Financial Fragility

IMF – Training Seminar

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Financial Fragility and Coordination Failures

- What makes financial systems fragile? What causes crises and breakdowns in financial institutions and markets?

- I will focus in this presentation on one cause that certainly played a role in many episodes in the history of financial crises: coordination failures.

- A coordination failure arises when economic agents take a destabilizing action based on the expectation that other agents will do so as well. The result is a self-fulfilling crisis.

- The key ingredient for this to arise is strategic complementarities: agents want to do what others do.
Example: Credit Freeze (Bebchuk and Goldstein, 2009)

- The model analyzes one of the features of the recent financial crisis – the credit freeze – whereby banks did not lend capital available to them.
- We describe an economy, where firms are interdependent:
  - Firm A buys inputs from firm B, whose employees are customers of firm C, who buys inputs from firm A, etc. See Cooper and John (1988) for more motivation.
- In such an economy, the success of a firm depends on the success of other firms, and hence lending by a bank is worthwhile if other banks lend.
- Then, credit freezes arise as a self-fulfilling belief.
Setup

- Continuum $[0,K]$ of banks, each one holds $1$.
- Need to decide whether to invest in a risk free asset, generating $1$, or lend to operating firms.
- Operating firms generate $1+R$ if projects succeed. Specifically, return is:

$$
\begin{cases}
1 + R & \text{if } aL + \theta \geq b \\
0 & \text{if } aL + \theta < b
\end{cases}
$$

- $\theta$ is fundamental of the economy.
- $L$ is mass of operating firms obtaining financing. $L = nK$, where $n$ is proportion of banks deciding to lend.
Multiple Equilibria

- Three ranges of fundamentals ($\theta$):
  
  - **Below $b - aK$** (lower dominance region):
    - Unique equilibrium: (efficient) credit freeze.
  
  - **Between $b - aK$ and $b$** (intermediate region):
    - Multiple equilibria: either lending or (inefficient) credit freeze.
  
  - **Above $b$** (upper dominance region):
    - Unique equilibrium: lending.
Source and Nature of Inefficient Credit Freeze

- In the intermediate range of fundamentals, an inefficient credit freeze may occur because of **strategic complementarities** among banks. They want to do what other banks do.
  - When other banks do not lend, the economy gets into a recession, and thus lending is expected to fail.

- As a result, a credit freeze is **panic-based**: It occurs as a result of the **self-fulfilling beliefs** that other banks are not going to lend.

- Moreover, here, a freeze is **unrelated to fundamentals**.
  - Some tend to attribute bad equilibria to sunspots.
Other Settings

• This basic story where strategic complementarities lead to coordination failures and financial fragility appears in many other contexts.

• Bank runs (Diamond and Dybvig, 1983):
  o Banks offer short-term deposits on long-term assets.
  o If many depositors demand early withdrawal, bank will run out of resources and go bankrupt.
  o Hence, expecting run by others, each depositor finds it optimal to run, leading to self-fulfilling bank runs.
• Currency attacks (Morris and Shin, 1998):

  o Government maintains an overly appreciated fixed exchange rate regime and defends it by selling foreign currency at a fixed price from its own reserves.

  o If many speculators buy foreign currency from the government (attack the currency), the government will run out of reserves and abandon the fixed exchange rate regime.

  o Expecting other speculators to attack, each speculator wants to attack and make a profit on the upcoming depreciation in the domestic currency.
• Financial-market crashes:
  o Not so simple: usual force in financial markets generates strategic substitutes. When traders sell, price drops and induces others to buy.
  o Potential sources of complementarities:
    ▪ Delegated trading and contracts: traders get punished for holding a stock, whose price dropped below a certain level (Morris and Shin, 2004).
    ▪ Feedback effects: financial-market prices affect real value of asset, for example, due to learning by decision makers (Goldstein, Ozdenoren, and Yuan, 2009).
Comments on Basic Framework

- The basic framework is a bit unsatisfactory, as it cannot pin down what will ultimately happen. This is an obstacle for:

  - **Policy analysis:** which policy tools are desirable to overcome crises?
    - Deposit insurance is perceived as an efficient tool to prevent bank runs, but it generates moral-hazard costs.
    - Without knowing how likely bank runs are, it is hard to assess the desirability of deposit insurance.
  
