

**IMPERFECT COMPETITION IN THE INTERBANK MARKET  
FOR LIQUIDITY AS A RATIONALE FOR CENTRAL BANKING**

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## Motivation

### The recent liquidity squeeze:

- The drying up of money markets beyond very short-term maturities.
- Hoarding of liquidity on bank balance sheets.
- Failure of traditional central bank mechanisms to redistribute liquidity:
  - Open market operations: Lend against narrow collateral to a few institutions.
  - Discount window: Lend against broader collateral to many institutions, but at penalty rate.
- Some success of subsequent changes to discount window: Extension of
  - Maturities.
  - Range of collateral.
  - Institutions to securities dealers.

**Our paper: A possible framework to understand some of these issues.**

## Market power in interbank markets for liquidity

- **Interbank lending:** Banks are special in peer monitoring (Rochet and Tirole, 1996).
  - Relationships (Furfine, 2001, Cocco et al, 2005).
  - Most flows are concentrated with few, large banks.
- **Asset sales:** Each bank is special but banks are special as a whole relative to outside markets.
  - Transfer of ownership may lead to allocation inefficiency.
- **Crises:** Situations with asymmetric, concentrated distribution of liquidity amongst banks.
  - Surplus banks extract market power in interbank markets.
  - Convert states of aggregate liquidity surplus into shortages or exacerbate shortages.

## The virtual and virtuous role of central banks

### Traditional view:

- Interbank markets can redistribute liquidity efficiently (Goodfriend and King, 1988).
- Little economic role for central bank's lender of last resort (LOLR) activity.

### Our paper:

- Interbank markets may work well most of the times, but be vulnerable to abuse of market power during crises.
- Public provision of liquidity, in fact its mere credibility, can improve interbank liquidity transfers.
- When can central banks play such a role?

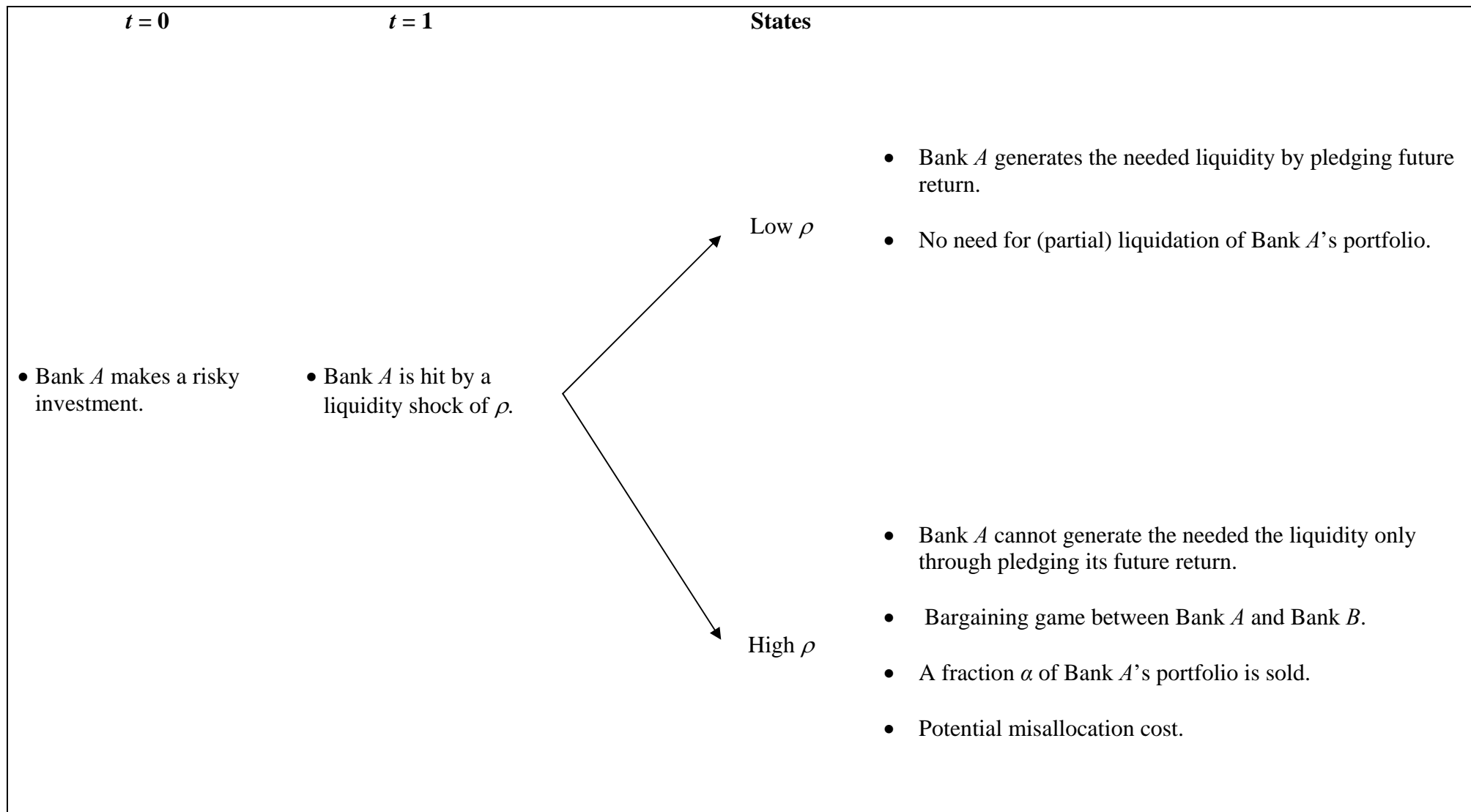
### Other theories of central bank's LOLR operations:

