Interbank contagion and resolution procedures: inspecting the mechanism

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(1) Background literature

- Network models (Nier et al., JEDC 2007; Gai and Kapadia, Proc. Royal Society 2010; May and Arinaminpathy, J Royal Soc. Interf. 2012; Gleeson et al. Advances in Network Analysis and its Applications 2013; Giansante and Krause, JEDC 2012, Iori et al. JEBO 2006 ; Battiston et al., JEDC 2012.)

- Explicit account of bank balance sheets;
- Interaction between interconnected agents;
- Direct investigation of shock propagation and contagion dynamics;

(2) Motivation

- Huge interest in resolution mechanisms (Haldane, June 2013), (Zhou et al. 2012, IMF), (Council of European Union, 27 June 2013):
- The resolution mechanism has not been adequately investigated from a macro-prudential point of view.
- Alternative resolution procedures and the resilience of the banking system: What do we know?
- This inspection is conducive to advance our understanding of:

i the trade-offs involved in the choice of the resolution procedure.

ii how we can manage negative financial network externalities.

Bank Resolution I

- What do we mean by Bank Resolution Procedure?
- Mechanisms and Rules designed to prevent the impact of a banking crisis and its effect on economic activity.(See Dewatripont and Freixas, 2012)
- 4 types of intervention can be undertaken:

1 Bank recapitalization: Shareholders are required to inject new capital

- Downside? Very hard to do during a period of stress

2 Bail-out: The government steps in to rescue troubled institutions.

- Downside(s)?
- Huge Taxpayer Transfers and Fiscal Imbalances,
- Expectations and incentives for risk taking, compensation and dividend policies.

Bank Resolution II

3 Bail-in: This is a statutory power to restructure the bank liabilities by either writing down unsecured debt (Wholesale funding, interbank borrowing with maturity longer than 7 days.) or converting in into equity up to a minimal viability threshold. The bank remains open and its basic operations are preserved.

4 Bank Liquidation: This procedure typically involves an official receiver in charge of bank asset management, recovery, sale and compensation of creditors. The bank is shut down and disappears as a legal entity.

Bank Resolution III

Should defaulted banks be forced into compulsory liquidation?

- Why to keep a failing bank alive?

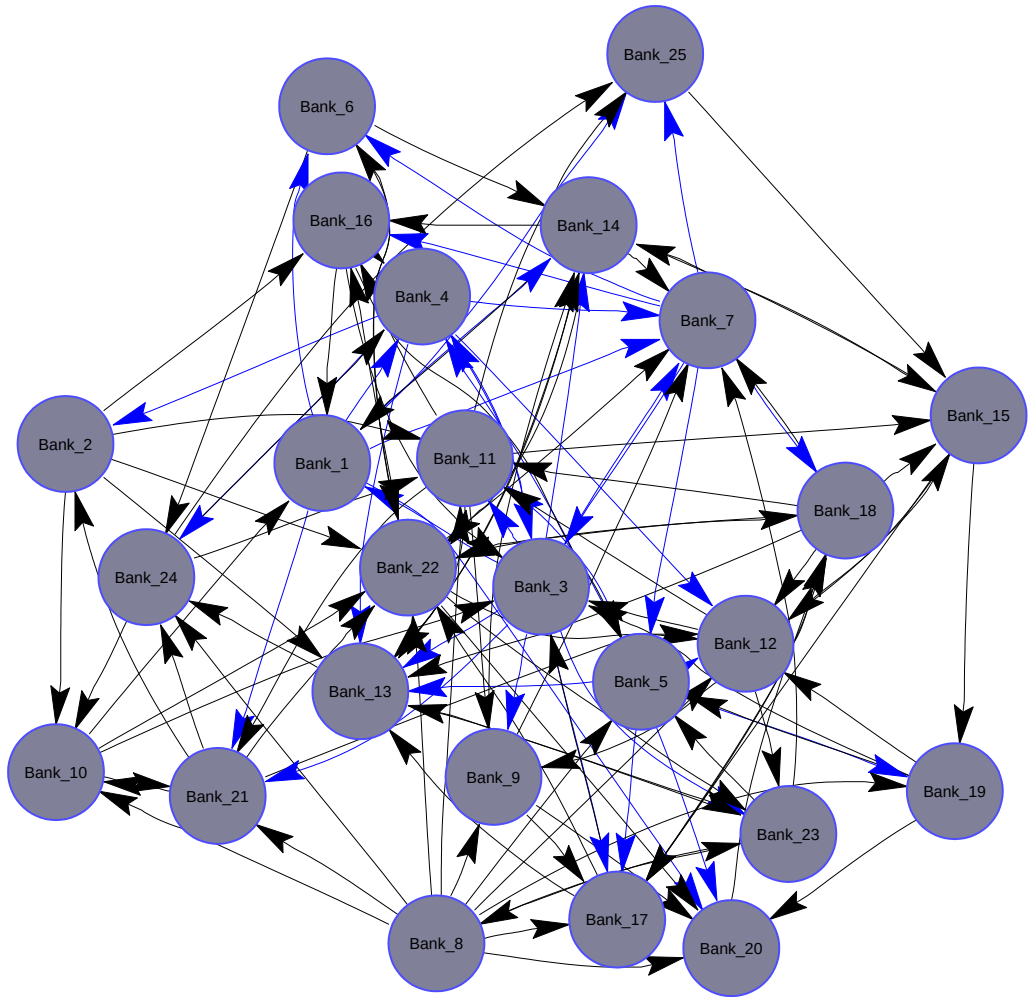
- preserve specific borrower-lender relationships,
- avoid disorderly liquidation,
- minimize the risk of costly litigation of the bank's contracts,
- guarantee the viability of the payment system,
- preserve firm's access to credit, avoid credit crunch and negative knock-on effects on real activity,
- curb contagion ?
- bank's failure weakens the regulator's reputation.

