The lender of last resort: liquidity provision versus the possibility of bail-out

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Motivation: crisis

• Central banks provided liquidity generously in 08/09.

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- Rescue packages for systemic stability: 11 large countries committed €5 trillion in capital, guarantees, purchases of bad assets to restore confidence (Panetta et al., 2009).
- Consensus: regulation has failed (lagged, provided wrong incentives) → change in financial regulation is necessary.
Proposed solutions

- Contingent capital or convertible debt
  (Kashyap/Rajan/Stein 2008, Flannery 2009)
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- Focus on crisis management: regulation with both liquidity and bailout functions, providing the right ex ante incentives. We set up a model with both regulatory features, and introduce liquidity and solvency problems.
Relevance for the literature - 1

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Problems in crisis management:

- Moral hazard and Too-Big-to-Fail (Freixas, 1999; Goodhart & Huang, 1999).
- Systemic risk:
- Indistinguishable liquidity and solvency problems: inefficient closure and forbearance (Freixas et al., 2004; Rochet & Vives, 2004).
Relevance for the literature - 2

Possible solutions for crisis management:

- Capital provision against insolvency, restore confidence in banks and the system (Diamond & Rajan, 2005).

- Multiple regulators: both liquidity and solvency decisions (Repullo, 2000; Kahn & Santos, 2005).
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- Capital provision against insolvency, restore confidence in banks and the system (Diamond & Rajan, 2005).
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- Our model combines:
  - Liquidity and solvency problems.
  - Central Bank (liquidity) and Fiscal Authority (solvency).
  - No penalty rate (MH!), but costly capital assistance.
  - Asymmetric information and strategic interaction.
The Model
The Economy

- Three dates, risk-neutral agents: depositors, two regulators (CB and FA), one systemic bank
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\[ I + M = E + D = 1 \]

\[ I : \quad \tilde{R} = \begin{cases} 
R_H > 1 \text{ with probability } p \\
R_L < 1 \text{ with probability } 1 - p
\end{cases} \]
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- We assume \( R_L = 0, \; R_H = R(p), \; \mathbb{E}(\tilde{R}) = pR(p) \geq 1 \)
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- \( M \) is risk-free storage \( (R_F = 1) \), \( E \) is capital provided by bank owner, \( D \) are fully insured deposits.

- \( I > E \): there is risk taking with leverage.
A liquidity shock

• At $t = 1$, a fraction $x$ of $D$ is withdrawn; this is public information when it occurs.
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The lender of last resort: liquidity versus bail-out
Regulator’s objectives

- $\overline{x}$ determined by the Central Bank (CB); wants to break even in expectation. Therefore, it will inject liquidity (at risk free rate) if:

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$$x \leq \bar{x} \equiv \frac{p}{1 - p} \frac{\alpha C}{D} + \frac{M}{D} \quad (1)$$

- When $x > \bar{x}$, Fiscal Authority injects capital. It demands a fraction $\gamma$ of bank value at $t = 2$:

$$\gamma \geq \gamma \equiv \frac{xD - M - p\beta C}{p[(R(p) - 1)I + E]} \quad (2)$$
Bank objective

- Bank owner maximizes expected equity value at $t = 2$, under limited liability and regulatory constraints.
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- At $t = 0$, she simultaneously chooses:
  - The amount of investment $I$ (and thus also liquid assets $M$).
  - The success probability $p$ of investment, by choosing monitoring effort.
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In general:

$$\max_{\substack{p, I}} p\left[(R(p) - 1)I + E\right]\left[1 - \gamma(1 - \bar{x})\right]$$

where $R'(p) < 0$, $R''(p) \leq 0$ and $R(1) \geq 1$. 

The lender of last resort: liquidity versus bail-out
Sequence of events

\[ t = 0 \]: Bank chooses \( p \) and \( I \) to maximize expected equity value.
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$t = 2$: Investment returns realize, repayment of support.
Social optimum

A central planner maximizes total bank value:

\[
\max_{p,I} \quad p[(R(p) - 1)I + M] + (1 - p)[M - I]
\]

Result:

- Choose \( p = p^{FB} \), maximizing \( \mathbb{E}(\tilde{R}) = pR(p) \).

- The above equation is increasing in \( I \) (since \( \mathbb{E}(\tilde{R}) \geq 1 \)). Therefore, \( I^{FB} = 1 \): do not keep any liquid assets.
Bank optimization without regulation

- Private bank owner chooses optimal portfolio under LL.
- No CB, no FA, no interbank market: bank fails if $x > x$. 

$$\max_{p,I} p[(R(p) - 1)I + E][x]$$  \hspace{1cm} (5)
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Result:

- $p^N < p^{FB}$, so the banker takes more risk than is optimal: gambling.
- There is illiquidity risk: the banker keeps a liquidity buffer ($M > 0$) and thus invests suboptimally ($I^N < I^{FB}$).
The Central Bank as sole LLR

- The CB provides liquidity if $x < x \leq x^L$, observing only the choice of $I$.