- Coordination problems (Diamond and Dybvig, 1983), asymmetric information (Bhattacharyya and Gale, 1987, Flannery, 1996), contagious failures (Diamond and Rajan, 2005, Gorton and Huang, 2006), aggregate liquidity shortages (Holmström and Tirole, 1998).
- Our paper is closest to Donaldson (1992).

## Benchmark model

**A bargaining model of interbank liquidity transfer with both lending and asset sale markets.**

- Three dates:  $t = 0, 1, 2$  (Figure 1).
- Two banks: Bank  $A$  and Bank  $B$ .
- Universal risk neutrality and no discounting.
  
- At  $t = 0$ , Bank  $A$  has a continuum of measure 1 of risky assets.
- All loans are identical (for now).
- At  $t = 2$ , each loan yields a random return  $\tilde{R} \in \{0, R\}$ .
- The realization of  $\tilde{R}$  depends on:
  - Was the loan monitored?
  - An unobservable state of nature  $\omega$  uniformly distributed over  $[0, 1]$ .



**Figure 1:** Timeline of the model.

## Benchmark model (continued)

### Liquidity shocks (Holmström and Tirole, 1998):

- At  $t = 1$ , each loan needs some refinancing of  $\rho$  units of cash.
- If a loan is not refinanced,  $\tilde{R} = 0$ .
- If a loan is refinanced,  $\tilde{R} = R$  if  $\omega \in [0, p]$  and  $\tilde{R} = 0$  otherwise.

### Moral hazard:

- The bank can affect the probability  $p$  by monitoring its loans at  $t = 1$ :
  - $p = p_H$  if it monitors, and
  - $p = p_L = (p_H - \Delta p)$  otherwise, with  $\Delta p > 0$ .
- Monitoring is non-verifiable and the bank enjoys a private benefit  $b$  per loan it does not monitor.
- If the loan is not refinanced, the bank derives no private benefit either.
- We assume it is efficient to refinance a loan only if it monitored:
  - $p_H > \rho/R > p_L$ , and
  - $\Delta p R > b$ .

## Liquidity transfers.

### Transfer of funds as well as assets:

- Bank  $B$  is assumed to have enough excess liquidity to refinance Bank  $A$ 's loans.
- The liquidity transfer can occur in two ways:
  - Bank  $A$  can borrow from Bank  $B$ , or
  - Bank  $A$  can sell to Bank  $B$  some of its loans.

### Borrowing:

- Transfer  $L$  from Bank  $B$  to Bank  $A$  against a repayment  $r$  if  $\tilde{R} = R$  and 0 if  $\tilde{R} = 0$ .
- Bank  $A$  chooses to monitor its loans if the following incentive compatibility constraint holds:
  - $\Delta p(R - r) \geq b$ , or in other words,
  - $r \leq (R - R_b)$  with  $R_b \equiv b/\Delta p$ .
- Therefore, Bank  $A$ 's borrowing capacity conditional on monitoring, is  $p_H(R - R_b)$ .

