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: c**oordination 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:

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

  - θ 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 (θ):
  - **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):**
  - Banks offer short-term deposits on long-term assets.
  - If many depositors demand early withdrawal, bank will run out of resources and go bankrupt.
  - Hence, expecting run by others, each depositor finds it optimal to run, leading to self-fulfilling bank runs.

- **Currency attacks (Morris and Shin, 1998):**
  - Government maintains an overly appreciated fixed exchange rate regime and defends it by selling foreign currency at a fixed price from its own reserves.
  - 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.
  - 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:**
  - Not so simple: usual force in financial markets generates strategic substitutes. When traders sell, price drops and induces others to buy.
  - 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; Demirguc-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 θ is normally distributed with mean y (public news) and standard deviation σ_θ (precision, $\tau_\theta = \frac{1}{(\sigma_\theta)^2}$).
- Banks obtain signals: $x_i = \theta + \varepsilon_i$, where ε_i is normally distributed with mean 0 and standard deviation σ_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
  - Banks lend if and only if their signals are above x^*.
  - Real projects succeed if and only if the fundamentals are above θ^*:

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., τ_p approaches infinity, x^* and θ^* 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 θ^*, 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 θ^*:

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

Important:

- Although θ 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.
  - θ acts like a coordination device for agents' beliefs.
- A crucial point: θ is not just a sunspot, but rather a payoff-relevant variable.
  - Agents are obliged to act according to θ.

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 θ^*, 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?
  - **A downward shift in fundamentals**:
    - Fundamentals drop to a level below θ^*.
  - **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 $\alpha l K$.
- What is the effect of infusing that capital to the banking system?
- This will reduce the likelihood of a freeze to:

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

- 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 θ^*: 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 θ^* 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 β of firms who always generate zero return.

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

  - $\mathbf{(1-(1-\alpha)l)K-(1-l)K>0}$ **below** $\boldsymbol{\theta^*_{Direct}}$**.**

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

  - $\mathbf{(1-(1-\alpha)l)K-\big(1-l+\alpha l(1-\beta)\big)K(1+R)}$ **between** $\boldsymbol{\theta^*_{Direct}}$ **and** $\boldsymbol{\theta^*_{Bank}}$**.**

- Here, direct lending prevents a credit freeze, but generates waste due to lending to bad firms. Sign is ambiguous.

- $\mathbf{(1-(1-\alpha)l)K(1+R)-\left(1-l+\alpha l(1-\beta)\right)K(1+R)>0}$ **above** $\boldsymbol{\theta^{*}_{Bank}}$**.**

  - 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:

  - Direct lending is preferred when y (known fundamental) is in an intermediate range, β 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:
  - **Government funds:** the government puts its capital in funds managed by private agents, who are compensated only on returns above 1.
  - **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)

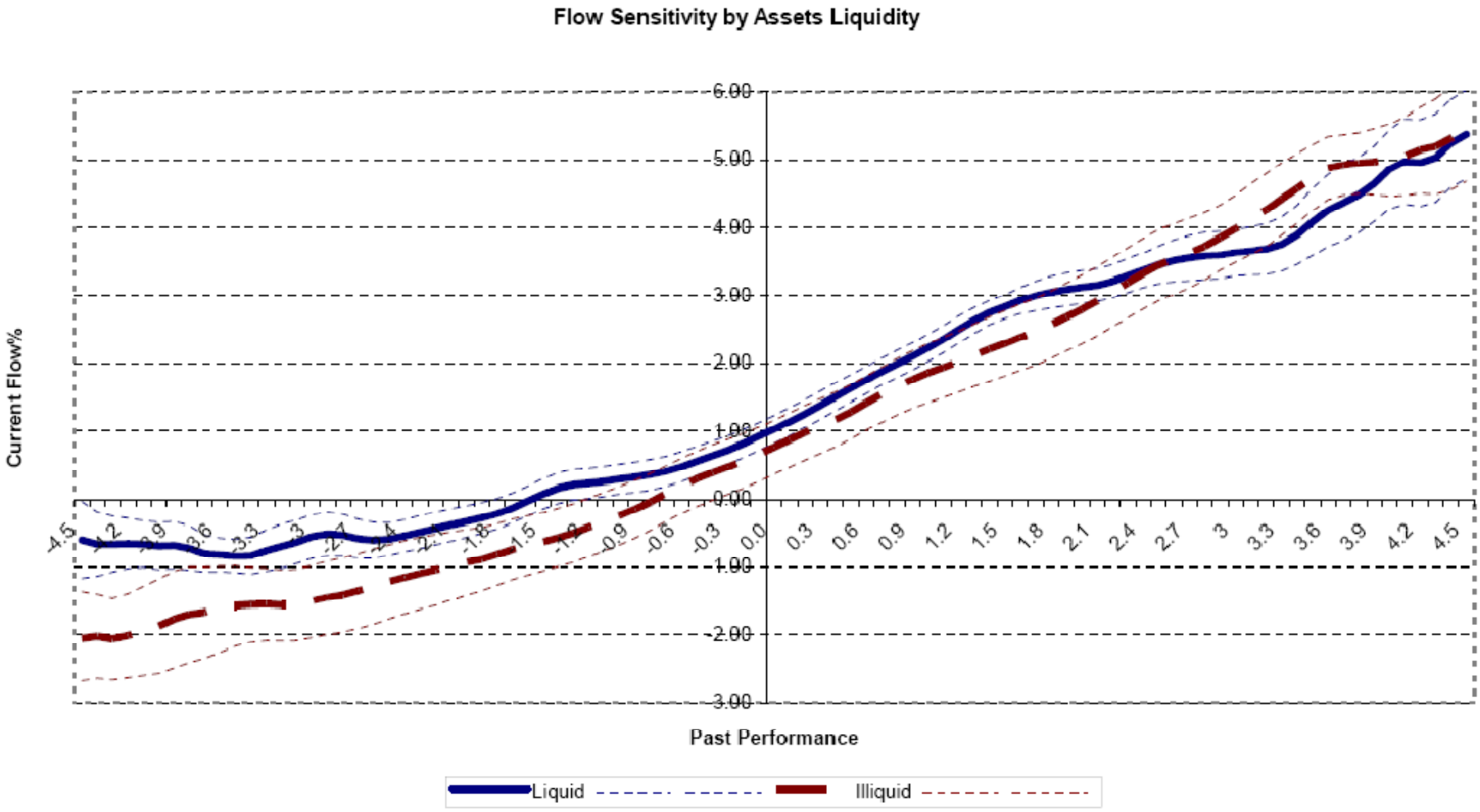
- Ample empirical evidence link crises episodes to weak fundamentals.
- However, as demonstrated by the theoretical framework above, this does not say much about whether or not coordination failures and strategic complementarities play a role.
    - Even when coordination failures are involved, crises 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:
  - Illiquid funds exhibit stronger sensitivity of outflow to bad performance than liquid funds.
    - The complementarities amplify response to fundamental shocks.
  - 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.


