Reputation and Persistence of Adverse Selection in Secondary Loan Markets

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Introduction

• Volume of new issues in Secondary loan markets
  ○ Reallocate loans from originators to other institutions

• New issuances in such markets sometimes collapse

• Collapses associated with fall in underlying loan value
**Illustration of Abrupt Collapses**

New Issuances of ABSs in 2000s

- Similar pattern for syndicated loans; real estate bonds in the great depression

*Source: Morganmarkets, JP Morgan Chase*

*No reliable data for Non-US RMBS after Q3 '08*

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Economic Importance of Secondary Loan Markets

- From 1986 to 2012, average of $500 bn of new loans syndicated and sold in secondary loan markets

- In 2007, $1.3 trillion dollars of new loans syndicated

- Volume of new loans to corporations, almost all syndicated, declined by 37% from Aug. 2007 to Aug. 2008 (Ivashina and Scharfstein (2010))
What We Do

- Develop model of volume of new issues in secondary loan markets
- Show model generates fluctuations in volume when asset values fall
- Use model to evaluate policies intended to restore volume
Ingredients of Our Model

• Adverse Selection
  ◦ Standard story of trade volume
    ○ Generates fluctuations in trade volume

• Reputation
  ◦ Show necessary and sufficient:
    - Necessity: Absent reputational concerns, adverse selection does not persist
    - Sufficiency: With reputational concerns, adverse selection does persist
Characteristics of Equilibrium

- Absent reputational concerns, equilibrium always separating

- With reputational concerns, equilibrium must have pooling
  - Complete Pooling: no information revelation (high values of reputation)
  - Partial Pooling: partial information revelation (low values of reputation)
Policy Implications

- Adverse selection typically implies inefficiency (Prescott and Townsend (1984))

- With reputational concerns
  - Equilibrium is efficient unless...
    - Asset values are low and reputation is low

- Efficiency dictates low degree of separation across types

- Buyers have incentives to cream-skim when allocation has low separation; in dynamic model, these incentives are strongest when asset values are low and reputation is low

- Role for policy targeted at low reputation banks when asset values are low
Other Policy Implications

- Our reputational model has multiple equilibria

- In some models, policy can implement unique equilibrium without external resources

- Conventional asset purchase policies cannot do this in our model

- Unconventional policies which limit private trade are needed
Related Literature


- Policy Analysis: Phillipon and Skreta (2009); Tirole (2011)


Outline

- Static Model of Adverse Selection in Secondary Loan Markets

- Dynamic Model of Adverse Selection in Secondary Loan Markets - Illustrative Two Period Model
  - Without Reputational Concerns
  - With Reputational Concerns

- Infinite Horizon Model with Stochastic Asset Values

- Implications for Policy
Static Model of Adverse Selection in Secondary Loan Markets
Model Environment

- Large number of loan originators, or banks

- Banks endowed with a portfolio of risky loans, size 1
  - Loan pays $v$ with prob. $\pi$, 0 with prob $1 - \pi$
    \[ v = \bar{v} - v \text{ is spread, } v \text{ is collateral value} \]
  - Probability of no default same for all loans in a bank’s portfolio
  - Two types of banks, $\pi \in \{\bar{\pi}, \bar{\pi}\}, \pi < \bar{\pi}$
  - Two buyers (Bertrand-style price competition)
• Each bank chooses how much of its loan portfolio to sell, $x$

• Let $t$ denote payment bank receives for selling $x$ loans, $p$ is price per loan

• Buyers have comparative advantage in holding loans $c > 0$

• Bank payoff from selling $x$ loans for payment $t$:

$$t + (1 - x)(\pi v - c)$$

• Buyer profits from $(x, t)$

$$x\pi v - t$$
Model Environment (cont.)

- Adverse selection: bank knows type of loans, potential buyers do not

- Buyers believe given bank is high-quality with probability $\mu$

- Distribution of Banks $H_2(\mu)$

- Call $\mu$ the *reputation* of the bank
Timing in Static Model

- Buyers simultaneously propose contracts consisting of offers to a given bank:
  
  \[ z = (x_h, t_h, x_l, t_l) \in Z \]

- Bank chooses whether to accept a contract or reject both

- If bank accepts a contract, then chooses which offer to accept

- Restrict to pure strategies for banks, possibly mixed strategies for buyers, \( F(z) \) for \( z \in Z \)

- Equilibrium is standard
Equilibrium Conditions in Static Model

- Incentive Constraints

\[ t_h + (1 - x_h)(\bar{\pi}v - c) \geq t_l + (1 - x_l)(\bar{\pi}v - c) \]

\[ t_l + (1 - x_l)(\pi v - c) \geq t_h + (1 - x_h)(\pi v - c) \]

- Zero Profits for Buyers (at each point in support of \( F \))

\[ \mu(x_h\bar{\pi}v - t_h) + (1 - \mu)(x_l\pi v - t_l) = 0 \]
Equilibrium Characterization in Static Model

Proposition

The static model has a (unique) separating equilibrium.

