The Price of Complexity in Financial Networks

Discussion by Kartik Anand
Bank of England

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Endogenous Financial Networks and Equilibrium Dynamics:
Addressing Challenges of Financial Stability and Monetary Policy

The usual disclaimer applies
Outline

1. The authors’ research question
2. Model structure
   A. Overview
   B. Questions
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4. Concluding questions
1. The authors’ research question

• Headline research question:

  *How can we estimate the probability of default for banks that are linked via an intricate web of claims and obligations?*

• A couple of specific sub-questions:

  *If all claims are secured(?) debt, what are the PDs?*

  *How do errors in the network structure influence the PDs?*

  *With a mix of debt and credit derivatives, what are the PDs?*
2. A Model structure: Overview

- Two-period model
- \( N \) leveraged financial institutions (banks)
- Each bank is characterized by its balance sheet
  - Assets: External (loans and securities portfolios) and Interbank (debt and derivatives)
  - Liabilities: Internal financing (own capital), interbank (debt and derivatives) and external (retail deposits)
2. A Model structure: Overview

• Value of external assets realized in the second period

\[ a_i^E(2) = a_i^E(1) \left( 1 + u_i \right) \]

• \( u_i \) (random shock) \( \sim \mathbb{R} \), mean \( \mu \) and standard derivation \( \sigma \)

• Second period default condition for bank \( i \)

\[ a_i^E(1) \left( 1 + u_i \right) + a_i^B(2) \sum_{j \neq i}^{N} B_{ij} \left( 1 - \chi_j \left[ 1 - \phi \right] \right) - l_i^B < 0 \]

• \( \chi_j \in \{0, 1\} \) is the default indicator and \( \phi \) is the recovery rate
2. A Model structure: Overview

- Re-arranging, one obtains that bank $i$ defaults ($\chi_i = 1$) whenever $u_i < \theta_i(\chi)$

- The ex-post outcome given by the fixed-point equation

\[
\chi_i^* = \mathbb{I} \left[ u_i - \theta_i(\chi^*) \right]
\]

- The ex-ante probability of default for bank $i$ is

\[
P_i = \int_{\theta_i(\chi^*)}^{\infty} dF(u)
\]
2.A Model structure: Overview

- Derivatives contracts can be included in the setup via

\[ \theta_i(\chi) \rightarrow \theta_i(\chi) - \delta \sum_{j,k} D_{ijk} y_{ijk}(P_k, P_j) \]
2.B Model Structure: Questions

• No limited liability for banks?

• Nature of the debt contract - shouldn’t the recovery rate (if the contract is unsecured) be endogenous?

• The fixed-point equations yields multiple solutions. What criteria do you use to select a solution?

• The probability of systemic default does not seem well defined - looks like it is the average over a product of indicator functions. Isn’t using the sum of indicator functions, i.e., the sum of banks that default better?

• When introducing derivatives into the setup, the ex-post default condition should not depend on the ex-ante PDs. Instead, you should have the derivatives’ values depend on the default indicators (χ)
3. Experiments

- First experiment - the planner has imprecise information regarding the bilateral contract values

- Authors conclude that even a small imprecision can lead to a large under- / over-estimation of the PDs

- I feel the analysis could be better grounded - e.g., suppose the planner has a prior belief $f(\gamma)$ about the structure of contracts ($\gamma$). However, the planner is unsure if this belief is correct and is willing to contemplate alternate beliefs (robust control)

$$g^* = \arg \max_g \int P^{sys}(\gamma)g(\gamma)d\gamma - \psi R(g, f)$$
3. Experiments

- Second experiment - the planner does not know the arrangement of contracts between banks, but only the maximum number of contracts.

- Since all (debt) contracts have the same unit value, the total number of possible networks, $\mathcal{N}$, is given by a similar combinatorial argument.

- Market complexity (drawing from the literature on statistical mechanics of complex networks) $\sim \log \mathcal{N}$.

- Authors claim that: as market complexity increases (networks become more dense), the probability of systemic default increase.

- However, this is counter-intuitive to the robust-yet-fragile notion.
4. Concluding remarks

- There are several similar models out there, some of which you mention in your paper. As such, the paper would benefit from a discussion regarding the differences between your method and the others.

- You implicitly argue that multi-layer networks are “bad” for financial stability. This is not clear to me.

  Interesting aside fact - in recent statements, the governor of the PBoC mentions reforming Chinese financial markets by “[… ] establishing multi-layered capital markets.”

- The paper is a bit light on economic / optimizing behaviour. Any thoughts on how to improve on this?