Reputation and Persistence of Adverse Selection in Secondary Loan Markets

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October 29th, 2013
Introduction

- Trade volume in Secondary loan markets
  - Reallocate loans from originators to other institutions
- New issuances in such markets sometimes fall abruptly
- 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

*No reliable data for Non-US RMBS after Q3 '08
Source: Morganmarkets, JP Morgan Chase
Introduction

- Two key ingredients:

  • Adverse selection
  • Reputation

How does adverse selection persist over time?

How does the interplay between adverse selection and reputation affect the dynamics of the market?

What are the inefficiencies in the market? Optimal policies?
Introduction

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  - Adverse selection
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- Two key ingredients:
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  - Reputation
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• Two key ingredients:
  ○ Adverse selection
  ○ Reputation

• How does adverse selection persist over time?

• How does the interplay between adverse selection and reputation affect the dynamics of the market?

• What are the inefficiencies in the market? Optimal policies?
**Introduction**

- **Persistence issue**: Absent reputational concerns, adverse selection does not persist

- **Correlation issue**: Absent reputational concerns, volume of trade not correlated across banks

- **With reputational concerns:**
  - Low reputation (prior): Partial Pooling of types
  - High reputation: Complete Pooling
  - Adverse selection persists (reputational motives put a limit on learning)

- **With reputational concerns**, trade volume correlated
Implication for Policy

- Externality imposed by competition against customers with many types

- Market outcome inefficient only when reputation is low enough and adverse selection is severe enough

- Policies should be directed toward low reputation originators (banks) when times are bad
Related Literature

- Adverse Selection in asset markets: Garleanu-Pedersen, Duffie-DeMarzo

- Reputation literature: Milgrom-Roberts, Kreps-Wilson, Mailath-Samuelson, Ordonez


Outline

• Static Model of Adverse Selection in Secondary Loan Markets

• Dynamic Model of Adverse Selection in Secondary Loan Markets
  ○ Without Reputational Concerns
  ○ With Reputational Concerns

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

• Large number of buyers

• 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 $1 - \pi$
    
    \[ \Rightarrow v = \bar{v} - \underline{v} \text{ is spread, } \underline{v} \text{ is collateral value} \]

  ○ Probability of no default same for all loans in a bank’s portfolio

  ○ Two types of banks, $\pi \in \{\underline{\pi}, \bar{\pi}\}, \underline{\pi} < \bar{\pi}$
• 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
- Focus on sales of individual bank with reputation $\mu$
- Focus on 2 buyers (Bertand-style price competition)
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
Proposition

The static model has a (unique) separating equilibrium.

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

- High reputation implies mixed strategies by buyers, cross-subsidization across types (Rosenthal and Weiss (1984))
Equilibrium Characterization in Static Model

• Low prior (reputation): Least cost separating equilibrium
Equilibrium Characterization in Static Model

- High reputation: pooling beats A and B

Chari, Shourideh & Zetlin-Jones (Collapse in S.L. Markets)
Equilibrium Characterization in Static Model

- Offer D to low-quality banks
Ride along low-quality bank’s indifference curve to zero profits
Equilibrium Characterization in Static Model

- Mixed Strategy Equilibrium
Equilibrium Characterization in Static Model

- Mixed Strategy Equilibrium

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Equilibrium Characterization in Static Model

- Why deviation is not profitable

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Equilibrium Characterization in Static Model

- Why deviation is not profitable
Equilibrium Characterization in Static Model

- Why deviation is not profitable

Chari, Shourideh & Zetlin-Jones() Collapse in S.L. Markets
Collateral Value Shocks and Volume

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

- Suppose $\mu$ is low:
  Incentive compatibility:

$$\pi v = \bar{\pi}v x_h + (1 - x_h)(\pi v - c)$$

- 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 increase 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.