Macroprudential Policy Package

- Crisis Prevention: Tool ⇒ (Counter-cyclical?) Capital Requirements and surcharges.
- Crisis Management Options ⇒ Bail-in or Liquidation?

- Bail-in tools: Order of Priority, State Guarantee at the Hold-to-Maturity-Value
- Desired Effect(s): Minimize the risk of a run, Discipline Device, Avoid disorderly and costly liquidation, curb fire-sales spirals, no need for government-assisted mergers that exacerbates the too-big-to-fail problem.
- Undesired effect: Higher-order Losses.
- Liquidation tool: liquidity requirement (Policy parameter) to hedge against funding shocks.
- Undesired effects: Illiquidity-driven failures.

Homogenous Banking Network



Definition of a Bank

The asset structure of bank i is made up as follows:

Assets	Liabilities
A_i	NW_i
L_i	B_i
	D_i

A_i=External Assets, L_i=Wholesale Assets
NW_i=Networth, B_i=Wholesale Funding, D_i=Deposits

Building up The Network

- Key-object in our agent-based laboratory: Liability matrix X^l.
- $B_i = \sum_{j=1}^{n} X_{ij}^l$ (horizontal summation) where B_i is the total interbank liabilities of bank i
- $L_j = \sum_{i=1}^{n} X_{ij}^l$ (vertical summation) where L_j is the total interbank assets of bank j
- Once X^l is in place, we can retrieve B_i and L_i $\forall$ i

- we built each bank asset structure in the following way:
  - $A_i = \alpha B_i$
  - $NW_i = \beta[A_i + L_i]$
  - $D_i = A_i + L_i - NW_i - B_i$

Bail-in Procedure

- We now introduce a shock $S_i = \gamma A_i$ that wipes out some or all of the external assets of bank i and we let the system adjust to it.
- $A_{i,t} \downarrow \Longrightarrow NW_{i,t} \downarrow$ if $NW_i < 0 \Longrightarrow$ bank i defaults
- $B_{i,t} \downarrow$ (Second-order loss)$\Longrightarrow L_{j,i,t+1} \downarrow \Longrightarrow NW_{j,t+1} \downarrow$ Contagion Channel
- $D_{i,t} \downarrow$ (Third-order loss)
- Public Guarantee of the hold-to-maturity value of the residual non-distressed bank assets.