Flow Sensitivity by Assets Liquidity
Current Flow%
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.5
-4.2
-3.9
-3.6
-3.3
-3
-2.7
-2.4
-2.1
-1.8
-1.5
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-0.9
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0.9
1.2
1.5
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2.1
2.4
2.7
3
3.3
3.6
3.9
4.2
4.5
Past Performance
Liquid
Illiquid

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

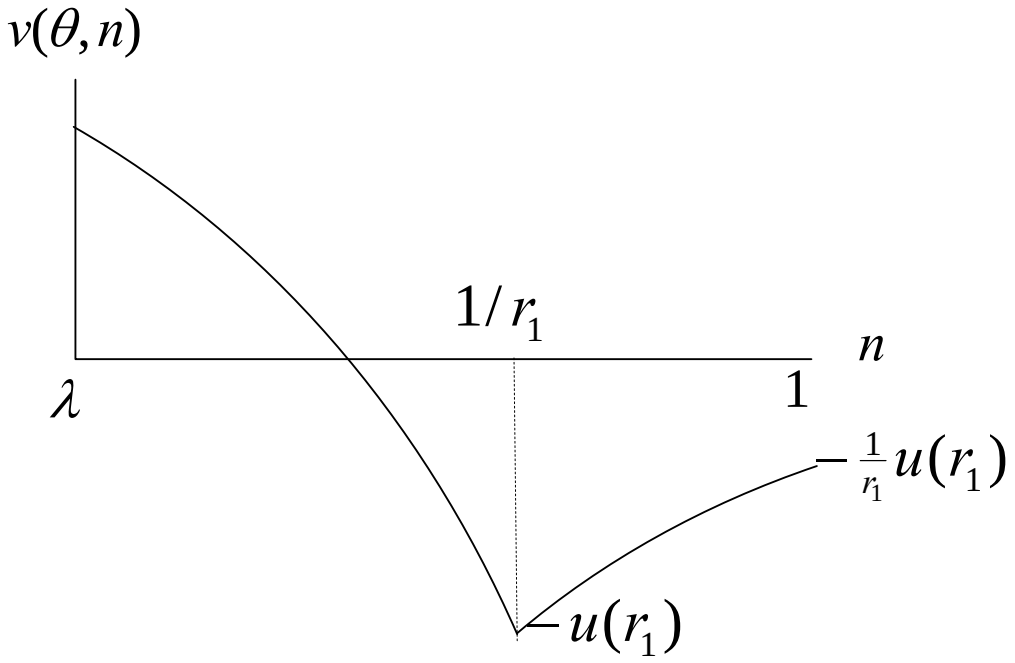
- **Information structure and its implications for uniqueness:**
  - As mentioned above, the analysis requires that private signals are precise relative to public ones. This observation and related analysis is presented in Hellwig (2002).
  - Angeletos and Werning (2006) analyze how the relative precisions are determined endogenously in the context of trading in a financial market, and the consequences for uniqueness of equilibrium.
  - 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 $r_1 > 1$.

o The payoffs as a function of the proportion *n* of agents who run:

Period	$n < 1/r_1$	$n \geq 1/r_1$
1	r_1	$\begin{cases} r_1 & prob \quad \dfrac{1}{nr_1} \\ 0 & prob\ 1 - \dfrac{1}{nr_1} \end{cases}$
2	$\begin{cases} \dfrac{(1-nr_1)}{1-n}R & prob \quad p(\theta) \\ 0 & prob\ 1-p(\theta) \end{cases}$	*0*

o This does not satisfy global strategic complementarities:



o Hence, working with such a model requires different proof techniques.

- **Design of Contracts and Mechanisms:**
  - Financial crises are often generated by the design of contracts and mechanisms that are thought to have other advantages.
  - 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.
  - 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.