Liquidity, Risk-Taking, and the Lender of Last Resort

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Banking, Financial Stability and the Business Cycle

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“There are few issues so subject to myth, sometimes unhelpful myths that tend to obscure rather than illuminate real issues, as is the subject of whether a central bank should act as a lender of last resort.”

Charles Goodhart (1999)

Introduction

- **Classical view on the LLR**

  "The Bank of England… must in time of panic do what all other similar banks do… And for this purpose there are two rules: First, that these loans should only be made at a very high rate of interest… Secondly, that at this rate these advances should be made on all good banking securities."

  Walter Bagehot (1873)

- **Two contemporary views**
  - LLR should only use open market operations
  - LLR should also lend to individual banks

Introduction

- Both sides agree that such lending creates moral hazard

  "The existence of a credible LLR must reduce the private cost of risk-taking. It can hardly be doubted that, in consequence, more risk will be taken."

  Robert Solow (1982)

- This paper shows that this is *not* generally true

Main results

- The existence of a LLR that does not charge penalty rates has
  - No effect on risk-taking
  - Negative effect on liquidity holdings

- Charging penalty rates leads to
  - Higher risk-taking
  - Lower liquidity holdings

Overview of paper

- The basic model
- The general model
- Extensions
    - Penalty rates
    - LLR’s discounting of future payoffs
    - LLR’s internalization of deposit insurance payouts
- Concluding remarks

The basic model

- Three dates $t = 0, 1, 2$
- Two risk-neutral agents: Bank and LLR
- At date 0
  - Bank raises 1 unit of insured deposits at zero interest rate
  - Bank chooses risk parameter p
  - Bank invests in illiquid asset with random return at date 2

$$R = \begin{cases} R_0 & \text{with probability } 1 - p \\ R_1 & \text{with probability } p \end{cases}$$

The basic model

- At date 1
  - Fraction $v \in [0,1]$ of deposit withdrawn $\rightarrow$ cdf $F(v)$
  - LLR observes signal $s \in \{s_0, s_1\}$
  - LLR decides whether to support the bank

Assumptions

1. $R_0 = 0$ and $R_1 = R(p)$ with $R(p)$ decreasing and concave
2. $\Pr(s_0 / R_0) = \Pr(s_1 / R_1) = q \geq 1/2$
3. Deposit withdrawal v is independent of R and s
4. Cost of bank failure $c > 0$

LLR decision rule

- LLR's payoff if it supports the bank $= -(v+c)\,\Pr(R_0/\text{s})$
- LLR's payoff if it does not support the bank $= -c$
- LLR's decision rule

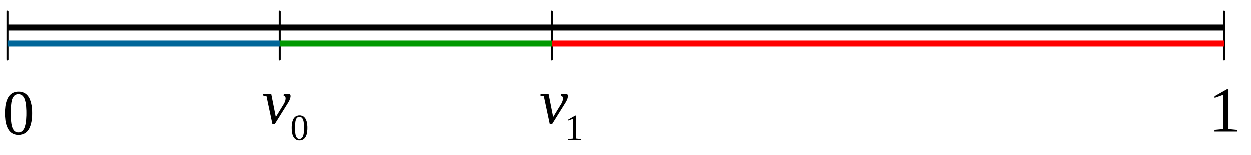
Support $\Leftrightarrow -(v+c)\,\Pr(R_0/s) \geq -c$

$$\Leftrightarrow v \leq \frac{c\,\Pr(R_1/s)}{\Pr(R_0/s)} = \begin{cases} \dfrac{cp(1-q)}{(1-p)q} = v_0 & \text{if } s = s_0 \\ \dfrac{cpq}{(1-p)(1-q)} = v_1 & \text{if } s = s_1 \end{cases}$$

LLR decision rule

- Note that

$$v_1 = \frac{cpq}{(1-p)(1-q)} = \left(\frac{q}{1-q}\right)^2 \frac{cp(1-q)}{(1-p)q} = \left(\frac{q}{1-q}\right)^2 v_0$$



Bank's objective function

- Bank gets $R(p)-1$ when $R = R_1$ and
  - either $s = s_0$ and $v \le v_0 \rightarrow \Pr = p(1-q)F(v_0)$
  - or $s = s_1$ and $v \le v_1 \rightarrow \Pr = pqF(v_1)$

- Bank's objective function

$$U_B = p\underbrace{[(1-q)F(v_0) + qF(v_1)]}_{\text{Independent of } p}[R(p)-1]$$

Independent of p

Nash equilibrium

- Nash equilibrium is (p^*, v_0^*, v_1^*) such that

$$p^* = \arg\max p[(1-q)F(v_0^*) + qF(v_1^*)][R(p)-1]$$

$$v_0^* = \frac{cp^*(1-q)}{(1-p^*)q} \quad \text{and} \quad v_1^* = \frac{cp^*q}{(1-p^*)(1-q)}$$

