Endogenous Systemic Liquidity Risk

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Outline

The myths of liquidity

Liquidity is the root of all evils.

- Financial markets: Notion of abundant liquidity;
  - *The Economist, A fluid concept* (Feb. 2007): "*World's financial markets are awash with liquidity*"
- However: Fear that liquidity may dry out suddenly (risk of fire sales);
- Liquidity squeeze may force central banks to ease policy again;
- However: Does expectation of such central bank reaction encourage excessive risk taking?
  - Over-investment in risky activities creates systemic risk?

Liquidity: Key to understanding monetary policy and banking regulation.

And, the controversies...

- **Mervyn King**, September 12, 2007
  - *"The provision of large liquidity facilities penalises those financial institutions that sat out the dance, encourages herd behaviour and increases the intensity of future crises."*
- **Lawrence Summers**, Financial Times, September 24, 2007
  - *"Moral hazard fundamentalists misunderstand the insurance analogy"*

Implication for banking regulation?

- **The Economist**, May 14, 2009
  - *"There is no single big remedy for the banks' flaws. But better rules — and more capital — could help..."*

Research questions. Our approach.

- Research questions:
  - Back to origin: What is liquidity? How is liquidity provided?
  - Monetary policy for financial stability, implication for banking regulation.
- This paper: An integrated approach towards banking regulation
  - Endogenized systemic liquidity risk in a bank run model;
  - Nominal contract and monetary policy;
  - Monetary policy and banking regulation;
  - Quantitative policy analysis for varieties of regulatory regimes, e.g. liquidity regulation, equity requirement, etc.

Structure of the model

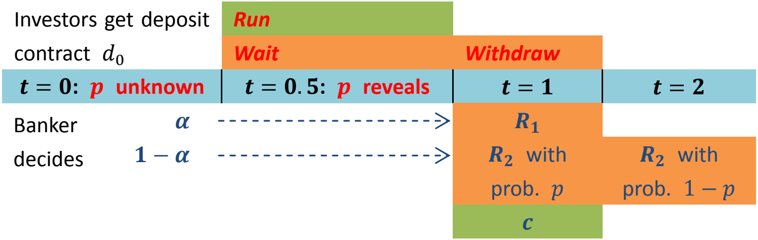
Baseline model: Risk-neutral agents and real contracts

Investors	**Entrepreneur i, $i = 1, 2$**
Unit endowment at $t = 0$, can be stored or invested in projects Investors want to consume at $t = 1$	$R_1 > 1$: Safe project, realized early at $t = 1$ $R_2 > R_1$: Risky project, may be delayed until $t = 2$, with probability $1 - p$

Competitive Bankers
Technology: Expertise to collect $0 < \gamma < 1$ from projects' return **Fragile structure**: Banks offer deposit contracts as commitment device not to abuse their collection skills **Cost**: Risk of bank runs with inefficient liquidation $0 < c < 1$ before $t = 1$

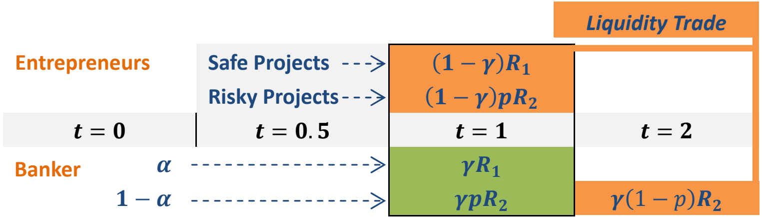
Information and timing

- $t = \frac{1}{2}$ is crucial: If investors anticipate to be paid less than d_0 at $t = 1$, they run already at $t = \frac{1}{2}$ — first-come-first-serve rule — even early projects have to be liquidated.



Return maximization and liquidity trade

- Bertrand competition in deposit market — Bankers maximize investors' return with all resources available at $t = 1$: Liquidity trade between bankers and entrepreneurs, market cleared at interest rate r.



Baseline results

Market outcome is in line with the solution of the planner's problem when

- **Deterministic p:** Banker i choose α_i to pay out d_0 to investors and refinance all late projects:

$$\alpha_i(p) = \frac{\gamma - p}{\gamma - p + (1-\gamma)\frac{R_1}{R_2}} \ : \ p \uparrow \Rightarrow \alpha \downarrow$$

- **Idiosyncratic risk:** As long as there are just idiosyncratic shocks, banks are always solvent via trade on the liquidity market:

$$\alpha_i(p) = \frac{\gamma - E[p]}{\gamma - E[p] + (1-\gamma)\frac{R_1}{R_2}}$$

Aggregate risk: A stategic trade-off

- p takes two values: $0 \leq p_L < p_H \leq \gamma$ with probability π for the lucky state with p_H.
- Planner's problem: Trade-off for the bankers
  - $\alpha(p_H)$ maximizes banks' return at p_H but banks will be unable to pay out high return at p_L so banks will be run at $t = \frac{1}{2}$ and can just pay return c;
  - $\alpha(p_L)$ maximizes banks' return at p_L but misses high profitability in the good state p_H.