High and Low Quality Value Functions
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
Dynamic Model of Adverse Selection in Secondary Loan Markets:

Without Reputational Concerns
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
- Correlation issue: volume across bank types not correlated
- Same with more periods.
Dynamic Model of Adverse Selection in Secondary Loan Markets:

With Reputational Concerns
No Fully Separating Equilibrium Exists

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 may 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:
  
  \[ t_h + (1 - x_h)(\bar{\pi}v - c) + \beta V(1; \bar{\pi}) \geq t_l + (1 - x_l)(\bar{\pi}v - c) + \beta V(0; \bar{\pi}) \]
  
  \[ t_l + (1 - x_l)(\pi v - c) + \beta V(0; \pi) \geq t_h + (1 - x_h)(\pi v - c) + \beta V(1; \pi) \]

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

- 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
  - Also, pareto optimal equilibrium – more on this later.

**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 accept same offer*

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

- **Cutoff**: $\mu^*$ such that $\hat{p}(\mu^*) = \bar{\pi}v - c$
  
  $$\hat{p}(\mu) = \mu \bar{\pi}v + (1 - \mu)\bar{\pi}v$$

- **When $\mu \geq \mu^*$**, equilibrium has **complete pooling**
  - High- and low-quality banks accept the same offer

- **Equilibrium features**:
  - Both banks sell all loans at actuarially fair prices
  - Reputation levels do not change
  - Off-path beliefs:

  $$\mu'(\hat{x}, \hat{t}) = \begin{cases} 1 & \text{if } \hat{t} + (1 - \hat{x})(\bar{\pi}v - c) \geq \hat{p}(\mu) \\ 0 & \text{otherwise} \end{cases}$$
Off-Path Beliefs Prevent Cream-Skimming

Complete Pooling with $x=1$

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

High Quality Break-Even line
Pooled Break-Even line
(1, $\hat{p}(\mu)$)
Low Quality Break-Even line

Chari, Shourideh & Zetlin-Jones
Collapse in S.L. Markets
Other Pooling Equilibria Exist

Complete Pooling with $x<1$

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

$$\mu(x,t) = 0$$

Chari, Shourideh & Zetlin-Jones()} Collapse in S.L. Markets
• When \( \mu < \mu^* \), equilibrium has *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:
    \[ t_h + (1 - x_h)(\bar{\pi}v - c) + \beta V(\mu'_h; \bar{\pi}) \geq t_l + (1 - x_l)(\bar{\pi}v - c) + \beta V(0; \bar{\pi}) \]
    \[ t_l + (1 - x_h)(\pi v - c) + \beta V(0; \pi) = t_h + (1 - x_h)(\pi v - c) + \beta V(\mu'_h; \pi) \]
  - 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:
    \[ \frac{1}{2} \mu(x_h \bar{\pi}v - t_h) + (1 - \mu)(\pi v - t_l - (1 - x_l)(\pi v - c)) \leq 0 \]
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
Partial Pooling with $x_i = 1$

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

Mathematical expressions:

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

$(1, t_l)$

$(x_h, t_h)$

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Partial Pooling with $x_i=1$

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

$\mu'(x,t) = 1$
$\mu'(x,t) = 0$

(Chari, Shourideh & Zetlin-Jones)
Properties of Maximal Trade Equilibria

- High $\mu$
  - Everyone sells,
  - No learning

- Low $\mu$:
  - Cross-subsidization,
  - Some learning,
  - Participation constraint for high quality bank binding,
  - Bertrand constraint sometimes binding
Response of Volume to Temporary Shock to Collateral Value

- Two effects on an increase in spread $v$:
  - Similar to static model: price in $(x_h, t_h)$ is higher than in $(1, t_l)$.
  - Cross subsidization: high quality participation constraint becomes tighter.
Response of Volume to Temporary Shock to Collateral Value

- Two effects on an increase in spread $v$:
  
  - Similar to static model: price in $(x_h, t_h)$ is higher than in $(1, t_l)$.
  
  - Cross subsidization: high quality participation constraint becomes tighter

  solve for $t_h$ from IC + zero profits

  $$t_h = (\hat{p}(\mu) + c(\mu/\mu_h - 1)x_h + (\mu/\mu_h - 1)[\beta(V(\mu'_h; \pi) - V(0; \pi)) - c]
  
  low reputation: $t_h$ less sensitive to $v$ than $\bar{\pi}v - c$.  
  
