To sell or to borrow?

A Theory of Bank Liquidity Management

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Motivation

- Banks manage liquidity using tradable assets that bear credit risk (in addition to cash and interbank markets)
- Reliance on tradable assets induces a trade-off
  - Lower cost of liquidity management
  - Liquidity management directly exposed to credit risk shocks like in August 2007
- **Goal of this paper:**
  - Understand this trade off
  - Positive and normative implications

Framework and Insights

- Theory of how banks cope with liquidity needs using internal **cash**, interbank **borrowing** and asset **sales**
  - A simplified Diamond-Dybvig setup *without runs*
  - Asymmetric information about asset quality complicates funding of a liquidity need
  - Equilibrium consequences on the interbank and secondary markets

- General insight: The interbank market more resilient than the secondary market
  - A model of an acute liquidity shock as in August 2007
  - Consistent with evidence: Afonso, Kovner, and Schoar (2011), Acharya, Afonso and Kovner (2013), Kuo, Skeie, Youle, and Vickrey (2013)
  - Conditions for illiquidity and policy implications

Literature review

1. On interbank markets:

- Freixas, Martin and Skeie (2011), Freixas and Holthausen (2005), Heider, Hoerova and Holthausen (2015)

2. On the secondary markets

- Bolton, Santos and Scheinkman (2011), Malherbe (2014))

Outline

1. Setup
2. Results
    1. Perfect information
    2. Private information
3. Policy implications
4. Conclusion

Setup

t=0:

- Continuum of mass 1 of identical banks maximizing their return at t=2
- Each bank invests $\lambda \in [0; 1]$ of its endowment in cash and $1 - \lambda$ in a risky asset (no debt at t=0)

t=1:

- Each bank receives **two private** signals about **quality** of its asset and its **liquidity** need
- The interbank and secondary markets open

t=2:

- The risky asset's returns are realized and payments are made

Private signals

- Signal about **asset's quality**

$$\begin{cases} R, \text{ with prob. } p_i \\ 0, \text{ otherwise} \end{cases} \quad \text{"}\textbf{Good}\text{"}: \; p_G = 1 \text{ with prob. } q, \text{"}\textbf{Bad}\text{"}: \; p_B = p < 1$$

  - $[q + (1-q)p]\, R > 1$ and $pR < 1$

- Signal about **liquidity need**
  - With prob. $1 - \pi$ the bank is **illiquid**, i.e. needs to pay $d < 1$ to survive till $t = 2$

- Asset's return and liquidity shocks are uncorrelated

Interbank and secondary markets

- Interbank lending (Freixas and Holthausen (2005), Heider, Hoerova and Holthausen (2009))
  - Unsecured, diversified, banks are price-takers
- Secondary market (Malherbe (2014)
  - Buyers: banks and competitive investors with deep pockets

Perfect information about liquidity needs and asset quality

- Illiquid banks are indifferent between selling and borrowing (Modigliani-Miller (1958))
- No cash-in-the-market effect on the interbank market
- No bank invests in cash at t=0 ($\lambda = 0$)

Private information about liquidity needs and asset quality

- Adverse selection on interbank and secondary markets
- Crucial difference to the perfect information case:
  - Feedback between asset price, loan rate, agents' expectations about quality of sold assets and borrowing banks, and illiquid banks' liquidity management decisions
- Solved backwards: equilibrium at t=1 and t=0

