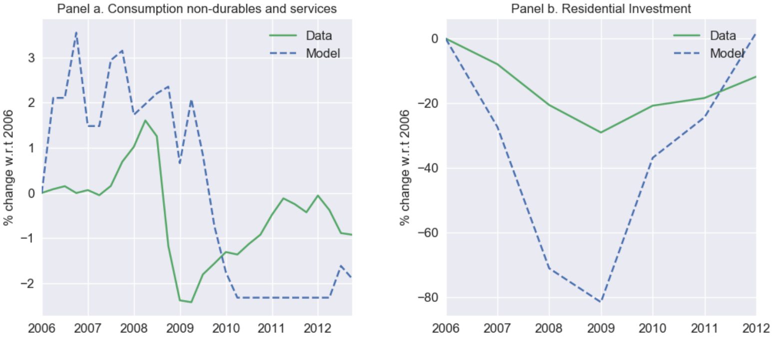
Great recession. Exogenous processes



Great recession. Primary and secondary market



Great recession. Households aggregates



Outline

1. Model
2. Calibration
3. Policy evaluation
    - Welfare effects of policy changes

Policy evaluation

1. Change in policy in 2012
   - Guarantee fee increased from 20 bps to 60 bps ▷
2. Private segment collapsed since 2008.
   - Effectively only government-backed segment. ▷

Policy evaluation: welfare changes

Description	$\Delta^{+}\tau$	$\Delta^{+}\gamma$
Borrower welfare	0.21	-0.44
Non-durable cons	-0.44	-0.16
Housing good cons	2.88	-1.45
Lenders' welfare	3.03	-1.68

(1)change in τ from 0.6μ to μ.(2)change in γ from 20 bps to 60 bps
* All numbers are in percentages. Moments for simulation (10 thousands periods).

- Main statistics

Policy evaluation: welfare changes

Description	$\Delta^+\tau$	$\Delta^+\gamma$	both policies
Borrower welfare	0.21	-0.44	-0.26
Non-durable cons	-0.44	-0.16	-0.54
Housing good cons	2.88	-1.45	0.68
Lenders' welfare	3.03	-1.68	1.15

(1)change in τ from 0.6μ to μ.(2)change in γ from 20 bps to 60 bps

* All numbers are in percentages. Moments for simulation (10 thousands periods).

- Main statistics

Conclusion

- Develop a framework that endogenously connects dynamics in the lending and secondary mortgage markets.
  - main friction: private information, adverse selection.
- Model predicts 2/3 of the collapse of the mortgage market during the great recession.
- Evaluate policy interventions:
  - *Increasing subsidy* generates welfare gains.
    Households benefit from lower interest rates but face higher taxes.
  - *Increasing originators fee* generates welfare losses.
    Households face higher interest rates.

Appendix

Other questions

- Actuarially fair fee
- Economy without gov interventions
- Economy without information frictions
- Economy without secondary markets

Actuarially fair insurance fee

What is the insurance fee at which the policy intervention self-finances?

- 1990-06 period: $72bps$

Description	$g_{\text{fee}} = 72bps$
avg mortgage spread, $r^m - r^f$	3.61
volatility mortg spread, std	0.14
fraction of loans traded	87.7
cost of policy, $\tau^s = \omega\mu$	2.8
borrower's share of tax bill	0.0

$^{(1)}$ fixed $\omega = 0.6$.

* All numbers are in (%). Moments for simulation (10 thousands periods).

- Welfare changes

Role of the Secondary Market

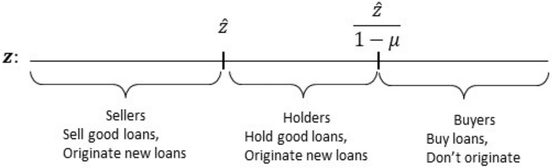
Reallocation of iliquid assets.

- Aggregate Lending:

$$\text{with SM}: \quad N = \int_{\underline{z}}^{p/q} n_t^j d\Gamma(b,z) + \int_{p/q}^{\frac{p/q}{1-\mu}} n_t^j d\Gamma(b,z)$$

$$\text{without SM}: \quad N = \int_{\underline{z}}^{\bar{z}} n_t^j d\Gamma(b,z)$$

- Most efficient operate.



