

# Optimal systemic risk mitigation in financial networks

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Agostino Capponi and Peng-Chu Chen

# High level overview

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- The authors present a sophisticated and novel model to investigate the role of a Lender of Last Resort (LLR) in mitigating systemic risk.
- The authors consider a stochastic interbank network, wherein payments from one bank to another vary over time.
- Clearing, or settlement, of interbank claims done using a dynamic extension to the algorithm of Eisenberg and Noe (2001).
- If there is an adverse shock to the payments from bank  $i$  to bank  $j$ , this may adversely affect bank  $j$  to repay its debtors.
- However, if there is a LLR to provide liquidity to troubled banks, this may mitigate contagion.

# Bagehot (1873), “Lombard Street: A description of the money market”

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- They must lend to merchants, to minor bankers, to ‘this man and that man’, whenever the security is good. In wild periods of alarm, one failure makes many, and the best way to prevent the derivative failures is to arrest the primary failure which causes them.
- We must keep a great store of ready money always available, and advance out of it very freely in periods of panic, and in times of incipient alarm.
- Advances should be made on all good banking securities, and as largely as the public ask for them. The object is to stay alarm. But the way to cause alarm is to refuse some one who has good security to offer.

# Some questions about the set up

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- In the paper, the LLR provides *bail-out* funds. It is perhaps better to define LLR support as *liquidity assistance*, since bail-outs typically imply lending to insolvent, rather than simply illiquid banks. Thoughts?
- If and when assistance is extended by the LLR to a bank, the model assumes that the LLR is the most senior debtor in the following periods (Equation 2.2). How is this justified?
- With regards to the grace period  $\theta$ , how does this fit in with resolution regimes in the US (FDIC) and elsewhere. The FDIC, for example can:
  - Provide creditors of a failed bank certificates of receivership, entitling them to share of proceedings from the sale and liquidation of the failed bank's assets.
  - Force the sale, or acquisition of the failed bank by another bank, which would take over the liabilities.
  - Provide assistance to ensure that the failed bank remains open.

# Comments and questions about the results

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- Analysis demonstrates that “*homogenous networks are more robust than heterogenous networks*” - perhaps this may also be viewed as a robust-e-fragile result, in that were homogenous networks to fail, they would fail spectacularly.
- Impact of Bail-out budget: Some caution is needed in interpreting these results, since sometimes (Ireland) too large banking sectors guarantees/bailouts can be viewed as non-credible, leading to runs on the banks and state alike.
- Impact of correlated shocks: If all banks have fewer liabilities, all banks should be less able to repay their creditors, hence greater systemic risk. However, results point to the opposite. Explanation?
- Which “bail-out rule” is closer to the traditional LLR rules (those prescribed by Bagehot, for example)?

# A network model approach to systemic risk in the financial system

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Han Chen and Shaun Wang

# High-level overview

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- The paper investigates the systemic risks inherent in the market for Credit Default Swaps (CDSs) using a network model.
- Focuses on CDS arrangements between FDIC regulated banks (institutional features are important). Naked CDS positions are not allowed in the model.
- Authors propose a new algorithm to re-construct the network of bilateral CDS exposures from publicly available data on aggregate exposures of banks.
  - Growing issue in the financial networks literature (more of this later).
- The model involves a simple contagion mechanism for the propagation of defaults.

# The algorithm

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- Simple and appealing stochastic approach.
- Probability bank  $i$  purchases CDSs from bank  $j$  is proportional to each bank's market share on the *sell side* of the CDS market.
- All banks hedge positions equally with counterparties - greater risk sharing.
- All banks have equal abilities to issue CDSs.
- Outcome - a series of balanced networks where banks have different arrangements of links.
- Strengths - can generate confidence intervals for estimates of systemic risk; should be capable of reproducing stylized facts of CDS markets (disassortative).



# Questions and comments about the algorithm

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- Unfortunately, none of the strengths are explored in the paper (yet).
- Have you thought of comparing your algorithm to existing approaches to reconstructing financial networks?
- From literature on interbank networks, greater risk sharing leads to underestimating of risk (robust-yet-fragile). Any thoughts on how to get around this issue?
- The assumption that all banks have the same (negligible) marginal costs of issuing CDS is stark. Any thoughts in relaxing this?
- Would be good to see some summary statistics for the networks you generate (not clear how many banks you have in your sample).