Equilibrium at t=1

- Perfect Bayesian equilibrium

1. Optimal banks' liquidity management decisions for given asset's price and loan rate

2. Combine these decisions with expectations and market clearing to pin down the equilibrium

The liquidity management decision problem of a bank

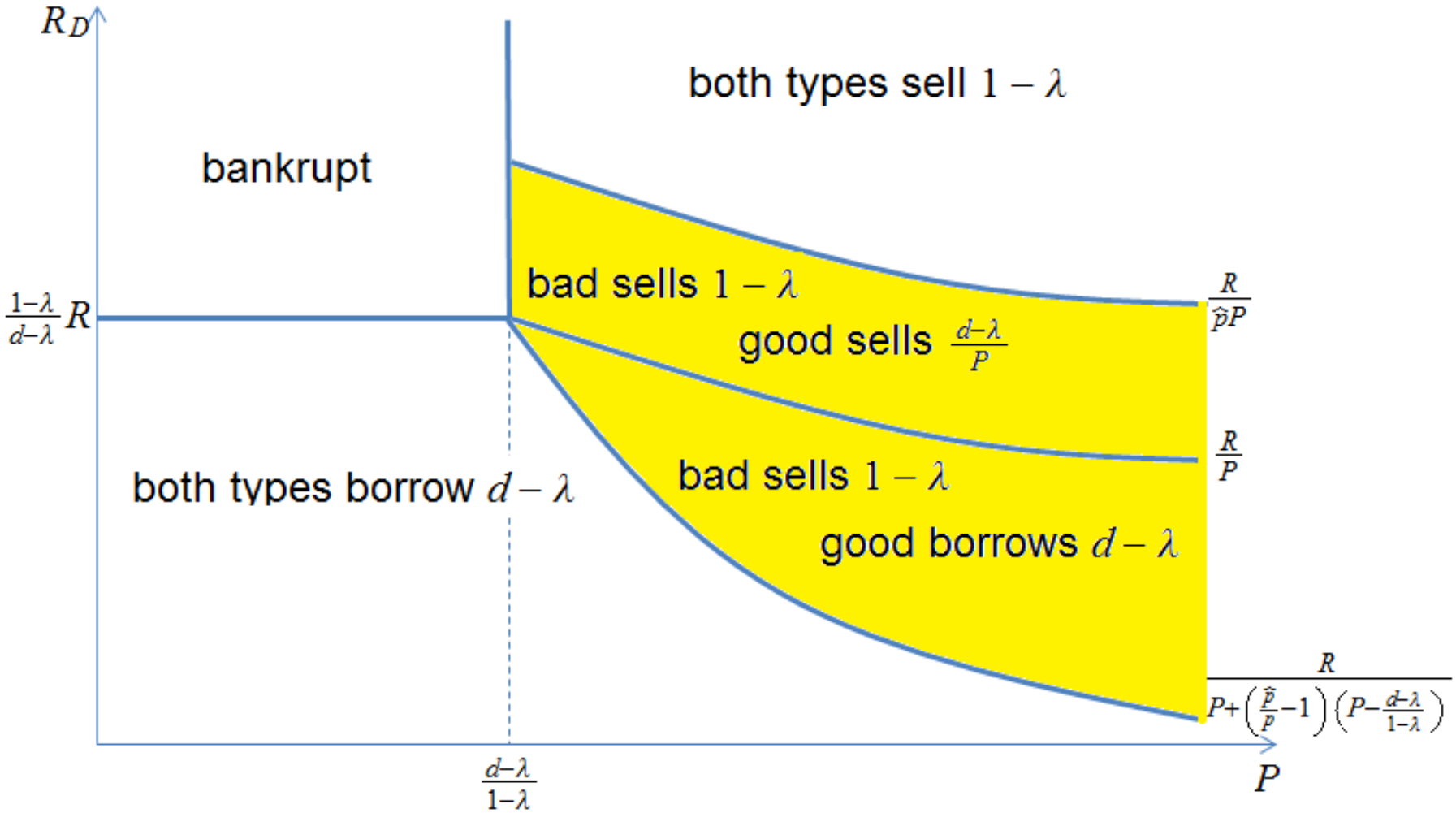
At t=1 each bank maximizes the return at t=2

$$\max_{I,S} \begin{cases} \underbrace{p_i(1-\lambda-S)R}_{\text{ASSET}} + \underbrace{(\lambda+SP-I-\mu d)}_{\text{EXCESS CASH}} + \underbrace{\widehat{p}R_D I}_{\text{LOANS}}, \text{ if } I>0, \\ p_i \max[0;(1-\lambda-S)R+(\lambda+SP-I-\mu d)+ \underbrace{R_D I}_{\text{REPAYMENT}} \quad] \\ +(1-p_i)\max\left[0;(\lambda+SP-I-\mu d)+R_D I\right], \text{ if } I \leq 0 \end{cases}$$

s.t. $S \in [0; 1-\lambda]$, $I \leq \lambda + SP - \mu d$.

Proposition 1

- "To sell or to borrow" by the good and bad illiquid banks for a given asset price P and loan rate R_D



Proposition 1

- Under adverse selection good banks are less reluctant to sell their assets:
  - Good and bad banks borrow the same $(d - \lambda)$
  - Bad banks sell more than the good
- Result: Adverse selection cost on the secondary market is higher than on the interbank market $\longrightarrow$ the good bank prefer to borrow
- The rest of the paper:
  - In equilibrium: the interbank market more resilient than the secondary market

Equilibria at t=1

- Perfect Bayesian equilibrium
  - Intuitive criterion eliminates an equilibrium in which none of the banks borrows
- Good illiquid banks borrow $\Longrightarrow$ relatively bad assets sold and equilibrium asset's price negatively impacted
- If asset's price sufficient to cover liquidity shortfall, equilibrium **without** liquidity shortage
- If asset's price too low to cover liquidity shortfall, equilibrium **with** liquidity shortage

Example of an equilibrium **without** liquidity shortage

- All good and bad illiquid banks borrow
- Interbank market:

$$\underbrace{\pi\left[q\lambda+(1-q)\left(\lambda+P^{*}\left(1-\lambda\right)\right)\right]}_{\text{Supply by liquid banks}}\geq\underbrace{\left(1-\pi\right)\left(d-\lambda\right)}_{\text{Demand by all illiquid banks}}$$