Policy interventions

Policy vector: $\pi = (\omega, \gamma, T^B)$, where: $\tau = \omega\mu$

Budget sets:

- Government:

$$\gamma N + T^B = \tau p D(X)$$

- Borrowers:

$$C + K' \leq W + qN + T^B$$

- lenders:

$$c + (q+\gamma)zn + (1-\tau)pd \quad \leq \quad (1-\lambda)\phi b + p(s_G + s_B)$$

back

Proof of Proposition 1

Lemma 1. Aggregate B is a *sufficient statistic* to predict aggregate quantities and prices. Aggregate states are given by: $X = \{B, H; \lambda, Y\}$.
Proof

Lemma 2. Given lender's savings b', if $p > 0$, optimal trading decisions $\{n, d, s_G, s_B\}$ are given by Table 1. If $p = 0$, trading decisions are $d = s_G = s_B = 0$, and a lender origination decision is $n = b' - (1-\lambda)\phi b$. Respecting non-negativity constraints $n \geq 0, \quad d \geq 0$. ▷

Lemma 3. Consumption and savings decisions. ▷

Lemma 4. $D(X) > 0$ in the secondary market only if the solutions to a relax program and an original program for lenders coincides. ▷

Lemma 5. Exists a $q > 0$ that clears the lending market contingent on p in the secondary market. ▷

back

Lemma 1. B is sufficient statistic

Proof

1. Assumptions: i) lender holds one asset: budget set is linear in b. ii) homothetic preferences, $u(c) = \log(c)$, imply:
   - policy functions are linear in b: $c(z, b, X), b'(z, b, X), s_G(z, b, X), s_B(z, b, X), d(z, b, X)$
2. By assumption $z \sim$ iid: z^j is independent of b^j, also $\Gamma(z, b) = F(z)G(b)$
3. for given $\{p, \mu\}$: aggregates S_G, S_B, D do not depend on the distribution of b.
4. Therefore, neither do market clearing values $p(X), q(X), \mu(X)$
5. Thus, it is not necessary to know the distribution Γ to compute aggregate quantities and prices. B is a sufficient statistic.

back

Lemma 2

Lemma 2. *Given a lender's savings b', if there exists a positive market price for loans $p > 0$, optimal trading decisions $\{n, d, s_G, s_B\}$ are given by Table 1. If there is no positive price that clears the secondary market, trading decisions are $d = s_G = s_B = 0$, and a lender origination decision is $n = b' - (1-\lambda)\phi b$. Respecting the non-negativity constraints $n \geq 0, \quad d \geq 0$.*

Table 1: Trading and lending decisions

	$z < p/q$	$z \in [p/q, \frac{p/q}{1-\mu}]$	$z > \frac{p/q}{1-\mu}$
d	0	0	$\frac{b' - (1-\lambda)(1-\phi)b}{1-\mu}$
s_G	$(1-\lambda)(1-\phi)b$	0	0
s_B	$\lambda(1-\phi)b$	$\lambda(1-\phi)b$	$\lambda(1-\phi)b$
n	b'	$b' - (1-\lambda)(1-\phi)b$	0

back

Lemma 3. Consumption and savings decisions

Lemma 3. The optimal consumption and savings policy functions that solve lender's program are given by:

$$\begin{aligned} c &= (1-\beta^L)W(b,z,X) \\ b' &= \beta^L \max\{zq, p/(1-\mu)\} W(b,z,X) \end{aligned}$$

where $W(b,z,X)$ is lender's virtual wealth, given by:

$$W(b,z,X) = b\left[(1-\lambda)\hat{\phi} + \lambda(1-\phi)p(X) + (1-\lambda)(1-\phi)\max\{p, \min\{zq, p/(1-\mu)\}\}\right]$$

back

Lemma 4

Lemma 4. $D > 0$ only if the solutions to lender's original program, and relaxed program coincide for all lenders.

- Market clearing requires:

$$S(p, q; X) \geq D(p, q; X) \text{ holding strict whenever} p > 0$$

- $D(p, q; X)$, Demand of loans comes from integrating purchases from buyers, for this we use lender's savings policy function, Lemma 3, and purchasing decisions from Lemma 2
- $S(p, q; X)$, Supply of loans in the secondary market is given by integrating the policy function of sales of good loans, and bad loans from all lenders, Lemma 2, across the distribution of lenders $F(z)$.

back

Lemma 5

Lemma 5. Credit supply in the primary credit market is contingent on the equilibrium outcome achieved in the secondary market.