# Algorithms to reconstruct interbank networks

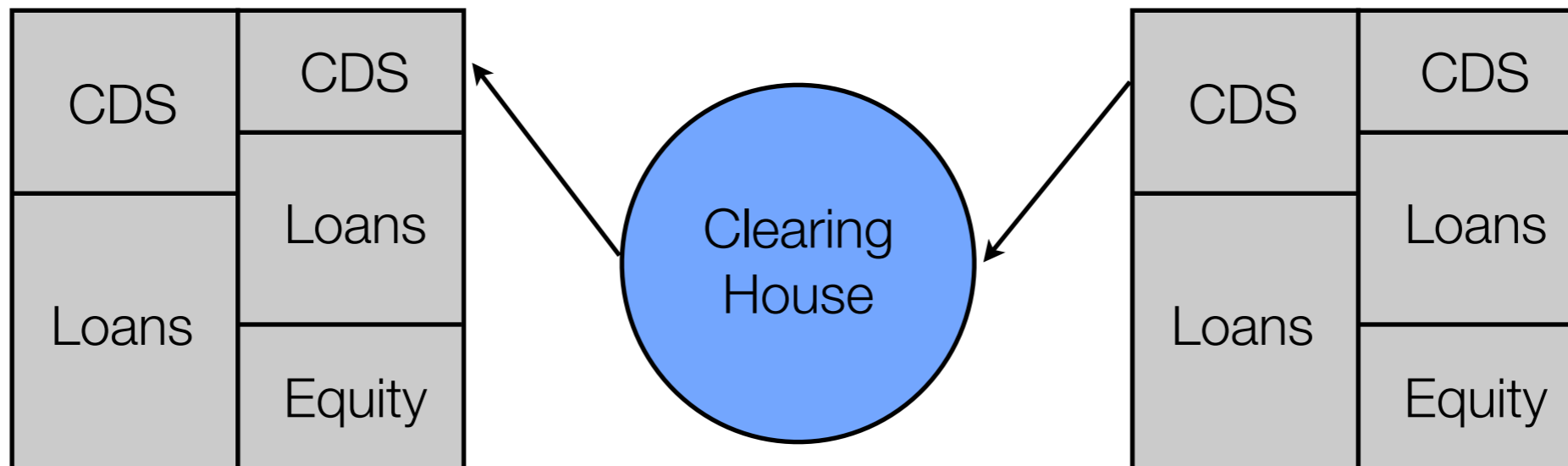
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- The “maximum entropy” approach.  
Upper and Worm (2004). *“Estimating bilateral exposures in German interbank markets: Is there a danger of contagion?”*
- Message passing algorithm.  
Mastromatteo et al (2012). *“Reconstruction of financial network for robust estimation of systemic risk”*
- Stochastic block modeling approach.  
Halaj and Kok (2013). *“Assessing interbank networks using simulated data”*

# The contagion mechanism

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- Stylized bank balance sheet



- Losses on loans to the real economy are accounted on the balance sheet.
- If the losses are greater than 20% of bank's equity, then the bank defaults on its CDS obligations to the clearing house, who is responsible for netting out the positions with the counterparty.

# Questions and comments about the mechanism

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- Why a 20% threshold?
- What features of the FDIC regulations for CDS operations are being captured in the model (clearing houses, for example), and what are being missed?

The FDIC also has the power, under 12 U.S.C. § 1821(e)(13)(A),<sup>108</sup> to “enforce any contract . . . entered into by the depository institution notwithstanding any provision of the contract providing for termination, default, acceleration, or exercise of rights upon, or solely by reason of, insolvency or the appointment of a conservator or receiver.” This provision thus allows the FDIC to avoid enforcement of an *ipso facto* clause predicated on a bank failure.<sup>109</sup> However, an exception is provided for certain market-sensitive financial contracts, referred to as “qualified financial contracts” (“QFCs”), defined to include mortgage-related securities, swap agreements and similar

- The “Systemic Risk Ratio” is similar to that of Markose et al (2010) - what are the differences, if any?