- Dynamic adjustment of interbank assets:

$$L_{j,i,t+1} = (1 - \theta_{i,t}) * L_{j,i,t} \tag{1}$$

$$1 - \theta_{i,t} = \begin{cases} \frac{B_{i,t} - (S_{i,t} - NW_{i,t})}{B_{i,t}} & \text{if } B_{i,t} - (S_{i,t} - NW_{i,t}) > 0 \\ 0 & \text{if } B_{i,t} - (S_{i,t} - NW_{i,t}) < 0 \end{cases} \tag{2}$$

$$L_{j,t+1} = \sum_{i \neq j} L_{j,i,t+1} \tag{3}$$

Contagion Dynamics

Time-Rounds	Contagion	Losses-given-default	Default
t	i $\Longrightarrow$ j	$\theta_{i,t}X_{j,i}$	$\theta_{i,t}X_{j,i} > NW_j \Longrightarrow$ j=Default(t)
	i $\Longrightarrow$ b	$\theta_{i,t}X_{b,i}$	$\theta_{i,t}X_{b,i} > NW_b \Longrightarrow$ b=Default(t)
$t+1$	j,b $\Longrightarrow$ e	$\theta_{b,t+1}X_{e,b} + \theta_{j,t+1}X_{e,j}$	$\theta_{b,t+1}X_{e,b} + \theta_{j,t+1}X_{e,j} > NW_e \Longrightarrow e = Default(t+1)$
	b $\Longrightarrow$ c	$\theta_{b,t+1}X_{c,b}$	$\theta_{b,t+1}X_{c,b} < NW_c \Longrightarrow c \neq Default(t+1)$
	j $\Longrightarrow$ b	$\theta_{j,t+1}X_{b,j}$	$\theta_{j,t+1}X_{b,j} + \theta_{i,t}X_{b,i} > NW_b \Longrightarrow b = Default(t)$
$t+2$	b $\Longrightarrow$ c	$\theta_{b,t+3}X_{c,b}$	$[\theta_{b,t+1} + \theta_{b,t+2}]X_{c,b} > NW_c \Longrightarrow c = Default(t+2)$

Restrictions:

- $X_{e,b} = X_{c,b}$
- $\theta_{j,t+1} = \theta_{b,t+1}$ if b and j were hit by the same type of shock.

Liquidation Mechanism

- $A_i \downarrow \Longrightarrow NW_i \downarrow$(First-order Loss)
- Bank i calls in all its interbank loans.
- $B_{j,i} \downarrow \Longrightarrow A_j \downarrow$ (Funding/Liquidity Shock)
- if $\Delta B_j > \delta A_j \Longrightarrow$ j defaults (Failure mechanism)

- Dynamic adjustment of interbank assets:

$$L_{j,i,t+1} = (1 - \theta_{i,t}) * L_{j,i,t} \tag{4}$$

$$(1 - \theta_{i,t}) = \begin{cases} \frac{\phi A_{i,t} + L_{i,t} - D_{i,t}}{B_{i,t}} & \text{if } 0 \leq \frac{\phi A_{i,t} + L_{i,t} - D_{i,t}}{B_{i,t}} \leq 1 \\ 0 & \text{if } \frac{\phi A_{i,t} + L_{i,t} - D_{i,t}}{B_{i,t}} < 0 \end{cases} \tag{5}$$

$$L_{j,t+1} = \sum_{i \neq j} L_{j,i,t+1} \tag{6}$$

The failed bank is fully liquidated and removed from the network

Calibration

The network is fully characterized by the following set of parameters:

Table: *Description of Parameters*

Parameters	Description	Benchmark Value	Range of Variation
n	Number of Nodes (Banks)	25	
p	Probability of Connectivity	-	0.01-0.95
α	External Assets to Interbank Borrowing Ratio	5	2-5
β	Net-worth to Total Assets Ratio	0.05	0.01-0.07
γ	Shock relative to External Assets of one bank	1	
θ	Loss-Given-Default Rate		Endogenous
ϕ	Recovery Rate on Sold Assets	1	0.7-1
δ	Liquidity requirements (wrt Ext.Assets)	0.1	0.05-0.5

Financial Network Externality

- Banks tend to rely on short-term funding and this creates a refinancing risk.
- Sudden withdrawals work as liquidity shocks.
- Banks may have an incentive to over-use short-term funding beyond what would be socially desirable.
- The net private value of short-term funding may be adjusted to take into account the refinancing risk Nonetheless, there is no automatic mechanism such that the individual bank will internalize the system-wide effect.(See Perotti and Suarez, IJCB 2011).
- The key issue is to try to align private and social costs of bankruptcy (Dewatripont and Freixas, 2012)
- Financial Network Externality (Over-lending to the wrong set of banks , See Acemoglu et al., MIT wp 2013)
- We focus on the externality due to liquidity-driven defaults.
- How can we quantify the size of this externality?
- How can the regulator intervene to force banks to equalize social and private costs and hence internalize the negative externality?