1. If there is a price $p > 0$ that clears the secondary market, credit supply in the primary market is given by

$$N^S(p, q; X) = \int_{z_a}^{\frac{p/q}{1-\mu}} n^j \, d\Gamma(b, z)$$

2. If instead, the only price that satisfy market clearing in the secondary market is $p = 0$, credit supply in the primary market is given by

$$N^S(p, q; X) = \int_{z_a}^{\bar{z}} n^j \, d\Gamma(b, z)$$

3. Credit supply is strictly increasing in p, whenever $p > 0$.
4. Credit supply is strictly decreasing in q.

back

Lender's problem

$$V^L(z,b;X) \quad = \quad \max_{\{c,b',n,d,s_B,s_G\}} \log c + \beta^L \mathbb{E}_{z',X'|X} V^L(z',b';X)$$

$$\begin{aligned}
c + nz(q+\gamma) + pd &\leq (1-\lambda)\phi b + p(s_G + s_B) \\
b' &= (1-\lambda)(1-\phi)b - s_G + n + (1-\mu\eta)d \\
s_G &\in [0,\ (1-\phi)(1-\lambda)b] \\
s_B &\in [0,\ (1-\phi)\lambda b] \\
& d \geq 0, \quad n \geq 0
\end{aligned}$$

- η is isomorphic to τ, by setting:

$$\eta = \frac{1}{\mu}\frac{\mu - \tau}{1 - \tau}$$

with $\tau \in [0,\mu] \rightarrow \eta \in [0,1]$.

back

Properties (cont.)

Proposition 2. *There exist a threshold $\bar{\lambda}$ such that for $\lambda_t > \bar{\lambda}$:*

- there is no trade in secondary markets, each lenders uses own tech.
- agg. cost of lending, and interest rate are higher than when SM operates.
- welfare of borrowers and lenders is lower.

Proof

Properties

Establish how cut-offs change when λ changes.

Assumption A1: $\forall\ \hat{z} \in [z_a, z_b]$:

$$\frac{1}{\hat{z}}\left(1 + \frac{\lambda}{1-\lambda}F(\hat{z})\right) < m(\hat{z})$$

where $m(\hat{z}) = \frac{F(\hat{z})}{f(\hat{z})}$ is the mills ratio or hazard rate of $\hat{z}$. ▷

Lemma 1. the adverse selection discount $\mu(\hat{z})$ is increasing in λ, and decreasing in $\hat{z}$. ▷

Lemma 2. Under assumption A1, $\frac{\hat{z}}{1-\mu(\hat{z})}$ is decreasing in $\hat{z}$.

Conjecture that exist a market cut-off $\hat{z}$ that satisfies $A1$, then an increase in λ leads to a decrease in $\frac{\hat{z}}{1-\mu(\hat{z})}$.

back

Assumption $A1$

Want: ratio $\frac{\hat{z}}{1-\mu(\hat{z})}$ to be decreasing in $\hat{z}$.

- for $\frac{d\cdot}{d\hat{z}} < 0$ to hold it must be that:

$$\frac{1}{\hat{z}}\left(1 + \frac{\lambda}{1-\lambda}F(\hat{z})\right) < m(\hat{z})$$

- $m(\hat{z}) = \frac{f(\hat{z})}{F(\hat{z})}$ is the inverse mills ratio or hazard rate.

back

Lemma μ

Lemma 1: the share of bad loans in the market λ^m is increasing in λ, and decreasing in $\hat{z}$.
Proof: by definition:

$$\begin{aligned} \mu(\hat{z}) &= \frac{s_B(\hat{z})}{S(\hat{z})} \\ &= \frac{\lambda(1-\phi)B}{\lambda(1-\phi)B + \int_{\underline{z}}^{\hat{z}} s_G dF} \\ &= \frac{\lambda}{\lambda + (1-\lambda)F(\hat{z})} \end{aligned}$$

last equality using: $s_G = (1-\lambda)(1-\phi)b$. F is the CDF of z.

back

Proof of proposition 2

Lemma 3.

1. *for any X, an equilibrium market cutoff $\hat{z}(X) > 0$ must satisfy A1 and the market clearing condition in Secondary market:*

$$D(\hat{z}; X) \quad = \quad S(\hat{z}; X)$$

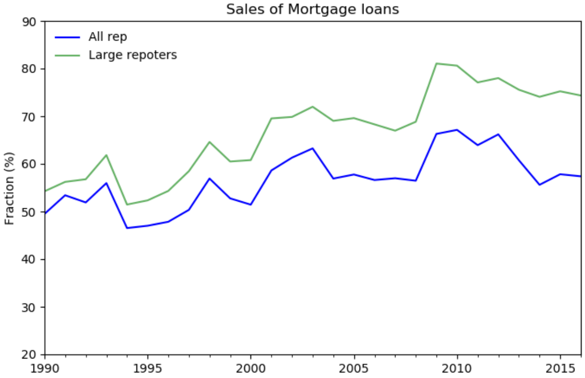
which implies:

$$\frac{\hat{z}}{1 - \lambda^m(\hat{z})} \leq \frac{\phi \beta^L}{(1-\phi)(1-\beta^L)}$$