## Liquidity transfers (continued)

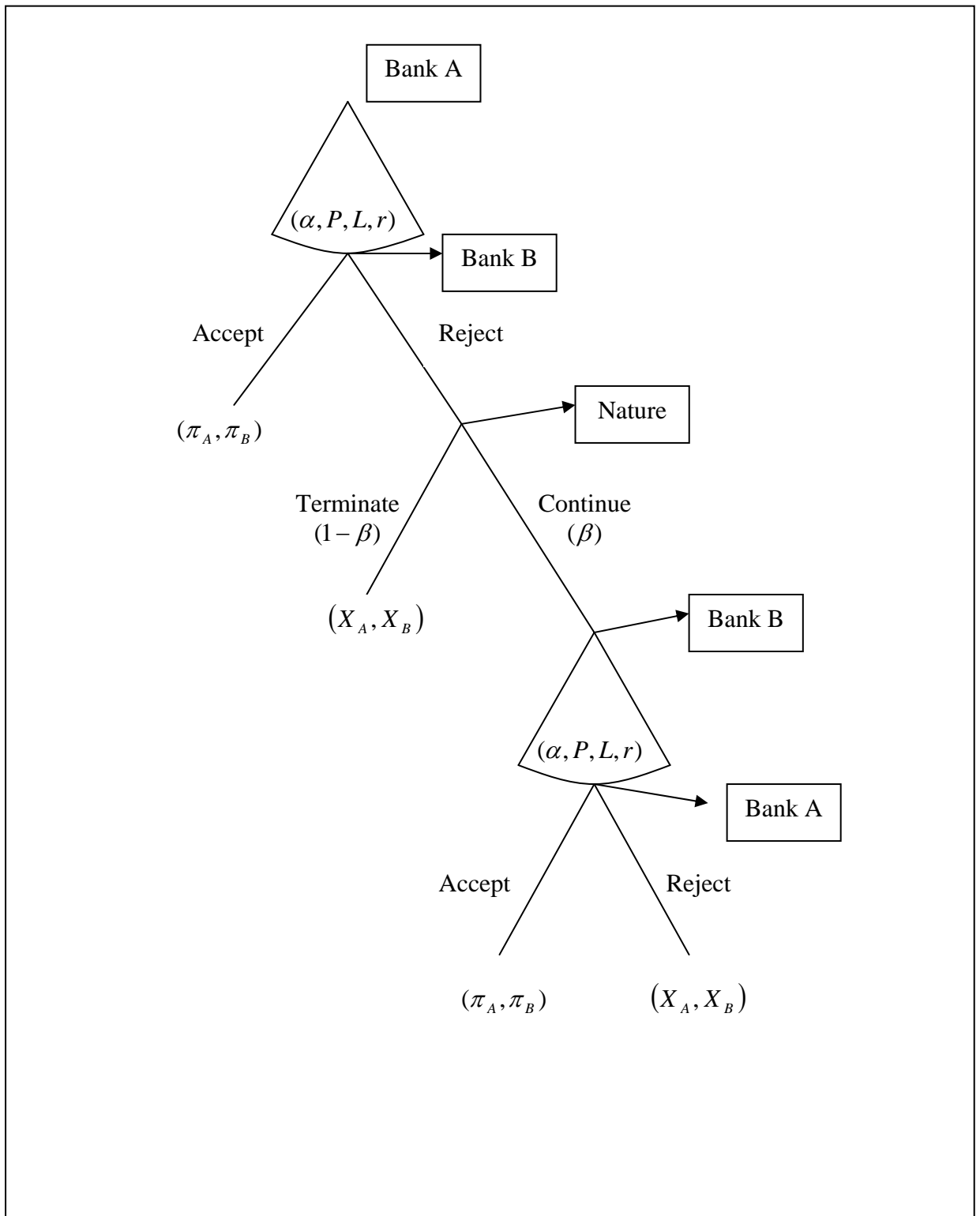
### Asset sales:

- Each loan can be sold to Bank  $B$  at a price  $P$ .
- We assume Bank  $A$  to be the most efficient user of its assets, i.e., they are Bank  $A$ -specific.
- We assume it is efficient to refinance loans even if run by Bank  $B$ :
  - $p_H > p_B > \rho/R$ .

### Remarks:

- With bank-specific assets, asset sales are less efficient than borrowing, conditional on monitoring.
- However, we assume that moral hazard in monitoring is severe (i.e.,  $b$  large) enough so that Bank  $A$  can raise more funds by selling a loan than by pledging some of its return:  $p_B R > p_H (R - R_b)$ .
- Our analysis is unchanged if the assumptions that a loan's value to Bank  $B$ ,  $p_B R$ , exceeds
  - Bank  $A$ 's valuation of the loan if unmonitored,  $p_L R$ , and
  - Bank  $A$ 's borrowing capacity against the loan if monitored,  $p_H (R - R_b)$ ,

held for some but not necessarily all loans.



