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

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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).
  - 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:
- Our paper is closest to Donaldson (1992).
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.

$t = 0$

- Bank $A$ makes a risky investment.

$t = 1$

- Bank $A$ is hit by a liquidity shock of $\rho$.

States

- Low $\rho$
  - Bank $A$ generates the needed liquidity by pledging future return.
  - No need for (partial) liquidation of Bank $A$’s portfolio.

- High $\rho$
  - Bank $A$ cannot generate the needed the liquidity only through pledging its future return.
  - Bargaining game between Bank $A$ and Bank $B$.
  - A fraction $\alpha$ of Bank $A$’s portfolio is sold.
  - Potential misallocation cost.
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,
  $$- r \leq (R - R_b) \quad \text{with} \quad R_b \equiv b / \Delta p.$$
- 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:

$$
\max_{\alpha, r, T} \quad (1 - \alpha)p_H r + \alpha p_B R - \alpha \rho - T \\
\text{s.t.} \quad r \leq (R - R_b) \\
T \geq (1 - \alpha) \rho \\
(1 - \alpha)p_H (R - r) - (1 - \alpha) \rho + T \geq X_A.
$$
• 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

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

\[
\max_{\alpha, r, T} \quad (1 - \alpha)p_H (R - r) - (1 - \alpha) \rho + T \\
\text{s.t.} \quad r \leq (R - R_b) \\
\quad T \geq (1 - \alpha) \rho \\
(1 - \alpha)p_H r + \alpha p_B R - \alpha \rho - T \geq E(\pi_B).
\]
• If $p_H(R - R_b) - \rho \geq E(\pi_B)$, then

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

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

\[
\pi_A = (1 - \alpha^*) p_H R_b.
\]
• 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 $A$ refines 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.,

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

- 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 $(p_H R - p_o(\theta))$. 

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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.,

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

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:
  – 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.