2. For sufficiently high λ this condition is violated (market shutdown).

back

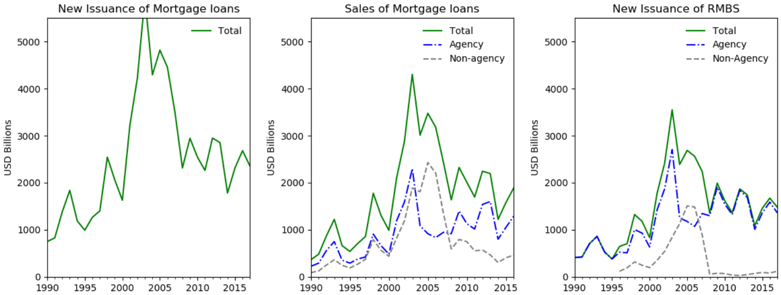
Fraction of sales across lenders, HMDA



Sales fraction	90-06	90-16
average (%)	61.8	66.7
std (%)	(6.9)	(9.0)

back

Primary and Secondary Market



Moments	**90-06**	**90-16**
corr(sales, lending), agg	0.99	0.98
corr(sales, lending), x-sectn	0.99	0.99
corr(sales frac, lending), x-sectn	0.88	0.67

back

Volume of sales and default rate

Table 2: Time Series, GLS regression

Dependent var: log(sales)	**coeff.**
default rate	-0.143*
10yr TB rate	-0.256***
DPI growth rate	-0.034
R-sq	0.478
Period	1990-2016

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

back

Volume of sales and default rate

Table 3: Fixed effects, panel regression

Dependent var: log(sales)	**Priv segment**	**Agency segment**
default rate	-0.060*	-0.040**
10yr TB rate	-0.436***	-0.405***
DPI growth rate	0.015	-0.052***
log (assets)	0.1209***	0.277***
R-sq	0.0717	0.0310
Number of obs	5,163	17,443
Period	1990-2016	1990-2016

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

back

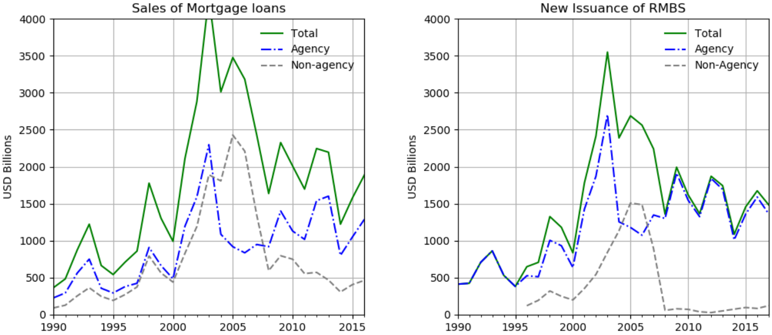
Motivation

private information: originators are better informed than investor about the probability of default of loans.

- empirical evidence:
  - Adelino, Gerardi, Hartman-Glaser (2018) JFE.
    Loans sold during the first 9 months of origination have higher ex-post default rates than those retained longer.
  - Keys, Mukerjee, Seru, Vig (2010) QJE.
    Loans that are more probable to be securitized have ex-post higher default rates than those that are retained.

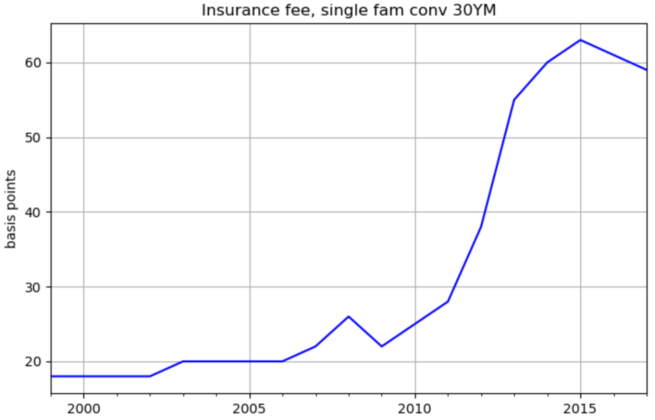
back

Secondary mortgage market



back

Insurance fee



back

Policy interventions in SM

Gov subsidizes purchases in secondary market.