**Figure 2:** Game tree for the bargaining game.

## Solution of the bargaining game

- We solve the model by backward induction.

- Bank  $B$ 's problem:

$$\max_{\alpha, r, T} (1 - \alpha)p_H r + \alpha p_B R - \alpha \rho - T$$

$$s.t. \quad r \leq (R - R_b)$$

$$T \geq (1 - \alpha) \rho$$

$$(1 - \alpha)p_H (R - r) - (1 - \alpha) \rho + T \geq X_A.$$

## Solution (continued)

- If  $X_A \geq p_H R_b$ , then

$$\hat{r}_B = (R - X_A/p_H), \quad \hat{\alpha}_B = 0, \quad \text{and} \quad \hat{T}_B = \rho,$$

and

$$\pi_B = p_H R - \rho - X_A.$$

- Otherwise,

$$\hat{r}_B = (R - R_b), \quad \hat{\alpha}_B = \left(1 - \left(\frac{X_A}{p_H R_b}\right)\right), \quad \text{and} \quad \hat{T}_B = \left(\frac{X_A}{p_H R_b}\right) \rho,$$

and

$$\pi_B = (p_B R - \rho) - X_A \left[1 - \frac{(p_H - p_B) R}{p_H R_b}\right].$$

## Solution (continued)

- At the time of first offer by Bank  $A$ , Bank  $B$ 's expected payoff must at least equal

$$E(\pi_B) = \beta\pi_B + (1 - \beta)X_B.$$

- Bank  $A$ 's problem is:

$$\max_{\alpha, r, T} (1 - \alpha)p_H(R - r) - (1 - \alpha)\rho + T$$

$$s.t. \quad r \leq (R - R_b)$$

$$T \geq (1 - \alpha)\rho$$

$$(1 - \alpha)p_H r + \alpha p_B R - \alpha\rho - T \geq E(\pi_B).$$

## Solution (continued)

- If  $p_H(R - R_b) - \rho \geq E(\pi_B)$ , then

$$\alpha^* = 0, \quad r^* = (E(\pi_B) + \rho) / p_H, \quad \text{and} \quad T^* = \rho,$$

and

$$\pi_A = p_H R - (E(\pi_B) + \rho).$$

- Otherwise, there are asset sales in equilibrium:

$$\alpha^* = \left( \frac{E(\pi_B) + \rho - p_H(R - R_b)}{p_B R - p_H(R - R_b)} \right), \quad r^* = (R - R_b), \quad \text{and} \quad T^* = (1 - \alpha^*) \rho,$$

and

$$\pi_A = (1 - \alpha^*) p_H R_b.$$

## Market power and inefficiency

- Inefficiency  $K^* = \alpha^*(p_H - p_B)R$ .
- A threshold  $\beta^* \in [0, 1]$  exists such that:
  - If  $\beta < \beta^*$ , the efficient outcome is reached, i.e., Bank  $A$  refinances all its assets without selling any to Bank  $B$ .
  - If  $\beta > \beta^*$ , the fraction  $\alpha^*$  of Bank  $A$ 's assets sold to Bank  $B$  and the associated inefficiency  $K^*$  increase strictly with  $\beta$ .

### Aggregate surplus turns into aggregate shortage:

- If  $p_H R_b > X_A$  and  $p_H(R - R_b) - \rho > X_B$  then  $\beta^* \in (0, 1)$ .
- In turn, the efficient outcome is not reached unless Bank  $B$  is sufficiently competitive.

## Effect of liquidity shock and outside options

- An increase in  $\rho$  and  $X_B$  and a decrease in  $X_A$  all have the following effects:
  - $\beta^*$  decreases weakly for  $\beta^* = 1$  and strictly for  $\beta^* \in (0, 1)$ .
  - For  $\beta > \beta^*$ , the fraction  $\alpha^*$  of Bank  $A$ 's assets sold to Bank  $B$  and the associated inefficiency  $K^*$  increase.

### Plan for rest of the presentation:

- Introduce variation in asset-specificity to understand which assets get transferred.
- Model the reservation option of Bank  $A$ :
  - Competitive, outside markets.
  - Central bank.
- Allow Bank  $A$  to arrange insurance from Bank  $B$  at date 0.
  - The role of aggregate liquidity shortages.