- With low reputation, pure strategies by buyers, least-cost separating outcome (Rothschild and Stiglitz (1976))

- With high reputation, mixed strategies by buyers, cross-subsidization across types
  - Follow Dasgupta and Maskin (1986) and Rosenthal and Weiss (1984) to prove existence and characterize equilibrium in mixed strategies
Equilibrium Characterization in Static Model

- Three general properties (Dasgupta & Maskin (1986))
  - $x_l = 1$
  - Buyers make zero profits
  - Incentive constraint for low-quality bank holds with equality:
    \[ t_l = t_h + (1 - x_h)(\pi v - c) \]

- Implies for each $t_l$, can uniquely determine $x_h$ and $t_h$

- For reputation below a threshold, $\tilde{\mu}$, least cost separating outcome has
  \[ t_l = \pi v, \quad t_h = x_h \bar{\pi} v \]
Equilibrium Characterization in Static Model

- Low prior(reputation): Least Cost Separating Equilibrium

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Equilibrium Characterization in Static Model

- At $\tilde{\mu}$, high-quality bank indifferent between pooling and Least Cost Separating outcome

- For reputation above threshold, $\tilde{\mu}$, no pure strategy equilibrium

- So focus on mixed strategy equilibrium

- Let $F$ denote the distribution over $t_l$

- Idea: deviations attract low-quality banks with disproportionate probability
High reputation: pooling (C) beats A and B
Equilibrium Characterization in Static Model

- Offer D to low-quality banks

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Equilibrium Characterization in Static Model

- Ride along low-quality bank’s indifference curve to zero profits; Cross-subsidization.
Equilibrium Characterization in Static Model

- Mixed Strategy Equilibrium

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Equilibrium Characterization in Static Model

- Mixed Strategy Equilibrium

Why deviation involving F is not profitable
Equilibrium Characterization in Static Model

- Why deviation F-G is not profitable
Equilibrium Characterization in Static Model

- Why deviation F-G is not profitable

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Comparative Statics: Collateral Value Shocks and Volume

• How does an increase in $v$ affect volume?

• Suppose $\mu$ is low:
  Incentive compatibility:
  
  $$\pi_v = \bar{\pi}vx_h + (1 - x_h)(\pi_v - c)$$

• An increase in $v$, increases RHS more than LHS
  Low quality bank more tempted to lie; lower fraction sold by high quality bank

• Similar argument for high $\mu$

Proposition

An decrease in collateral value leads to a decline in total volume of trade.
Main take-away

- Static separating equilibrium; Volume decreasing in spread
- Value function implied by static model - strictly sub-modular.

![Graph](image-url)

Dynamic Model of Adverse Selection in Secondary Loan Markets
Dynamic Environment

- In each $t = 1, 2$, banks originate loan portfolio

- Buyers offer 1 period contracts $z$

- Banks discount future payoffs at rate $\beta$

- Buyers observe contracts chosen by bank in previous periods

- Simplifications (abstract from other sources of learning):
  - Bank type is fully persistent
  - Buyers do not observe returns on loans in previous periods
Without Reputational Concerns

Proposition

Suppose $\beta = 0$ (or small). The equilibrium features full separation and complete learning in the first period. Trade volume in second period is independent of collateral values.

- Persistence issue: trade volume not linked to collateral values in second period
- Correlation issue: volume across bank types not correlated
- Same with more periods
- Why reputation is necessary
Findings With Reputational Concerns

- When $\beta$ is large enough, no equilibrium features full separation
  - Implies Adverse Selection persists
  - Why reputation is sufficient

- Equilibrium has complete pooling for high reputations

- Equilibrium has partial pooling for low reputations

- Volume of trade in both periods declines when collateral values fall
Proposition

Suppose $\beta \geq \beta_1$. Then no equilibrium has complete separation of high- and low-quality banks in the first period.

- In a separating equilibrium, static loss from mimicking the high type, but dynamic gain. For $\beta$ sufficiently large, dynamic gain dominates.