Policy instruments

- τ, subsidy to buyers.
- γ, insurance fee on originators.

$$
\begin{aligned}
V(z,b;X) &= \max_{c,b',n,d,s_B,s_G} \log(c) + \beta^L \mathbb{E}_{X'|X} V(z',b';X') \\
c + (q+\gamma)zn + (1-\tau)pd &\leq (1-\lambda)\phi b + p(s_G + s_B) \\
b' &= (1-\lambda)(1-\phi)b + (1-\mu)d - s_G + n \\
& \quad n_1 \geq 0,\ d \geq 0,
\end{aligned}
$$

- deficit financed with lump sum transfer to borrowers: T^B
- policy vector: $\pi = (\tau, \gamma, T^B)$

back

Policy evaluation: main statistics

Description	**benchmark**	$\Delta^+\tau$	$\Delta^+\gamma$	**both policies**
mortgage spread	3.1	2.6	3.5	3.0
mortg spread, std	0.12	0.07	0.14	0.07
gov. policy, τ	2.8	4.4	2.8	4.4
borrower's share of tax bill	71.9	83.0	16.7	49.6

$\Delta^+\tau$:change in subsidy from 0.6 to 1.0. $\Delta^+\gamma$:change in fee from 20 bps to 60 bps.
* All numbers are in percentages. Moments for simulation (10 thousands periods).

back

Counterfactual economies: welfare changes

Table: Welfare changes wrt benchmark

Description	CI	AI no policy	no SM
Borrower welfare	0.03	-0.13	-5.61
Non-durable cons	0.63	0.60	-1.29
Housing good cons	-2.17	-2.85	-21.3
Lenders' welfare	-4.77	-3.55	-5.48

(1) *CI*: Complete information with no policy. (2) *AI* & no policy: Asymmetric information with no policy. (3) *no SM*: Economy without secondary markets.

⋆ All numbers are in (%). Moments for simulation (10 thousands periods).

back

Counterfactual economies: mains statistics

Description	1990-06	CI	AI no policy	no SM
avg mortgage spread, $r^m - r^f$	3.07	3.52	3.76	10.3
volatility mortg spread, std	0.12	0.23	0.28	0.26
fraction of loans traded	87.7	100	73.3	-

(1) *CI*: Complete information with no policy. (2) *AI* no policy: Asymmetric information with no policy.
(3) *no SM*: Economy without secondary markets.

* All numbers are in (%). Moments for simulation (10 thousands periods).

back

Actuarially fair gfee: Welfare effects

Description	$g_{\text{fee}} = 72bps$
Borrower welfare	-0.59
Non-durable cons	-0.20
Housing good cons	-1.99
Lenders' welfare	-2.2

$^{(1)}$change in coverage ω from 0.6 to 1.0$^{(2)}$change in g_{fee} from 20 bps to 60 bps
* All numbers are in (%). Moments for simulation (10 thousands periods).

back

Change in welfare

Consumption Equivalent Units

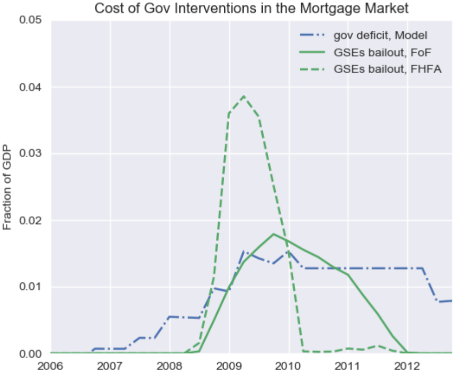
final consumption good only.

$$\begin{aligned}
\mathbb{E}_{s|s_0} V(c_t, k_t; b_t, s_t) &= \mathbb{E}_{s|s_0} V(\theta \tilde{c}_t, \tilde{k}_t; \tilde{b}_t, s_t) \\
&= \sum_{t=0}^{\infty} \beta^t \left(\alpha \log \theta \tilde{c}_t + (1-\alpha) \log \tilde{k}_t \right) \\
&= \frac{\alpha \log \theta}{1-\beta} + \sum_{t=0}^{\infty} \beta^t (\alpha \log \tilde{c}_t + (1-\alpha) \log \tilde{k}_t) \\
\alpha \frac{\log \theta}{1-\beta} &= \mathbb{E}_{s|s_0} V(c_t, k_t; b_t, s_t) - \mathbb{E}_{s|s_0} V(\tilde{c}_t, \tilde{k}_t; \tilde{b}_t, s_t)
\end{aligned}$$

