The Price of Complexity in Financial Networks

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

The usual disclaimer applies

Outline

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2. Model structure
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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:

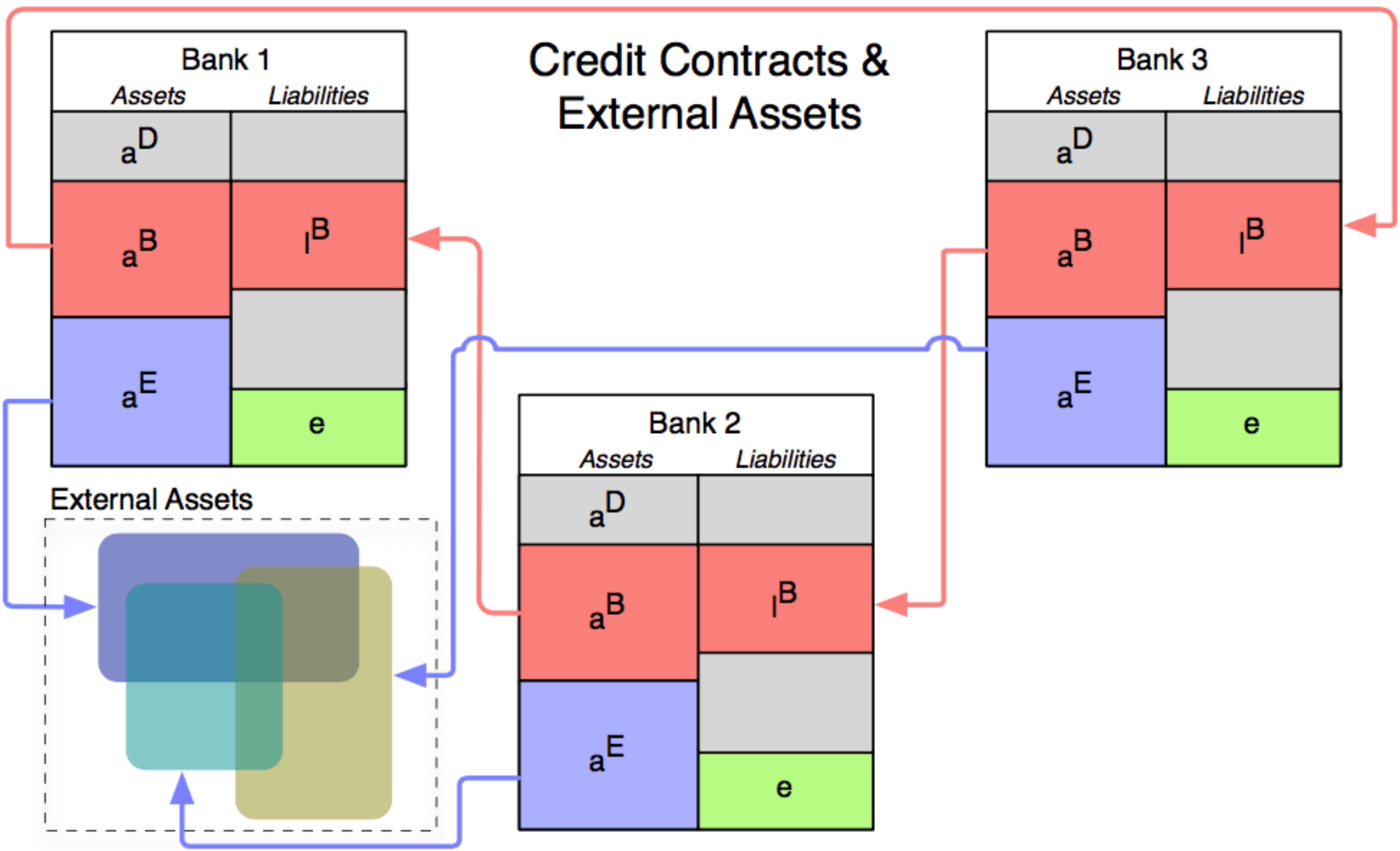
  If all claims are secured(?) debt, what are the PDs?

  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)



Credit Contracts &
External Assets
Bank 1
Assets
Liabilities
a^D
a^B
l^B
a^E
e
Bank 2
Assets
Liabilities
a^D
a^B
l^B
a^E
e
Bank 3
Assets
Liabilities
a^D
a^B
l^B
a^E
e
External Assets

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) ~ $\mathbb{R}$, mean μ and standard derivation σ

- 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 ϕ 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

$$\chi_i^* = \mathbb{I}\Big[u_i - \theta_i\big(\chi^*\big)\Big]$$

- 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

$$\theta_i(\chi) \to \theta_i(\chi) - \delta \sum_{j,k} D_{ijk} y_{ijk}(P_k, P_j)$$

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(**γ**) about the structure of contracts (**γ**). However, the planner is unsure if this belief is *correct* and is willing to contemplate alternate beliefs (robust control)

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

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) ~ $\log\mathcal{N}$
- 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 you 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?