- Note that

$$p^* = \arg\max p[R(p)-1]$$

The general model

- At date 0
  - Bank raises $1-k$ deposits and k capital
  - Bank invests $1-\lambda$ in risky asset and λ in safe asset
  - Bank chooses risk parameter p
- At date 1
  - Fraction v of deposits withdrawn $\rightarrow v(1-k)$
  - LLR observes signal $s \in \{s_0, s_1\}$
  - LLR decides whether to support the bank

Assumptions

1. LLR observes k and λ
2. Capital requirement $k \geq \kappa(1-\lambda)$
3. Expected return required by shareholders $\delta \geq 0$
4. Safe interest rate $= 0$

Characterization of equilibrium

- Two possible cases at date 1

(1) $v(1-k) \le \lambda$

- Bank can pay depositors
- Bank's payoff in good state: $(1-\lambda)[R(p)-1]+k$

(2) $v(1-k) > \lambda$

- Bank needs to borrow $v(1-k)-\lambda$ from LLR
- Bank's payoff in good state $(1-\lambda)[R(p)-1]+k$

LLR decision rule

- LLR's payoff if it supports the bank $= -[v(1-k) - \lambda + c]\Pr(R_0/\mathrm{s})$
- LLR's payoff if it does not support the bank $= -c$
- LLR's decision rule

$$\text{Support} \Leftrightarrow -[v(1-k) - \lambda + c]\Pr(R_0/\mathrm{s}) \geq -c$$

$$\Leftrightarrow v \leq \begin{cases} \dfrac{v_0 + \lambda}{1-k} & \text{if } s = s_0 \\ \dfrac{v_1 + \lambda}{1-k} & \text{if } s = s_1 \end{cases}$$

Bank's objective function

- Bank gets $(1-\lambda)[R(p)-1]+k$ when $R = R_1$ and
  - either $s = s_0$ and $v(1-k)-\lambda \le v_0$
  - or $s = s_1$ and $v(1-k)-\lambda \le v_1$

- Bank's objective function

$$U_B = p\left[(1-q)F\left(\frac{v_0+\lambda}{1-k}\right)+qF\left(\frac{v_1+\lambda}{1-k}\right)\right]$$

$$\times[(1-\lambda)[R(p)-1]+k]-(1+\delta)k$$

Nash equilibrium

- Nash equilibrium is $(\lambda^*, k^*, p^*, v_0^*, v_1^*)$ such that

$$(\lambda^*, k^*, p^*) = \arg\max p\left[(1-q)F\left(\frac{v_0^* + \lambda}{1-k}\right) + qF\left(\frac{v_1^* + \lambda}{1-k}\right)\right]$$
$$\times[(1-\lambda)[R(p)-1]+k] - (1+\delta)k$$

$$v_0^* = \frac{cp^*(1-q)}{(1-p^*)q} \quad \text{and} \quad v_1^* = \frac{cp^* q}{(1-p^*)(1-q)}$$

- Note that

$$p^* = \arg\max p[(1-\lambda^*)[R(p)-1]+k^*]$$

Nash equilibrium

- If capital constraint is binding, first-order condition becomes

$$R(p^*) + p^* R'(p^*) = 1 - \kappa$$

$$\Downarrow$$

p^* only depends on the capital requirement κ

Equilibrium without a LLR

- Bank's objective function

$$U_B = pF\left(\frac{\lambda}{1-k}\right)[(1-\lambda)[R(p)-1]+k]-(1+\delta)k$$

- As before we have $R(p^*)+p^*R'(p^*)=1-\kappa$

$\rightarrow$ *The existence of a LLR does not have any effect on* p^*

Numerical illustration

	With LLR	Without LLR
λ^*	0.11	0.23
k^*	0.09	0.08
p^*	0.59	0.59
v_0^*	0.10	-
v_1^*	0.22	-

Comparative statics

x	$\frac{\partial p^*}{\partial x}$	$\frac{\partial \lambda^*}{\partial x}$	$\frac{\partial k^*}{\partial x}$	$\frac{\partial v_0^*}{\partial x}$	$\frac{\partial v_1^*}{\partial x}$
κ	+	+	+	+	+
δ	0	+	-	0	0
q	0	-/0	+/0	-	+
c	0	-/0	+/0	+	+

Extensions

- Penalty rates
  - LLR charges interest rate $r > 0$
- LLR's discounting of future payoffs
  - LLR discount factor $\beta < 1$
- LLR's sharing of deposit insurance payouts
  - LLR share $\gamma \in [0,1]$

Comparative statics

x	$\frac{\partial p^*}{\partial x}$	$\frac{\partial \lambda^*}{\partial x}$	$\frac{\partial k^*}{\partial x}$	$\frac{\partial v_0^*}{\partial x}$	$\frac{\partial v_1^*}{\partial x}$
r	-	-	+	+	+
β	0	+	-	-	-
γ	0	-	+	-	+

Concluding remarks

- Results are fairly robust
  - Full deposit insurance is not needed
  - Purely random deposit withdrawals are not needed
- Rationale for “constructive ambiguity”