Resilience and Connectivity - Part I

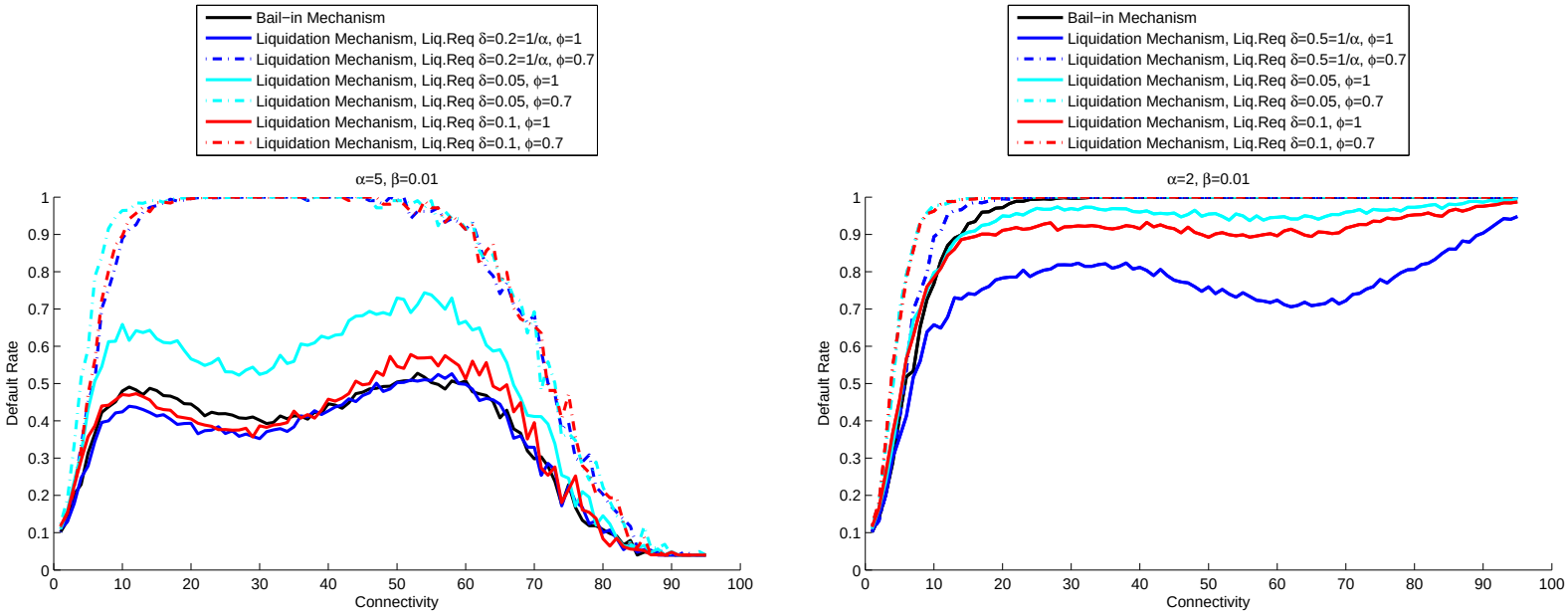


Figure: *Shallow/Deep Interbank Market - Undercapitalized System*

Resilience and Connectivity - Part II

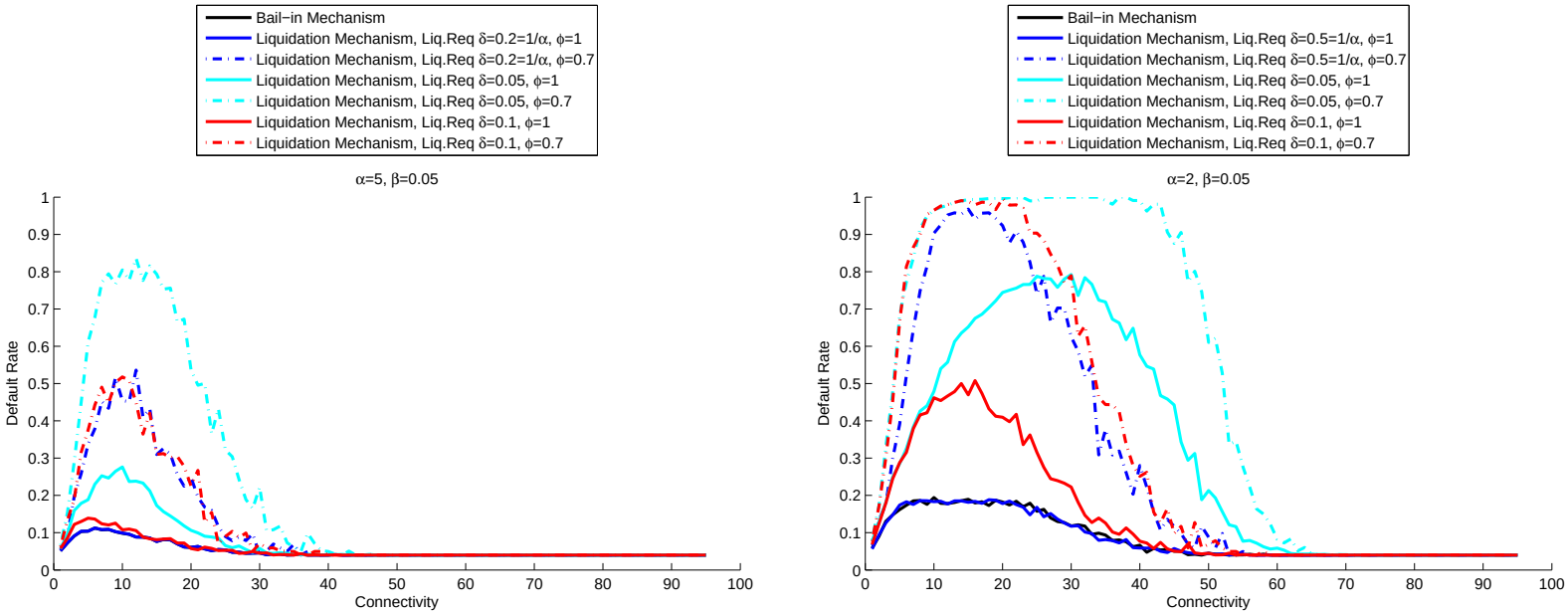


Figure: *Shallow/Deep Interbank Market - Medium-Capitalized System*

(1) CONCLUSIONS

- The present analysis provides a framework that allows us to quantify the cost of the negative financial externality that arises with liquidity-driven defaults.
- Liquidity requirements should be directly tied down to the exposure on the interbank market.
- This forces banks to internalize the cost of unforseen liquidity shocks that would otherwise amplify contagion dynamics.
- Severe underpricing of fire-sold assets may render higher liquidity requirements ineffective in an undercapitalized system.
- This is so because the effect of fire-sales is so disruptive that contagion dynamics are almost entirely governed by solvency-driven defaults.
- Orderly liquidation procedures must be put in place to maximize the effect of liquidity requirements

- Setting a wrong (too low) liquidity requirement, with full recovery of sold assets and a shallow interbank market, does not dramatically destabilize the system.
- A deeper interbank market weakens the system to a greater extent even when recovery is full.
- The regulator should favor the formation of network with connectivity levels in the desired range given the structure of the banking system, such that capital and liquidity requirements can be best effective.

(2) POLICY ISSUES: WELFARE ANALYSIS?

- An efficient implementation of the liquidation procedures involves orderly and timely asset management procedures (to minimize fire-sales) and adequate liquidity requirements (to internalize financial externality). If (and only if) this is done properly, bail-in interventions and compulsory liquidation yield the same contagion dynamics. Is the regulator indifferent between the two resolution procedures?
- The central planner must trade-off the negative indirect effects of the two mechanisms:
- Bail-in affects the liability side: possible price-adjustments? To the extent that some debt instruments can be written off or converted into equity, returns required on those instruments will tend to that of equity and hence adjusted upwards. Cost of funding increases.
- Liquidation affects the asset side: Possible quantity adjustments? High (too high?) liquidity requirements may have perverse effects on asset composition. Banks may reduce credit to the real economy (households and firms) and shrink their active position on the interbank market. The quantity and quality of liquidity provision is reduced.