- Implies any equilibrium features at best partial revelation of information over time.

- Implies adverse selection must persist so changes in collateral value induce changes in volume in the long-run.
No Fully Separating Equilibrium Exists

Proof:

- In a separating equilibrium, incentive compatibility:

\[ th + (1 - x_h)(\bar{\pi}v - c) + \beta V(1; \bar{\pi}) \geq tl + (1 - x_l)(\bar{\pi}v - c) + \beta V(0; \bar{\pi}) \]

\[ tl + (1 - x_l)(\bar{\pi}v - c) + \beta V(0; \bar{\pi}) \geq th + (1 - x_h)(\bar{\pi}v - c) + \beta V(1; \bar{\pi}) \]

- Add them up:

\[ (x_l - x_h)(\bar{\pi} - \bar{\pi})v \geq \beta[(V(1; \bar{\pi}) - V(0; \bar{\pi})) - (V(1; \bar{\pi}) - V(0; \bar{\pi}))] \]

- When \( \beta \) is large enough, impossible to satisfy
**Equilibrium Characterization in Dynamic Model**

- Proposition above implies outcomes must have some pooling

- Signaling model with lots of equilibria: focus on the maximal-trade equilibrium
  - Maximal trade equilibrium pareto dominates other equilibria – more on this later

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**Proposition**

*If $\beta$ is larger than $\beta_1$, the maximal trade equilibrium in the first period has the form:*

- When reputation is high, equilibrium has complete pooling: both types sell all their loans

- When reputation is low, equilibrium has partial pooling: low types randomize
Characterization for High Reputation

- Look for equilibrium with full trade

- At threshold $\mu^*$, high-quality bank indifferent between pooling outcome and holding its loan

- When $\mu \geq \mu^*$, equilibrium has *complete pooling* with full trade
  - High- and low-quality banks sell all their loans

- Equilibrium features:
  - Both banks sell all loans at pooling price
  - Reputation levels do not change
  - Off-path beliefs:

  $$
  \mu'(\hat{x}, \hat{t}) = \begin{cases} 
  1 & \text{if } \hat{t} + (1 - \hat{x})(\bar{\pi}v - c) \geq \hat{p}(\mu) \\
  0 & \text{otherwise}
  \end{cases}
  $$
Logic of Proof for High Reputation

- Consider cream-skimming contracts with lower number of loans sold and payment attractive only to high-quality banks
  - Such cream-skimming profitable deviation in static model

  - In dynamic model, reputational gains imply low-quality can earn future profits by accepting cream-skimming contracts

  - So such deviation not profitable

- We show logic of argument extends to deviations where buyer proposes contracts with different offers
Off-Path Beliefs Prevent Cream-Skimming

Complete Pooling with $x=1$

- High Quality Break-Even line
- Pooled Break-Even line
- Low Quality Break-Even line

$$\mu'(x,t) = 1$$

$$\mu'(x,t) = 0$$
Characterization for Low Reputation

- When $\mu < \mu^*$, full trade not an equilibrium; instead we have *partial pooling*

- Any symmetric equilibrium is of the following form:
  - Buyers offer $z = (x_h, t_h, x_l, t_l)$
  - High quality bank: choose $(x_h, t_h)$
  - Low quality bank: randomize
Characterization for Low Reputation

- Properties induced by equilibrium:
  - IC:
    \[ t_h + (1 - x_h)(\bar{\pi}v - c) + \beta V(\mu'_h; \bar{\pi}) \geq t_l + (1 - x_l)(\bar{\pi}v - c) + \beta V(0; \bar{\pi}) \]
    \[ t_l + (1 - x_l)(\bar{\pi}v - c) + \beta V(0; \bar{\pi}) = t_h + (1 - x_h)(\bar{\pi}v - c) + \beta V(\mu'_h; \bar{\pi}) \]
  - zero profits
  - Participation for high quality bank
    \[ t_h + (1 - x_h)(\bar{\pi}v - c) + \beta V(\mu'_h; \bar{\pi}) \geq \bar{\pi}v - c + \beta V(0; \bar{\pi}) \]
  - Betrand Competition:
    \[ \frac{1}{2} \mu(x_h \bar{\pi}v - t_h) + (1 - \mu)(\bar{\pi}v - t_l - (1 - x_l)(\bar{\pi}v - c)) \leq 0 \]
Characterization for Low Reputation

Proposition

A contract \( z = (x_h, t_h, x_l, t_l) \) is a partial pooling symmetric equilibrium if and only if it satisfies the above.