  - **Empirical analysis:** what constitutes sufficient evidence for the relevance (or lack of) of strategic complementarities in fragility?
Large body of empirical research (e.g., Gorton, 1985; Demirgüc-Kunt and Detragiache, 1998; Kaminsky and Reinhart, 1999; Martinez-Peria and Schmukler, 2001) associates crises with weak fundamentals. Is this evidence against the panic-based approach?

- **Mechanism and contract design:** what are the optimal contracts financial institutions should offer in light of potential fragility?
  - Demand deposit contracts are known to generate risk sharing, but also create potential for runs.
  - Designing optimal contract is impossible if likelihood of run cannot be assessed.
Global-Games Approach

- The global-games approach – based on Carlsson and van Damme (1993) – enables us to derive a unique equilibrium in a model with strategic complementarities and thus overcome the problems associated with multiplicity of equilibria (discussed above).

- The approach assumes lack of common knowledge obtained by assuming that agents observe slightly noisy signals of the fundamentals of the economy.

- The classic illustration is by Morris and Shin (1998). I will illustrate using credit-freeze example.
Back to Credit-Freeze Example: Unique Equilibrium

• Suppose that fundamental $\theta$ is normally distributed with mean $\gamma$ (public news) and standard deviation $\sigma_\theta$ (precision, $\tau_\theta = \frac{1}{(\sigma_\theta)^2}$).

• Banks obtain signals: $x_i = \theta + \varepsilon_i$, where $\varepsilon_i$ is normally distributed with mean 0 and standard deviation $\sigma_p$ (precision, $\tau_p = \frac{1}{(\sigma_p)^2}$).

• As long as private information is sufficiently precise relative to public information (formally, $\frac{\tau_\theta}{\sqrt{\tau_p}} \leq \frac{\sqrt{2\pi}}{aK}$), there is a unique equilibrium, where
  
  o Banks lend if and only if their signals are above $x^*$.
  
  o Real projects succeed if and only if the fundamentals are above $\theta^*$:
**Intuition** (see board illustration)

- Banks choose whether to lend or not based on their signals.
- Because they only observe imperfect signals, they must take into account what other banks will do at other signals.
- This ‘connects’ the behavior of banks at different fundamentals, and ultimately links it to the known behavior at the extreme dominance regions.
- The outcome is unique determination of banks’ behavior.
Equilibrium Characterization (limit case)

- When banks observe very precise signals, i.e., $\tau_p$ approaches infinity, $x^*$ and $\theta^*$ converge to the same value:

$$\theta^* = b - aK + aK \frac{1}{1 + R}$$

- Three ranges of fundamentals:
  - Below $b - aK$: **Efficient credit freeze.**
  - Between $b - aK$ and $b - aK + aK \frac{1}{1 + R}$: **Inefficient credit freeze.**
  - Above $b - aK + aK \frac{1}{1 + R}$: **No credit freeze.**
What determines the threshold?

- When observing $\theta^*$, a bank is indifferent between lending and not lending.
  - The bank is (almost) certain about the level of the fundamentals.
  - But, faces a strategic risk about what other banks are going to do. He expects a uniform distribution about the proportion of other banks that receive a signal above his and decide to lend.

- This gives the following indifference condition, which can be rearranged to express $\theta^*$:

$$1 = \left(1 - \frac{b - \theta^*}{aK}\right)(1 + R)$$
Important:

- Although $\theta$ uniquely determines the equilibrium, attacks are still driven by bad expectations, i.e., still panic-based:
  
  - In the intermediate region speculators attack because they believe others do so.
  
  - $\theta$ acts like a coordination device for agents' beliefs.

- A crucial point: $\theta$ is not just a sunspot, but rather a payoff-relevant variable.
  
  - Agents are obliged to act according to $\theta$. 
Why Is This Equilibrium Interesting?

- **First**, reconciles panic-based approach with empirical evidence that fundamentals are linked to crises.
- **Second**, panic-based approach generates empirical implications.
  - The probability of a crisis is pinned down by the value of $\theta^*$, which depends on parameters in the model.
- **Third**, once the probability of crises is known, one can use the model for policy implications.
- **Fourth**, captures the notion of strategic risk, which is missing from the perfect-information version.
Working with the Model to Analyze Policy Responses

• First, what may trigger a credit freeze?
  
  o A downward shift in fundamentals:
    
    ▪ Fundamentals drop to a level below $\theta^*$. 
  
  o A decrease in banks’ capital:
    
    ▪ Suppose that banks lost a fraction $l$ of their capital, the threshold for a credit freeze would increase to:

$$\theta^* = b - aK(1 - l) + aK(1 - l) \frac{1}{1 + R}$$
Capital Infusion to Banks

