How does macroprudential regulation change bank credit supply?\textsuperscript{1}

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\textsuperscript{1}Disclaimer: The views expressed are those of the authors and do not necessarily represent those of the Federal Reserve Board of Governors or anyone in the Federal Reserve System.
Motivation

- Propose a model where the banking sector has the following functions:
  1. Provides liquidity insurance
  2. Enhances sharing of aggregate risk
  3. Expands credit extension to the real economy

- Study the externalities emerging from intermediation and examine regulation to mitigate their effect

- We modify the classic Diamond-Dybvig model to address these issues
Our modifications to DD

1. Runs depend on fundamentals and are not just due to sunspots (or indeterminate)
2. Loans are made to fund a risky technology
3. The banks and the borrowers are subject to limited liability and markets are incomplete
4. Banks raise both deposits and equity

Consequences of these modifications:

- Runs create a risk that can result in under-investment
- Limited liability creates an incentive for excessive risk-taking
The Agents

- A continuum of poor entrepreneurs (P) who owns the rights to a project but must borrow to implement it.
- A continuum of rich savers (R) who can invest in a riskless asset, or make a bank deposit, or buy bank equity.
  - Idiosyncratic liquidity shocks in intermediate period to consume early or late.
  - Proportion of early consumers fixed, but shocks are private information and cannot be hedged.
- A continuum of bankers (B) who has some trapped equity that can only be used for lending.
  - B can also raise funds from R, to invest in P and the riskless asset.
**Basic Diamond-Dybvig**

- **t=1**: Riskless loan funded by deposits
- **t=2**: Idiosyncratic preference shocks
- **t=3**: Certain investment outcome

- **No bank run**: Totally random
- **Investment payoff**
- **Bank run**: Totally random
- **Early investment liquidation**

**Our Framework**

- **t=1**: Risky investment funded by deposits & equity
- **t=2**: Idiosyncratic preference shocks
- **t=3**: Uncertain investment outcome

- **No bank run**: Function of fundamentals
- **Investment payoff**
- **Loan and deposits repayment**
- **Bank run**: Function of fundamentals
- **Early investment liquidation**
Externality from risk-taking

- Banks are tempted to gamble to exploit limited liability
- Depositors anticipate this and require an interest rate that accounts for the expected losses in bankruptcy
- If possible, they would rather write a contingent contract that ties the interest rate to the bank’s risk-taking
- Hence, the private contract does not fully undo the limited liability distortion
- The planner accounts for these incentives and sets deposit rates accordingly
Externality from bank-runs

- Agents form rational expectations about the probability of a run, but take it as given.
- In a global game they would get signals about the probability of a bad outcome to decide whether to run.
- Goldstein-Pauzner work out an exact version:
  - For our setting running depends on debt/equity mix and amount of safe assets relative to risk assets.
- We appeal to Goldstein-Pauzner and impose a particular functional form connecting the run probability to fundamentals:
  - Run is only possible if resources in the interim period are insufficient to repay everyone if they run. With insufficient resources, a run is more likely when leverage is higher or credit risk is higher.
  - Probability of a run \( q = f \) (Capital ratio, Liquidity ratio, Liquidation value).
- The planner accounts for this dependence.
### Table: Change in the probability of a bank-run: Constrained Planner vs. Competitive Equilibrium

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<thead>
<tr>
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1. Raise liquidity to control a run without preventing the bank from gambling (purple)
2. Raise bank equity to control a run and reduce investment to manage excess risk-taking (blue)
3. Raise bank equity to control a run and raise investment to help P or R (green)
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Capital regulation and dividend tax vs. capital and liquidity regulations

Table: Optimal Regulation for $w^P = 0.2$, $w^R = 0.6$, $w^B = 0.2$

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<thead>
<tr>
<th></th>
<th>Competitive Equilibrium</th>
<th>Constrained Planner</th>
<th>Capital Regulation</th>
<th>Optimal Mix</th>
<th>Capital &amp; Liquidity Regulation</th>
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CR & LR: Alternative weights
Challenges of eliminating the run and limiting risk-taking

- Capital requirements can eliminate the run, but result in higher investment.

- Deposit insurance eliminates the run, but it increases the incentives for risk-shifting.