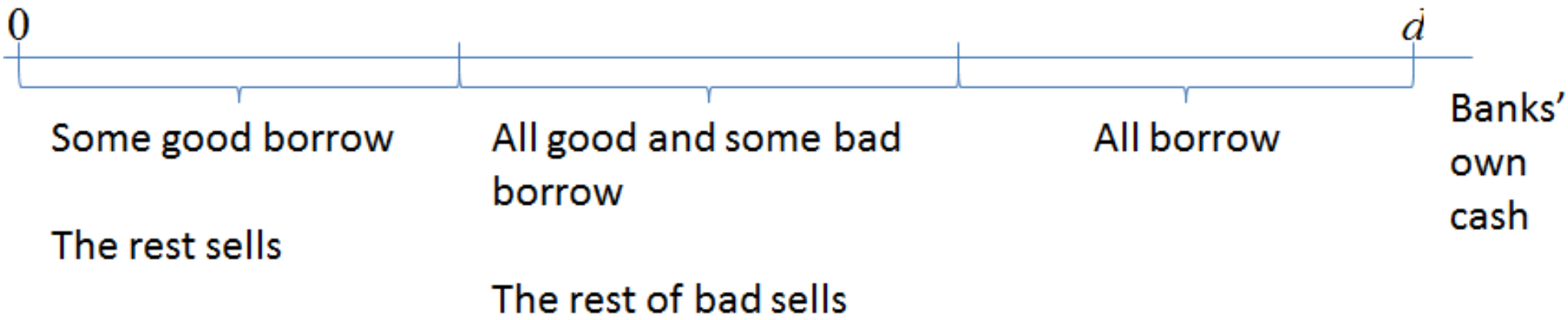
$$R_{D}^{*}\in\left[\frac{1}{\widehat{p}^{*}};\frac{R}{P^{*}+\left(\frac{\widehat{p}^{*}}{p}-1\right)\left(P^{*}-\frac{d-\lambda}{1-\lambda}\right)}\right)$$

$$\widehat{p}^{*}=q+\left(1-q\right)p$$

- Secondary market: $P^{*}=pR$.

Proposition 2 - Equilibrium without liquidity shortage

- Banks' ability to borrow depends on the amount of cash on the interbank market
- If banks' own cash low enough, bad banks start to sell



- The paper's punch line:
  - Under asymmetric information the secondary market functions, i.e., illiquid banks sell, if not enough interbank loans

Equilibrium **with** liquidity shortage

- In Proposition 2, selling banks cover liquidity shortfall only if asset price is high enough: $(1-\lambda)P \geq d - \lambda$
  - For high cash, high share of good banks, and/or low repayment d

- If asset price is low and not enough loans for all illiquid banks, **an equilibrium with liquidity shortage**
  - Low price $\longrightarrow$ Selling banks cannot cover liquidity shortfall $\longrightarrow$ they want to borrow
  - Not enough loans $\longrightarrow$ loans are rationed $\longrightarrow$ some banks go bankrupt

Choice of cash reserves at t=0

- Cash is valuable at t=0 because of speculative and precautionary motive
  - If liquid, the bank lends at a loan rate implying positive net return
  - If illiquid, the bank borrows less of costly loans
- Generally, the banks' choice of cash increases as the asset's profitability decreases
- Possibility of multiple equilibria

Social welfare

- At t=1
  - Equilibrium without liquidity shortage: welfare is just the value of banks' portfolio
  - Equilibrium with liquidity shortage:
    - Missed unit of payment by a bankrupt bank costs $\tau > 0$
    - Welfare below the maximal because some banks are bankrupt

Social welfare

- At t=0, socially optimal cash
  - Zero if it leads to equilibrium without liquidity shortage
  - Positive if zero would lead to equilibrium with liquidity shortage
- Banks' private choice of cash inefficient for two reasons
  - Positive cash because they do not internalize the effect on asset price
  - An equilibrium with liquidity shortage can occur because banks do not internalize their bankruptcies

Policy implications

- Ex post: after the shocks hit
- Ex ante: before the banks choose their cash reserves

Policy implications - Ex post

- Policy intervention only in equilibrium with liquidity shortage
- Liquidity injections on the interbank market prevent defaults
- Asset purchases are not effective
  - Price decline due to adverse selection (even with fire sales)

Policy implications - Ex ante

- If there is no (aggregate) uncertainty about equilibrium type at t=1:
  - If no liquidity shortage, banks should be mandated to hold zero cash
  - If liquidity shortage, banks should be mandated to hold positive cash
- With aggregate uncertainty, the above solution is not optimal
  - Cash is socially costly in good but socially beneficial in bad states
- Optimal intervention: zero cash and inject enough interbank loans when liquidity shortage

Conclusion

- Simple but novel model of bank liquidity management
  - Theoretical novelty: adverse selection affects two markets
  - Novel results consistent with existing evidence