- Suppose that the government has total capital of $\alpha lK$.
- What is the effect of infusing that capital to the banking system?
- This will reduce the likelihood of a freeze to:

$$\theta^*_\text{Bank} = b - aK(1 - (1 - \alpha)l) + aK(1 - (1 - \alpha)l) \frac{1}{1 + R}$$

- But, there are still inefficient credit freezes that occur just because banks believe that other banks are not going to lend to operating firms.
- What is the mechanism at work?
• The additional capital available to banks gives other banks confidence that operating firms will do well if they receive financing, and may induce them to lend capital they already have.
  
  ▪ Recall the indifference condition behind the threshold $\theta^*$: with additional capital available to banks, a uniform distribution for the proportion of lending banks implies more capital being lent and higher likelihood of success. This reduces the fundamental $\theta^*$ that makes banks indifferent.

• But, coordination failures still arise, as banks choose not to lend if they expect other banks will not lend.
Is Direct Lending to Operating Firms Better?

• A traditional LOLR policy would be to provide capital directly to operating firms.

• This is indeed more efficient in getting the economy out of a credit freeze and inducing banks to lend, yielding the threshold:

\[
\theta^*_{Direct} = b - aK(1 - (1 - \alpha)l) + aK(1 - l) \frac{1}{1 + R}
\]

  ○ Recall that: \[
  \theta^*_{Bank} = b - aK(1 - (1 - \alpha)l) + aK(1 - (1 - \alpha)l) \frac{1}{1 + R}
  \]

• The fact that the government provides the capital directly to operating firms makes banks even more confident that real projects will succeed.
• But, suppose that the government does not have the skill of banks to identify good borrowers, and lends to proportion $\beta$ of firms who always generate zero return.

• Then, comparing capital infusion to banks with direct lending yields:

  $$(1 - (1 - \alpha)l)K - (1 - l)K > 0 \text{ below } \theta_{Direct}^*.$$  

  - Here, credit freeze occurs in both regimes; under direct lending, government ends up making bad loans (to good and bad firms).

  $$(1 - (1 - \alpha)l)K - (1 - l + \alpha l(1 - \beta))K(1 + R) \text{ between } \theta_{Direct}^* \text{ and } \theta_{Bank}^*.$$
- Here, direct lending prevents a credit freeze, but generates waste due to lending to bad firms. Sign is ambiguous.

  \[ (1 - (1 - \alpha)l)K(1 + R) - (1 - l + \alpha l(1 - \beta))K(1 + R) > 0 \]

  above \( \theta_{Bank}^* \).

- Here, credit freeze does not occur in both regimes; under direct lending, government ends up making bad loans (to bad firms).

- Overall, formal comparison yields:

  o Direct lending is preferred when \( y \) (known fundamental) is in an intermediate range, \( \beta \) is low, and \( R \) is high.
Other Mechanisms

- The challenge is to have a policy that obtains the lower likelihood of credit freeze while utilizing the ability of private agents to find good banks.

- With this approach, one can analyze other potential policy responses. In particular, the paper goes on to analyze:
  
  o **Government funds:** the government puts its capital in funds managed by private agents, who are compensated only on returns above 1.
  
  o **Guarantees:** The government does not use its capital for lending, but rather provides guarantees to banks in case their loans fail.
More Generally

- By allowing us to determine the probability of a crisis under different policies, one can use the global-games framework to assess the desirability of policy tools.

- There are other papers that provide related analysis in different contexts: Rochet and Vives (2004), Corsetti, Guimaraes, and Roubini (2006), Morris and Shin (2006).

- Overall, there is still room in the literature for a thorough analysis of the optimal policy against crises in light of the moral-hazard costs that such policy may have.
Detecting the Link between Complementarities and Fragility in the Data (Chen, Goldstein, and Jiang, 2009)

- Ample empirical evidence link crises episodes to weak fundamentals.

- However, as demonstrated by the theoretical framework above, this does not say much about whether or not coordination failures and strategic complementarities play a role.
  
  - Even when coordination failures are involved, crises are more likely to occur at low fundamentals.

- Using mutual-fund data, we present an empirical test that relies on cross-sectional differences in the level of strategic complementarities.
Institutional Background

- In mutual funds, investors can redeem their shares every day at the market value of that day.

- Their redemptions might lead the fund to trade later in order to rebalance the portfolio.