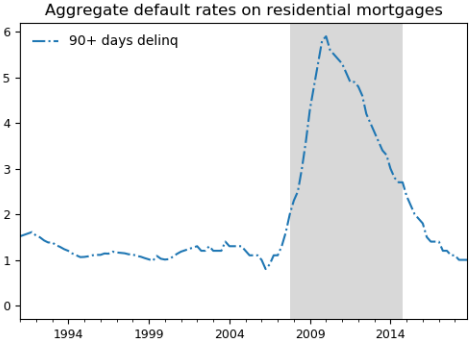
both goods:

$$\begin{aligned}
\mathbb{E}_{s|s_0} V(c_t, k_t; b_t, s_t) &= \mathbb{E}_{s|s_0} V(\theta \tilde{c}_t, \theta \tilde{k}_t; \tilde{b}_t, s_t) \\
\frac{\log \theta}{1-\beta} &= \mathbb{E}_{s|s_0} V(c_t, k_t; b_t, s_t) - \mathbb{E}_{s|s_0} V(\tilde{c}_t, \tilde{k}_t; \tilde{b}_t, s_t)
\end{aligned}$$

Great recession. Cost of interventions



Default rate



Default rate

- Percentage of mortgage loans 90 or more days delinquent, in foreclosure, or associated with bankruptcy at the end of quarter.
- Source: National Mortgage Database(NMDB), FHFA.the NMDB is a nationally representative five percent sample of residential mortgages in the United States.

back

Borrower's problem

$$V^B(b, h; X) = \max_{c,n,h',b'} u(c, h) + \beta^B \mathbb{E}_{X'|X} V^B(b', h'; X')$$

$$\begin{aligned}
c + h' - (1-\lambda)(1-\delta)h &\leq y - (1-\lambda)\phi b + qn - T^B \\
b' &= (1-\lambda)(1-\phi)b + n \\
b' &\leq \pi h' \\
&\text{given} \quad b_0, h_0
\end{aligned}$$

- Aggregate states: $X = \{\lambda, Y, B, H, \Gamma\}$
- preferences: $U^B(C, H) = (1-\theta)\log C + \theta \log H$

back

Calibration: borrowers

Description	param	value	target, period 90-06	var	**Data**	**Model**
disct factor	β^B	0.92	cons. ndur + serv to DPI.	C/Y	0.79	0.84
housing exp share	θ	0.20	cons. ndur + serv to RE.	C/H	0.40	0.41
housing depr	δ	0.03	RE invest to RE stock.	I/H	0.03	0.035
borr const	π	0.43	mortgage debt to RE ratio.	B/H	0.43	0.43

- borrower's problem ▷

back

Calibration: exogenous aggregate processes $\{\lambda, Y\}$

1. Estimate VAR for period 1990-06

var	Auto-corr	Cross-corr
Y_t	0.692***	-0.002*
λ_t	0.894***	0.547

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

2. Map to joint Markov process of first order: $\{\mathcal{S}, \Pi\}$

	var	moment	data	Markov
Cyclical comp DPI	Y	mean	1.0	1.0
		std	0.88%	0.88%
default rate, delinq 90d^{+}	λ	mean	1.33%	1.33%
		std	0.19%	0.20%
		corr	-0.21	-0.18

back

Cross Sectional Distribution of Mortgage Lending

Table 4: cross sectional distribution of Mortgage Lending

Moments	average	std-err
Mkt shr top 10% Inst. $>=$ avg vol	0.89	0.03
Mean/median	1.007	0.32
std	2.10	0.08
skewness	0.31	0.07

Source: HMDA LARs and Reporter Panel 1990-2017.
Statistics correspond to conventional, 1-4fam, owner occupied, home purchase loans.

- Volume in levels, dist 1990, 2000, 2010, 2017.
- Volume in log-levls, dist 1990, 2000, 2010, 2017.
- Time series of moments, log-levels. $\rightarrow$
- Market shares $\rightarrow$

back

Non-targeted moments

Description	Model	Data	Description
fraction of sales in SM	88	62	% mortg sales in SM, HMDA 90-06
corr (sales, lending)	0.81	0.98	Time series, HMDA, 90-06

- Calibration 1990-06 implies negative transfer to borrowers.

Description		1990-06
cost gov. policy	τ	2.7%
borrower's share of tax bill		0.76

*Moments for model simulation (10 thousands periods).