- A combination of capital requirements and dividend taxes can eliminate the run and tame risk-taking, but it can violate the incentive compatibility constraint of patient depositors. Thus, it may also require a tax on liquid assets in order to yield the desired reduction in risk taking.

- Capital and liquidity requirements together eliminate the run and reduce risk-taking, but also reduce the profits from intermediation and are harmful for the bankers.

- Capital and loan-to-value requirements together can also eliminate the run and reduce risk-taking, but are harmful for the entrepreneur and reduce profits from intermediation.
Conclusions

- Lots of insights from this approach, but must
  - use GE models, with forward looking agents, and allow banks to provide multiple services
- Regulations that reduce the risk of a run can potentially generate Pareto improvements
- Preventing the excessive gambling is harder because of counterbalancing effects on different agents
- Allocational consequences of different regulations creates incentives for regulatory arbitrage and to lobby
BACK-UP SLIDES
Externality from risk-taking

\[
\sum_{s \notin s^D} (1 - q) \cdot \omega_{3s} U^B'(c_{3s}^{B, no-run}) \left[ V_{3s}^I (1 + r^I) - \frac{1 - \delta}{1 - \delta (1 + r_2^D)} (1 + r_3^D) \right] = 0
\]

- This equation implies that the banks takes on sufficient risk and leverage so that it makes losses in the medium risk state of the world.
- This risk-shifting takes place because the banks ignore the consequences of its investment decision in the bankruptcy state \((V_{3b}^I (1 + r^I) - (1 + r_2^D))\).
- But, \(R\) takes this into consideration and charges a higher deposit rate:

\[
-\lambda_{1}^{R} + \lambda_{2}^{R,i, no-run} (1 + r_2^D) + \lambda_{2}^{R, run, paid} (1 + r_2^D) + \sum_{s} \lambda_{3s}^{R, p, no-run} V_{3s}^D (1 + r_3^D) = 0
\]
Assume that the probability of the state of the world, which is realized at $t = 3$, is driven by a state variable $z_\tau$, $\tau \in \{1, 2\}$ and that $z_2 = z_1 + \eta$, where $\eta \sim U[-\bar{\eta}, \bar{\eta}]$.

We assume that $\eta$ is realized at the beginning of period 2, but it is not publicly revealed. Rather, each depositor obtains a signal $x_i = \eta + \epsilon_i$, where $\epsilon_i$ are small error terms that are independently and uniformly distributed over $[-\epsilon, \epsilon]$.

While all impatient depositors demand early withdrawal, patient ones need to compare the expected payoffs from going to the bank in period 2 or 3. The ex-post payoff of a patient agent from these two options depends on both $\eta$ and the proportion $m$ of agents demanding early withdrawal.

We are interested in a threshold equilibrium in which a patient depositor with signal $x_i$ withdraws his deposits at $t = 2$ when the signal is below a common threshold, i.e. $x_i \leq x^*$. Otherwise, he withdraws at $t = 3$. This implies also a threshold for the fundamental, i.e. a run will occur when $\eta \leq \eta^*$.

\[
\int_{m=\delta}^{\theta} \sum_s \omega_{3s} \left( z_1 + x^* + \epsilon \left( 1 - 2 \frac{m - \delta}{1 - \delta} \right) \right) U^R(c_{3s}^{R, no-run, wait}) \, dm + \int_{m=\theta}^{1} \frac{\theta}{m} U^R(c_{3s}^{R, run, unpaid}) \, dm = \\
\int_{m=\delta}^{\theta} \sum_s \omega_{3s} \left( z_1 + x^* + \epsilon \left( 1 - 2 \frac{m - \delta}{1 - \delta} \right) \right) U^R(c_{3s}^{R, no-run, withdraw}) \, dm + \int_{m=\theta}^{1} \frac{\theta}{m} U^R(c_{3s}^{R, run, paid}) \, dm
\]

where $\theta = \frac{LIQ + \xi \cdot I}{DR(1+iD_2)}$.
Combining CR and LR for $w^P = w^R = 0.35$, $w^B = 0.3$

**Figure**: Risky investment (left) and social welfare (right) for stricter liquidity requirements under optimal capital regulation ($w^P = 0.35$, $w^R = 0.35$).