$\pi = 0$ -- $\pi = 1$

$\boldsymbol{\alpha(p_L)}$	$\boldsymbol{\alpha}???$	$\boldsymbol{\alpha(p_H)}$

- However: Market outcome deviates for intermediate π.

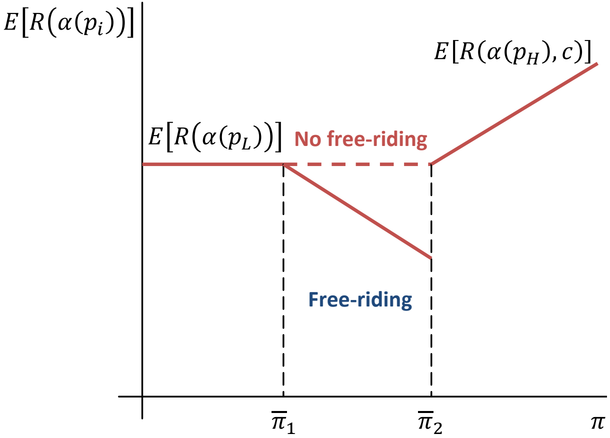
Free-riding, equilibrium of mixed strategies

- Opportunity for free-riding liquidity provision at mid- π
  - In state p_H, early entrepreneurs provide excess liquidity supply;
  - Profitable free-riding: Setting $\alpha = 0$ and trade liquidity at $t = 1$ by its high return from late projects;
  - Though run in state p_L.

- Equilibrium? Mixed strategies (cf. Allen & Gale, 2004)
  - More free-riding banks become free-riders with $\alpha = 0$, interest rate r_H bid higher;
  - The prudent banks reduce $\alpha_s < \alpha(p_L)$, to cut down the opportunity cost of investing in safe projects;
  - Ex ante probability θ of being free-rider: Determined by aggregate market clearing conditions in both states.

Free-riding and inferior solution

Investors' expected return



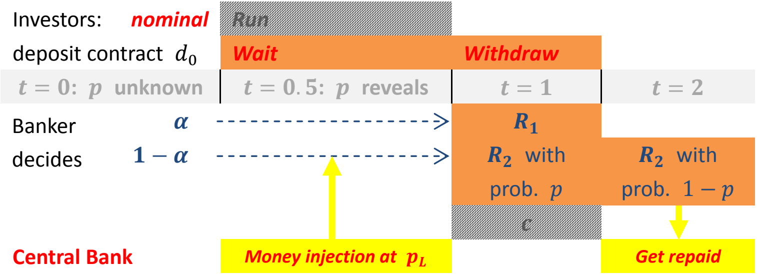
Nominal contracts and cash-in-market pricing

- What can central bank do? How does central bank intervention affect the outcome?
  - Inefficiencies:
    - Inferior mixed strategy equilibrium, and
    - Costly bank run.
  - Nominal deposits – allow central bank to implement state contingent payoffs as a public good: Injection of additional liquidity
    - To prevent bank runs;
    - To eliminate free-riding.

- Cash-in-the-market principle (Allen & Gale, 2004): Price level determined by the ratio of market liquidity (sum of money and real goods) to real goods.

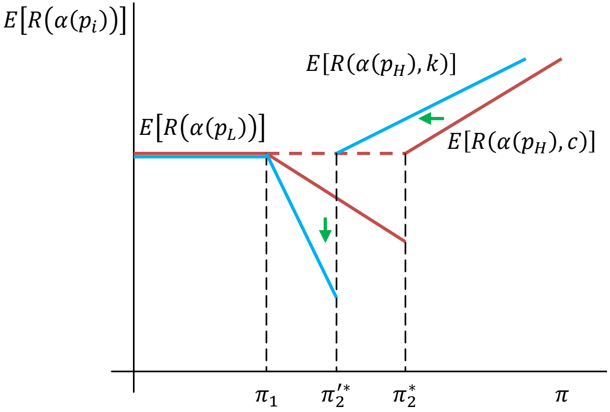
Liquidity requirement & conditional bail out

- Via open market operation, central bank injects paper money to the banks whose $\alpha \geq \underline{\alpha}$, filling in liquidity shortage.