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Maximal Trade Equilibrium

Reputation $\mu$

$\chi_h$

Chari, Shourideh & Zetlin-Jones

Collapse in S.L. Markets
Maximal Trade Equilibrium

Reputation $\mu$

$\times h$

Volume of Trade and Collateral Values

Proposition

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

- $H_2(\mu)$ 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 $v_t \sim G(v_t), v_t \in [v_l, \infty)$

- 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

\[ \text{Loan Spread, } v_t \]
\[ \text{Reputation, } \mu_t \]
\[ \mu_h \rightarrow \infty \]

Pooling, Both Types Sell

Pooling, Both Types Hold

Partial Pooling, High-Quality Banks Hold

\[ \mu^*(v) \]

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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
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 $\beta \geq \beta_0$ 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
  ○ Respect lack of commitment: do nothing in the second period
  ○ Bester and Strausz (2001): direct mechanisms with mixed strategies
Planning Problem

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

subject to

- IC:

\[
\begin{align*}
    t_h + (1 - x_h)(\bar{\pi}v - c) + \beta V(\mu'_h; \bar{\pi}) & \geq t_l + (1 - x_l)(\bar{\pi}v - c) + \beta V(\mu'_l; \bar{\pi}) \\
    t_l + (1 - x_l)(\bar{\pi}v - c) + \beta V(\mu'_l; \bar{\pi}) & \geq t_h + (1 - x_h)(\bar{\pi}v - c) + \beta V(\mu'_h; \bar{\pi})
\end{align*}
\]

with complementary slackness

- Banks’ Participation:

\[
\begin{align*}
    t_i + (1 - x_i)(\pi_i v - c) + \beta V(\mu'_i; \pi_i) & \geq \pi_i v - c + \beta V(0; \pi_i), i = h, l
\end{align*}
\]

- Buyer’s participation: Profits \geq 0
Efficiency with High Reputation

Proposition

Pooling with full volume of trade is constrained efficient.

- Suppose there is some separation via mixing
- Could potentially increase continuation values

\[
t_h + (1 - x_h)(\bar{\pi}v - c) + \beta V(\mu'_h; \bar{\pi}) \geq t_l + (1 - x_l)(\bar{\pi}v - c) + \beta V(\mu'_l; \bar{\pi})
\]

\[
t_l + (1 - x_l)(\bar{\pi}v - c) + \beta V(\mu'_l; \bar{\pi}) \geq t_h + (1 - x_h)(\bar{\pi}v - c) + \beta V(\mu'_h; \bar{\pi})
\]

Add the incentive constraints:

\[
(x_l - x_h)(\bar{\pi} - \bar{\pi})v \geq \beta [(V(\mu'_h; \bar{\pi}) - V(\mu'_l; \bar{\pi})) - (V(\mu'_h; \bar{\pi}) - V(\mu'_l; \bar{\pi}))]
\]

- Sub-modularity of the value function: lowers volume
- Volume effect dominates
Efficiency with Low Reputation

Proposition

Partial pooling 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

- Some (partial) intuition
  - Strict sub-modularity: Planner wants as little separation as possible
  - Bertrand constraint: subsidies to $\pi$ big enough
  - As $v$ rises, $x_h$ should fall to get high type to participate
  - When $\mu$ is low there is a lot of low types
  - Lowers the subsidy; Harder to compete

- Higher Separation in equilibrium: relaxes Bertrand constraint
Implications for Policy

• Intervene when adverse selection is severe

• Target low reputation banks

• Optimal Policy: Tax low-price/high-quantity trades.

• Multiplicity: Policy might be needed for strict implementation
Conclusions

- Developed a model with sudden collapses in secondary loan markets

- Showed that reputation plays a key role in allowing adverse selection to persist

- Persistence of adverse selection implies fluctuations in collateral values induce fluctuations in trade volume in the long run

- Optimal Policy response to fluctuations: target low reputation banks in bad times.