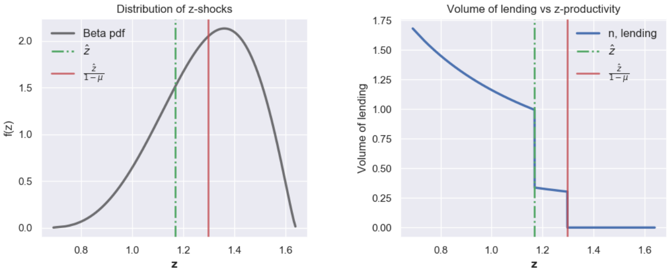
back

Model: cross-sectional distribution

- Beta distribution and Volume of lending, option 1 ▷
- Beta distribution and Volume of lending, option 2 ▷
- Lending Distribution ▷

back

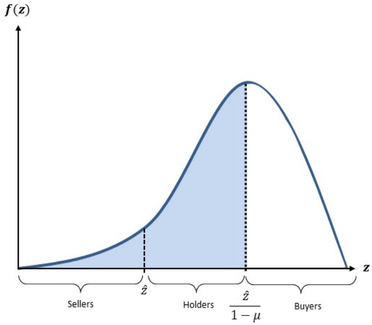
Calibration: beta distribution



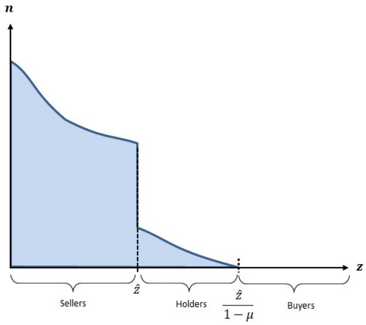
back

Calibration: beta distribution

Panel a. Beta distribution

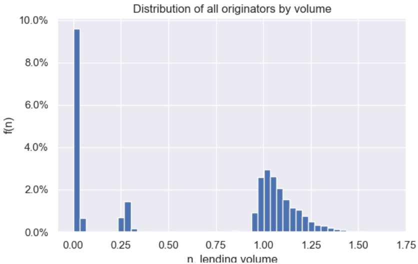


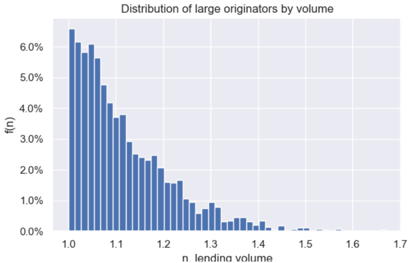
Panel b. Volume of lending



back

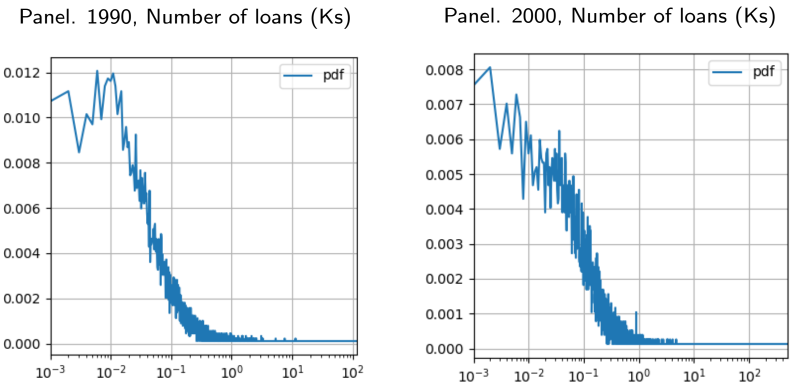
Calibration: distribution of lending





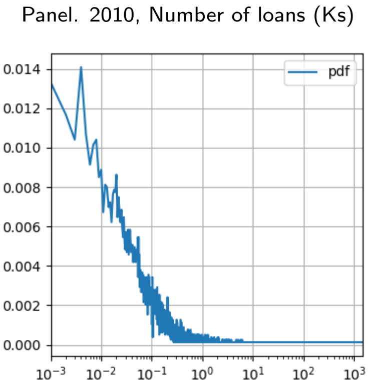
back

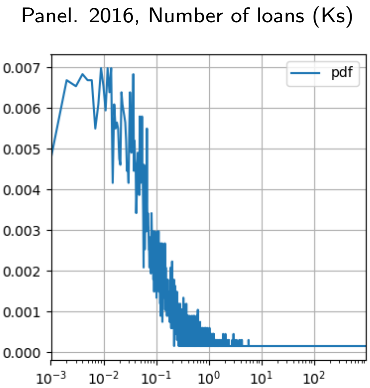
Distribution of Lending



back

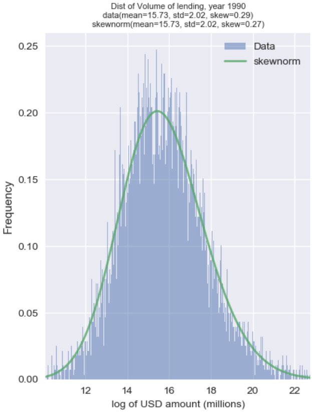
Distribution of Volume of Lending

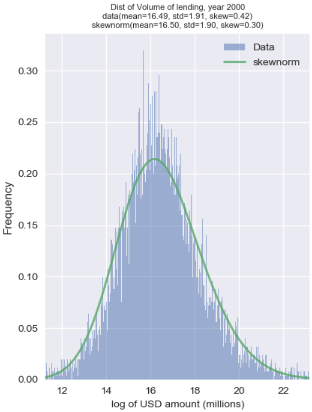




back

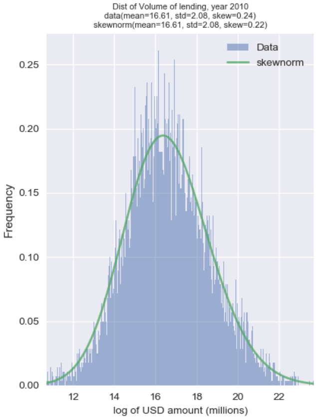
Distribution of Volume of Lending

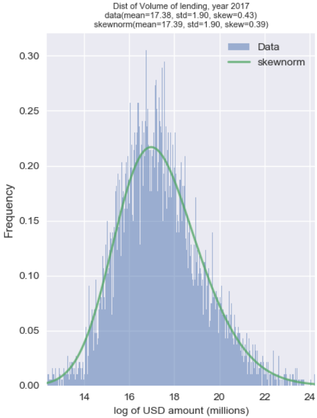




back

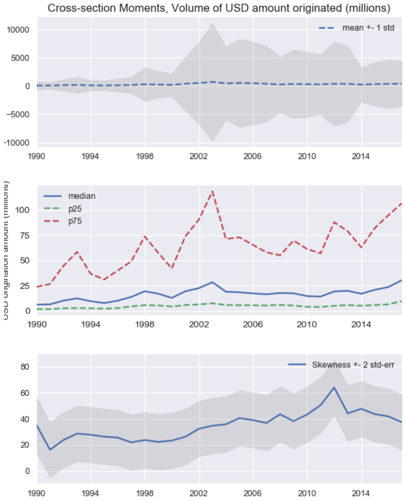