Risk-taking and welfare improvement

Investors' expected return



Dynamic inconsistency problem

In a systemic crisis, conditional liquidity support (the commitment not to provide liquidity to free-riders) is not credible! — Dynamic inconsistency problem.

- Illiquidity problem: Free-riding banks have sufficient "good collaterals"; so
- Always ex post optimal to bail out free-riders.
- Prudent banks driven out whenever there is unconditional liquidity supply! — Bagehot Rule not sufficient!
- Surprising result: Moral hazard arises even in an economy with pure illiquidity risk.

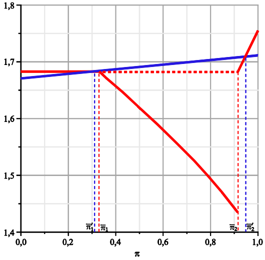
Equity requirement: Introducing equity

- Equity requirement: Banks required to hold some equity level k in their assets.
  - Introducing equity: Banks issue a mixture of deposit contract and equity for the investors in $T = 0$;
  - Equity holders can only get a share of $\zeta = \frac{1}{2}$ from the surplus $\rightarrow k = \frac{\frac{\gamma E[R_{s,i}] - d_{0,i}}{2}}{\frac{\gamma E[R_{s,i}] - d_{0,i}}{2} + d_{0,i}} \Rightarrow d_{0,i} = \frac{1-k}{1+k}\gamma E[R_{s,i}]$.
- Optimal level of k? Intuition: Holding equity is costly for the banks, therefore k should make banks just stay solvent in the bad state ("narrow banking")

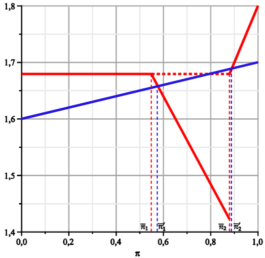
$$\underbrace{\frac{1-k}{1+k}\gamma E[R_H]}_{\text{deposit contract}} = \underbrace{\alpha(p_H) R_1 + (1 - \alpha(p_H)) p_L R_2}_{\text{real resource in bad state}}.$$

Does capital requirement help?

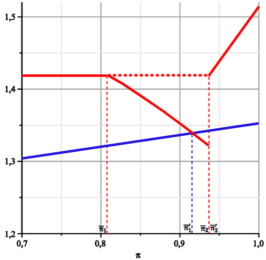
- Outcome: Equity requirement versus laissez-faire.



$p_H = 0.3, p_L = 0.25,\ \gamma = 0.6, R_1 = 1.8,$
$R_2 = 5.5, c = 0.9$



$p_H = 0.4, p_L = 0.3,\ \gamma = 0.6, R_1 = 2,$
$R_2 = 4, c = 0.8$

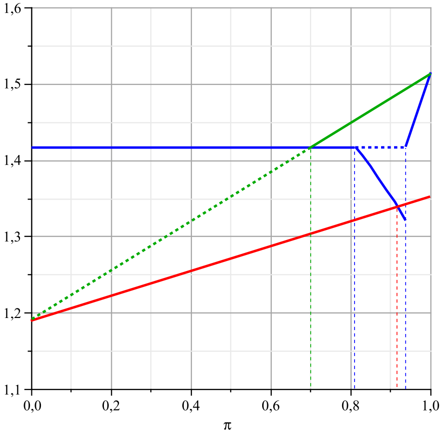


$p_H = 0.5, p_L = 0.25,\ \gamma = 0.7, R_1 = 1.8,$
$R_2 = 2.5, c = 0$

Intuition: More equity helps absorb losses in bad time. But: Costly in good time.

Does equity requirement help? (cont'd)

- Equity requirement dominated by *credible* monetary policy. Still: Equity holding is costly.



Conclusion

- Key findings:
  - Endogenized liquidity risk: Free-riding incentive and coordinative failure;
  - Inefficiencies of banking: Inferior mixed strategy equilibrium and costly bank run;
  - Nominal contract and its impact on the equilibrium: Central bank improves allocation by targeted liquidity injection. But: Dynamic inconsistency problem!
  - Equity requirements: Stability gain at a cost; dominated by credible bail out policy;
  - Stricter regulation and supervisory reform.
- Future research:
  - Illiquidity versus insolvency. Preliminary results: Cao (2009).