- There is no FA ($\gamma = 1$): the bank fails if $x > x^L$.

- Simultaneous Nash game in $p^L$ and $\bar{x}^L$, belief through $I$.

\[
\max_{p,I} p[(R(p) - 1)I + E][\bar{x}^L]
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- Simultaneous Nash game in $p^L$ and $\overline{x}^L$, belief through $I$.

$$\max_{p,I} p[(R(p) - 1)I + E[\overline{x}^L]]$$

Result: bank trades off investment against risk.

- $p^L < p^N$, so having an LLR leads to moral hazard.

- However, because of this safety net we have $I^L > I^N$: a lower liquidity buffer is necessary.
Figure 1: The optimal solvency threshold $\overline{x}$

\[ R(p) = 3 - p^2, \quad E/I = 8\%, \quad \alpha = 1, \quad C = 10\%, \quad p^{FB} = 0.71 \]
Introducing the possibility of bailout

- The CB operates in the same way as before.
- Additionally, the FA provides capital when $x > x^C$, at equilibrium rate $\gamma^C$ (zero profit).
- Simultaneous Nash game in $p^C$ and $\gamma^C$, belief through $I$.

$$\max_{p,I} p[(R(p) - 1)I + E][1 - \gamma(1 - x^L)]$$  \hspace{1cm} (7)
Introducing the possibility of bailout

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Result:

- FA trades off investment and risk, depending on \( \gamma^C \)
- This depends ultimately on \( \beta \), measuring the FA’s concern for bankruptcy.
Trade-off

Comparative statics:

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- High $\beta (> \alpha)$: regulator concerned about stability, milder. Higher charter value: take less risk, but also invest less.

- The latter is more realistic: systemic stability is important.
Figure 2: The optimal required return $\gamma^C$ (High $\beta$, $p^{FB} = 0.71$)
Conclusion

Analyzing simultaneous liquidity & capital provision:

- No regulation: too much liquidity, too much risk relative to social optimum
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- FA bailout: trade-off.
  - Mild conditions reduce moral hazard, but also investment.
  - Strict conditions increase investment but also risk.
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- Current situation: concerned authorities, relatively mild. This leads to a high charter value: less risk taking, but also to cautious lending!
Thank you for your attention
Returns

\[ R_L = 0, \quad R_H = R(p), \quad \] (8)
\[ R'(p) < 0, \quad R''(p) \leq 0, \quad \] (9)
\[ R(1) \geq 1, \quad R(1) + R'(1) < 0, \quad \] (10)
\[ E(\bar{R}) \geq 1 \quad \] (11)

\[ \tilde{V}_2 = \left\{ \begin{array}{ll}
V^L_2(p) = p[R(p)I + M - D] \\
\text{w.p.} & \int_0^x f(x)dx = x \\
V^M_2(p) = p[R(p)I + M - D] \\
\text{w.p.} & \int_0^\bar{x} f(x)dx = \bar{x} - x \\
V^H_2(p) = (1 - \gamma)p[R(p)I + M - D] \\
\text{w.p.} & \int_{\bar{x}}^1 f(x)dx = 1 - \bar{x}
\end{array} \right. \]
First Order Conditions

First Best:

\[ R(p^{FB}) + p^{FB} R'(p^{FB}) = 0 \]  \hspace{1cm} (12)

\[ I^{FB} = E + D \]  \hspace{1cm} (13)

No Regulation

\[ R(p^{N}) + p^{N} R'(p^{N}) = 1 - E/I^{N} \]  \hspace{1cm} (14)

\[ I^{N} = \frac{1}{2} \left[ 1 - \frac{E}{R(p^{N}) - 1} \right] \]  \hspace{1cm} (15)
First Order Conditions

Central Bank as sole regulator

\[ R(p^L) + p^L R'(p^L) = 1 - \frac{E}{I^L} \] (16)

\[ I^L = \frac{1}{2} \left[ \frac{p^L}{1 - p^L} \alpha C + 1 - \frac{E}{R(p^L) - 1} \right] \] (17)

Possibility of bailout

\[ R(p^C) + p_1^C R'(p^C) = 1 - \frac{E}{I^C} \] (18)

\[ p^C \left\{ (R(p^C) - 1)[1 - \gamma^C (1 - \bar{x}^C)] - \right\}

\[ \left[ (R(p^C) - 1) I^C + E \right] \left[ \frac{\partial \gamma^C}{\partial I^C} (1 - \bar{x}^C) + \gamma^C \left( \frac{1}{D} \right) \right] \} = 0 \] (19)