- Maximal Trade Equilibrium: Maximize trade volume subject to above
Logic of Proof for Low Reputation

- As when reputation high, reputational gains ensure buyers cannot profitably cream-skim.

- Buyers also have incentive to induce better sorting by low-quality types by adjusting \((x_l, t_l)\).

- Such a deviation
  - may increase profits per low-quality bank
  - attracts low-quality banks with greater probability.

- Bertrand Competition constraint ensures deviation attracts disproportionate number of low-quality banks so deviation is unprofitable.
Off-Path Beliefs Prevent Cream-Skimming

Partial Pooling with \( x_l=1 \)

- High Quality Break-Even line
- Pooled Break-Even line
- Low Quality Break-Even line

\[
\mu'(x,t) = \begin{cases} 
1 & \text{for } (1, t_l) \\
0 & \text{for } (x_h, t_h) 
\end{cases}
\]

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Off-Path Beliefs Prevent Cream-Skimming

Partial Pooling with $x_l=1$

- High Quality Break-Even line
- Pooled Break-Even line
- Low Quality Break-Even line

$\mu'(x,t) = 0$

$\mu'(x,t) = 1$

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Off-Path Beliefs Prevent Cream-Skimming

Partial Pooling with $x_l=1$

- High Quality Break-Even line
- Pooled Break-Even line
- Low Quality Break-Even line

$\mu'(x,t) = 1$

$\mu'(x,t) = 0$

$(x_h, t_h)$

$(1, t_l')$

$(1, t_l)$

• Explaining Bertrand Constraint

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Properties of Maximal Trade Equilibria

- **High \( \mu \)**
  - Both bank types sell
  - No learning \( (\mu' = \mu) \)

- **Low \( \mu \):**
  - Cross-subsidization
  - Some learning
  - Can show participation constraint for high-quality bank binds
  - Can show Bertrand constraint binds only when \( v \) is high and \( \mu \) is low
Comparison Statics on Collateral Value

- $x_h$ in maximal trade equilibrium

Chari, Shourideh, & Zetlin-Jones (2020) - Reputation and Persistence in S.L. Markets
• Increase in $v$ lowers $x_h$ and so volume in maximal trade equilibrium
Volume of Trade and Collateral Values

Proposition

Temporary reduction in collateral values in first period reduces expected trade volume for both types

- If $H_1(\mu)$ has mass at or below $\mu^*$: trade volume falls
- Infinite horizon: endogenize distribution of reputation
Dynamic Model of Adverse Selection in Secondary Loan Markets:

Infinite Horizon With Reputational Concerns
Infinite Horizon with Stochastic Collateral Value

- Assume \( v_t \sim G(v_t), v_t \in [v_{min}, v_{max}] \)

- Quality of banks not fully persistent:
  - Each period, bank draws new quality with prob. \( \lambda \) (observable)
  - If new draw, becomes high-quality with prob. \( \mu_0 \sim H(\mu_0) \)
    - \( H(\cdot) \): continuous distribution; support = \([0, 1]\)
The Model with Stochastic Loan Spreads

- If banks patient, then no separating equilibrium exists

- Equilibrium:
  - For each \( v_t \), low reputation has partial-pooling, high reputation has complete pooling
  - For each \( \mu_t \), low spread has both types selling, high spread has at least high-quality bank holding

- Partial Pooling
  - high-quality bank holds loans, low-quality bank mixes between holding and selling

- Complete Pooling:
  - For low spreads, both types sell
  - For high spreads, both types hold
The Model with Stochastic Loan Spreads

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The Model with Stochastic Loan Spreads

- Why Complete Pooling, Both Types Hold?
  - Low-quality banks hold to maintain reputation
  - Sell at favorable prices in future when spreads fall
  - Expected future aggregate shocks imply maintaining reputation has value

- Would not be consistent with equilibrium in deterministic model

- Implies anticipation of future shocks to $v$ affects nature of equilibrium
  - Greater value to maintaining a reputation
Anticipated Shocks to Collateral Values

- Invariant distribution:
  - Mass at 0, $\mu_h$
  - Continuous everywhere else

- Mass points at 0, $\mu_h$: discontinuous change in volume

Proposition

If $\beta \geq \overline{\beta}$ and shocks to collateral values are independent over time, aggregate volume is declining in the spread, $v$, and declines are discontinuous.
A Simulation

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Implications for Policy
Implications for Policy