- If the fund holds illiquid assets, this will generate costs that will be imposed on the investors who stay in the fund.

- Hence, in mutual funds that hold illiquid assets (illiquid funds), there are strategic complementarities in the redemption decision, more so than in funds that hold liquid assets (liquid funds).
Hypotheses

• Using a global-games models, we develop the following predictions:
  o Illiquid funds exhibit stronger sensitivity of outflow to bad performance than liquid funds.
    ▪ The complementarities amplify response to fundamental shocks.
  o This pattern will be weaker in funds that are held mostly by large/institutional investors.
    ▪ These investors can better internalize the externalities, and thus respond less to complementarities.
• These hypotheses are confirmed in the data, while alternative explanations are refuted.
General Takeaway

- Global-games tools can help develop empirical predictions that can be taken to the data to empirically assess the effect of complementarities.
- Mutual-fund data provides a very convenient setting to work with, given the richness of data and cross-sectional differences across funds.
  - This is also a setting where significant turbulence has been noted in the recent financial crisis when money-market mutual funds were subject to massive runs.
- Ultimately, similar methodologies can be used to test for the origins of fragility in other contexts. This is crucial for policy recommendations.
Other Issues

• **Information structure and its implications for uniqueness:**
  
  o As mentioned above, the analysis requires that private signals are precise relative to public ones. This observation and related analysis is presented in Hellwig (2002).
  
  o Angeletos and Werning (2006) analyze how the relative precisions are determined endogenously in the context of trading in a financial market, and the consequences for uniqueness of equilibrium.
  
  o Angeletos, Hellwig, and Pavan (2006) study the signaling role of the policymaker’s policy and the effect that this has on the informational environment and on the uniqueness of equilibrium.
Different Payoff structures:

- The basic global-game analysis assumes global strategic complementarities:
  - The incentive to take an action always increases when more agents take it.
- But, things are often not that simple.
- Take the bank-run model analyzed by Goldstein and Pauzner (2005):
  - The bank has 1 unit of asset in period 1 that can generate $R > 1$ in period 2 with probability $p(\theta)$.
  - Agents who run in period 1 are promised $r_1 > 1$. 
The payoffs as a function of the proportion $n$ of agents who run:

<table>
<thead>
<tr>
<th>Period</th>
<th>$n &lt; 1/r_1$</th>
<th>$n \geq 1/r_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$r_1$</td>
<td>$\begin{cases} r_1 &amp; \text{prob } \frac{1}{nr_1} \ 0 &amp; \text{prob } 1 - \frac{1}{nr_1} \end{cases}$</td>
</tr>
<tr>
<td>2</td>
<td>$\begin{cases} \frac{(1-nr_1)}{1-n} R &amp; \text{prob } p(\theta) \ 0 &amp; \text{prob } 1 - p(\theta) \end{cases}$</td>
<td>$0$</td>
</tr>
</tbody>
</table>
○ This does not satisfy global strategic complementarities:

![Diagram](image)

○ Hence, working with such a model requires different proof techniques.
• **Design of Contracts and Mechanisms:**
  
  o Financial crises are often generated by the design of contracts and mechanisms that are thought to have other advantages.
  
  o Using global-game techniques, one can assess the likelihood of a crisis and how it is affected by the initial contract/mechanism, and then use this to study the optimal design of contracts/mechanisms.
  
  o This has been done in a few contexts:

    - Goldstein and Pauzner (2005) analyze optimal banking contracts in light of the risk of bank runs that is generated by the banking contract.
• They characterize a contract that trades off the benefits from risk sharing against the cost of bank runs.

• They develop conditions under which banks are viable.
  ▪ Dasgupta (2004) analyzes the optimal design of interbank contracts in light of the risk of contagion and fragility that they involve.
  ▪ Cukierman, Goldstein, and Spiegel (2004) analyze the choice of exchange rate regime taking into account the effect that this has on the likelihood of currency attacks.
    o Such analysis admits that crises are part of optimal mechanisms, and attempts to find their optimal probability.
Conclusions

- I presented the view that strategic complementarities and coordination failures are important sources of financial fragility.
  - This occurs in various settings: bank runs, currency attacks, credit freezes, financial-market crashes, etc.
- I discussed the global-games approach, which provides tools to analyze policy responses and contract/mechanism design in a framework where complementarities create fragility and crises.
- I showed how the link between complementarities and fragility can be detected in the data, and the importance this may have for policy analysis.