Distribution of Volume of Lending





back

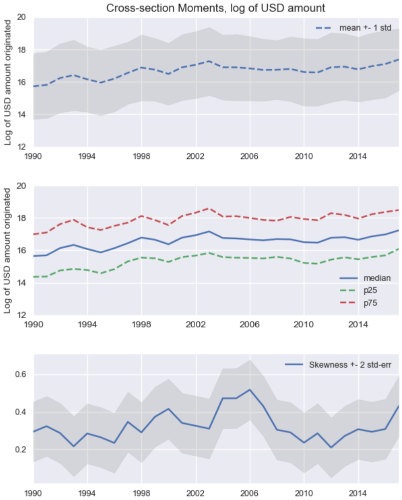
Cross section moments, logs of lending volume



Source: HMDA LARs and Reporter Panel 1990-2017

back

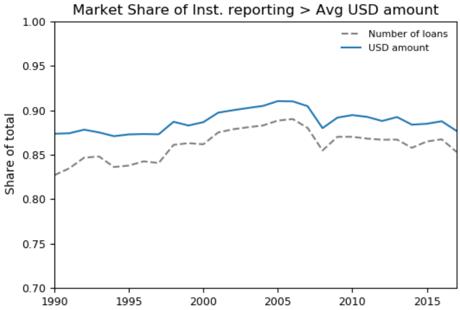
Cross section moments, lending volume millions USD



Source: HMDA LARs and Reporter Panel 1990-2017

back

Cross section moments, Market shares



Source: HMDA LARs and Reporter Panel 1990-2017

back

Persistence in Volume of origination

Panel Fixed Effects Regression, 1990-2017

$$\log N_{j,t} = \alpha_j + \rho \log N_{j,t-1} + \beta \log \mathit{assets}_{j,t} + u_{j,t}$$

Dependent: $\log N_{j,t}$	M1	M2
$\log N_{j,t-1}$	0.524^{***}	0.336^{***}
	(0.0048)	(0.0057)
$\log \mathit{assets}_{j,t}$	0.281^{***}	0.167^{***}
	(0.0109)	(0.0121)
$\log \mathit{SMsales}_{j,t}$		0.249^{***}
		(0.0038)
No. obs	193,298	100,811
adj. R-sq	0.375	0.544

Standard errors in parentheses.
$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.
$N_{j,t}$: volume of origination in million of USD, prices of 2015.

back