• End of 2007, policymakers implemented programs intended to re-start volume of trade in secondary loan markets

• Optimal Policies in this environment? Two period model

• Our notion of constrained efficiency with commitment
  ○ Maximize ex-ante payoff of banks
  ○ Respect incentives
  ○ Do nothing in the second period
  ○ Bester and Strausz (2001): direct mechanisms with mixed strategies
First period bank payoffs equal to $\hat{p}(\mu) - c(1 - T)$, so that

$$\max \hat{p}(\mu) - c\mathbb{E}_\mu [(1 - x_i)] + \beta \mathbb{E}_\mu V(\mu'_i; \pi_i)$$

subject to

- Incentive compatibility
- Banks’ participation constraints
- Buyers’ participation constraints
- Note: equilibrium has Bertrand constraint in addition
Efficiency with High Reputation

Proposition

*Pooling with full volume of trade is constrained efficient.*

- Complete pooling maximizes first period payoffs
- Separation could increase second period continuation values
- Separation tightens IC, has lower trade trade in first period and so lower first period payoffs
- Show separation cannot increase welfare because value functions satisfy decreasing differences (sub-modularity)
Efficiency with Low Reputation

Proposition

Maximal Trade equilibrium is inefficient if and only if reputation is low and \( v \) is high. When inefficient, there is too much separation in equilibrium.

• Basic logic:
  ◦ Planner’s allocation: partial pooling allocation
  ◦ Recall the maximal trade equilibrium
  ◦ Extra Constraint: imposed by Bertrand competition
  ◦ Works as an externality
Efficiency with Low Reputation

- Efficiency pushes outcomes towards minimal separation

- Also requires $\mu'_h = \tilde{\mu}$

- As $v$ rises, more cross-subsidization at $x_h, t_h$ (rather than at $x_l, t_l$)

- Implies subsidy to low-quality bank at $x_l, t_l$ decreasing in $v$

- Bertrand constraint (in equilibrium) requires higher subsidies to low-quality bank at $x_l, t_l$
Implications for Policy to Weakly Implement Efficient Allocations

- Intervene when adverse selection is severe
- Target low reputation banks
Asset Purchase Policies and Strict Implementation

- Possible motivation for asset purchase policies:
  - Strict implementation of high volume equilibrium

- Policies that work require outside revenues or limits to private trade
Asset Purchase Policies that Do Not Work

- Consider version of our model without strategic interaction of buyers

- Banks and buyers take price $p(\mu)$ as given

- Banks choose $x_h, x_l$ loans to sell

- Buyers choose $y$ loans to buy
  - Buyers payoffs:
    $$y \left[ \mu 1_{[x_h>0]}(\pi v - p(\mu)) + (1 - \mu) 1_{[x_l>0]}(\pi v - p(\mu)) \right]$$

- Model has a competitive equilibrium with externalities
Static Model with Price Taking Behavior

- When $\mu \geq \mu^*$, multiple equilibria

- High-trade: $p(\mu) = \hat{p}(\mu) = \mu \bar{\pi}v + (1 - \mu)\pi v$
  - Both banks sell their loans

- Low-trade: $p(\mu) = \pi v$
  - Only low-quality banks sell their loans

- Good policy: Offer to buy at $\hat{p}(\mu)$
  - Eliminates low-trade equilibrium
  - Does not require resources by Gov’t
  - Similar to deposit insurance in bank run models
Asset Purchase Policies in Dynamic Model

• Why we prefer our equilibrium concept
  ◦ Buyers have strong incentives to cream-skim, use nonlinear contracts
  ◦ Restricting to linear contracts, have strong incentives to offer pooling price near $\hat{p}(\mu)$

• Our model has multiple equilibria:
  ◦ Suppose equilibrium switches from maximal volume to zero volume in our dynamic model
Asset Purchase Policies That Do Work

- Gov’t offers to buy \((1, \hat{p}(\mu))\) in first period

- Policy at best ineffective
  - Either nobody sells to government or only low-quality banks sell to government

- Reason:
  - An individual buyer could have offered this contract
  - Did not do so because was not profitable
  - So policy does not work

- For price \(p > \hat{p}(\mu)\) can attract high-quality banks but also attract low-quality banks
  - Implies policy requires outside resources

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Conclusions

• Adverse selection is a promising candidate for fluctuations

• Lack of anonymity implies those who think adverse selection is promising should take reputation seriously

• We have developed a tractable model of adverse selection and reputation; useful for other applications as well