# Literature on network model for CDS markets

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- Nascent, but growing field, e.g.,
  - Markose et al (2010). *“Too Interconnected To Fail: Financial Contagion and Systemic Risk In Network Model of CDS and Other Credit Enhancement Obligations of US Banks”* - Agent based network model based on detailed micro-data on CDS contracts between US banks obtained from the DTCC; Conduct simulations to determine the fragility of the system; Propose a systemic risk ratio for each bank.
  - Heise and Kühn (2012). *“Derivatives and Credit Contagion in Interconnected Networks”* - Consider a network model for credit derivatives involving banks, insurers and the “real economy”; Analytically characterize the conditions for stability, with and without Naked CDS positions.

# Efficiency and stability in a financial architecture with too-interconnected-to-fail-institutions

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Michael Gofman

# High level overview

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- Very interesting and innovative approach to modeling over-the-counter financial markets using networks.
- The paper studies the tradeoff between efficiency of a particular architecture in allocating liquidity to the stability of the market.
- Trade motivated by demand for liquidity by cash-poor banks from cash-rich banks. Prices are determined by a bargaining process.
- The author estimates the model to data from the Federal Funds market, and evaluates the potential benefits / costs of new regulation.

# Some specifics

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- Each bank has an endowment of liquidity  $E_i$ , and a value for liquidity  $V_i$ . Assume that at any given time, only one bank has excess liquidity,  $E_i = 1$ .
- Trade motivated since others banks seek liquidity (have  $V > 0$ ).
- Bilateral trading price formation modeled as bargaining process, where the bargaining power of the seller bank matters.

**Definition (Equilibrium).** *Equilibrium trading decisions and valuations are defined as follows:*

*i. For all  $i \in N$ , bank  $i$ 's equilibrium valuation is given by:*

$$P_i = \max\{V_i, \max_{j \in N(i,g)} V_i + B_i(P_j - V_i)\}. \quad (1)$$

*ii. For all  $i \in N$ , bank  $i$ 's equilibrium trading decision is given by:*

$$\sigma_i = \arg \max_{j \in N(i,g) \cup i} P_j. \quad (2)$$

- Equilibrium is uniquely determined: is there an intuitive explanation for this?



# Estimation process

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- Structure of OTC market: Driven by a preferential attachment process.
  - Could also use a fitness model, where probabilities of attachment are driven by the “fitness” of banks - may allow you to match better with institutional features. See Iori et al (2007). *“A network analysis of the Italian overnight money market”*.
- Price setting: Assuming equal bargaining powers,  $B_i = 0.5$ , or  $B_i = 1 - 0.5/k_i$ , where  $k_i$  is number of *direct* trading partners.
  - Clarification: The network is undirected, correct?
- Shocks: Uniform endowment shocks.

# Efficiency

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- Allocations of liquidity are efficient if banks with the highest valuations receive the most liquidity through trading.
  - Question: How does the number of iterations needed to converge to an equilibrium scale with number of banks?
- Key result: The estimated financial architecture with large interconnected banks is 11 times more efficient than a financial architecture without large interconnected institutions.
  - Perhaps you can estimate the contributions for individual “core” banks, i.e., using some sort of Gale-Shapely measure. See Drehmann and Tarashev (2011). *“Measuring the systemic importance of interconnected banks”*.

# Stability

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- Analysis follows the lines of Albert et al (2000). *“Error and attack tolerance of complex networks”*.
- Assuming 10% of banks fail at random, the expected welfare loss increases by 115% in the estimated financial architecture with large interconnected banks, while the increase is only 29% in the counterfactual architecture.
  - This result counter to the prevailing belief that scale-free networks are more “robust”.

# Collateral!

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- The “good” being traded is money/liquidity. However, some of the other OTC markets (especially those dealing with credit derivatives) have to trade in collateral in some form or the other.
- This introduces frictions in the trading game - asymmetric information with stochastic values.
  - Any thoughts on how the trading game can be extended to handle this?
- Recent models of OTC network - traders must decide whether to engage in costly due diligence in accepting a security - there are strategic complementarities. Could one bring such elements into your framework?