## Central banking

- We focus on lender of last resort role of a government agency, such as the central bank.
- If bargaining breaks down, Bank  $A$  first raises liquidity from outsiders.
- If Bank  $A$  sells no assets while raising liquidity from outsiders, then central bank plays no role.
- Otherwise, Bank  $A$  seeks liquidity from central bank as a last resort.
- The central bank does not buy assets, i.e., no nationalization.
- When borrowing from the central bank, Bank  $A$ 's private benefit is  $b_C$ , and let  $R_b^C \equiv b_C/\Delta p$ .
- Bank  $B$  is better than the central bank at making loans to Bank  $A$ , i.e.,  $b_C \geq b$ .
- The central bank has full power in its bargaining with Bank  $A$ .
- The central bank maximizes social surplus subject to its expected losses not exceeding  $\Lambda \geq 0$ .
- Note: There will be no lending by the central bank in equilibrium.

## LOLR with no supervision

- A central bank that is no better than outsiders at monitoring (i.e.,  $b_C \geq b_o$ ) and does not extend any loss-making loans (i.e.,  $\Lambda = 0$ ) cannot ameliorate the inefficiency from Bank  $B$ 's market power.

- If prepared to make losses, the optimal intervention amounts to a pure transfer to Bank  $A$ , i.e.,

$$\hat{T}_C = \min \{ \Lambda, \max \{ \rho - p_H (R - R_b^o), 0 \} \}.$$

- It is efficient for outsiders to monitor.
- The central bank cannot affect Bank  $A$ 's borrowing capacity from outsiders.
- Hence, the central bank simply makes a liquidity transfer.
  - First to avoid the termination of some loans, which generates a surplus  $(p_H R - \rho)$  per loan.
  - Next, to avoid the sale of Bank  $A$ 's loans to outsiders, which generates a surplus  $(p_H R - p_o(\theta))$ .

## LOLR with supervision

- Suppose that the central bank can monitor banks better than outsiders, i.e.,  $b \leq b_C \leq b_o$ .
- In this case, the central bank's optimal intervention is to extend loans to Bank  $A$ , i.e.,

$$\hat{T}_C = \frac{\min \{ \rho - p_H(R - R_b^C), \Lambda \}}{\rho - p_H(R - R_b^C)} \rho.$$

Bank  $A$  should not borrow from outsiders.

- As before, there is a priority to usage of central bank funds.
- Supervision is naturally coincident with lender-of-last-resort activity:
- The expected loss the central bank must incur to achieve a given level of efficiency decreases with its ability to monitor loans, i.e.,

$$\frac{\partial \Lambda^*(K, b_C)}{\partial b_C} > 0.$$

## Effect of LOLR on outcomes

- The fraction of loans  $\alpha^*$  sold to Bank  $B$  and the deadweight loss  $K^*$  decrease with the central bank's ability to monitor loans to Bank  $A$  (if it exceeds that of outsiders) and with its willingness to extend loss-making loans to Bank  $A$ , i.e.,

$$\left(\frac{\partial \alpha^*}{\partial b_C}\right) > 0 \quad \text{and} \quad \left(\frac{\partial \alpha^*}{\partial \Lambda}\right) < 0.$$

### Remarks:

- Limits to outsiders being monitors.
- Evidence that supervisory reports contain intelligence unless they are stale (Berger et al, 2000).
- Alternative policies and robustness.
- Limitations of our analysis:
  - $\mu$  assumed to be common knowledge, so no uncertainty about aggregate surplus versus shortage.
  - See, for example, Diamond and Rajan (2005).

## Discussion

- Discount window and open-market operations:
  - Might open-market operations hurt during crises by concentrating liquidity in few players?
  - Lack of usage of discount window does not mean it plays no economic role.
  - Choice of penalty rate and collateral.
  - Traditional versus new forms of Federal Reserve funding.
- Moral suasion and coordination by central banks.
- Recent examples:
  - LTCM and Bear Stearns in 1998.
  - Amaranth and J.P.Morgan Chase in 2006.
  - Bear Stearns and J.P.Morgan Chase (again and again!) in 2008.

## Concluding remarks

- An attempt to introduce market power in theory of interbank markets and central banking.
- Relies crucially on confluence of bank specialness in lending to corporate borrowers as well as in lending to each other.
- Key results:
  - Aggregate surpluses can be rendered as aggregate shortages.
  - This is more likely during times of greater aggregate uncertainty.
  - Central bank commitment to supervision and LOLR activities help, if designed appropriately.
- Future work:
  - Consider bargaining between Bank  $B$  and the central bank.
  - Model central bank's contracting environment and derive optimal liquidity provision mechanisms.
  - Bridge IO theory on optimal regulation of market power and (central) banking theory.