Bail-ins and Bailouts: Incentives, Connectivity, and Systemic Stability

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Task Force Meeting, New York  
August 29, 2018
Introduction
Systemic risk in an interbank network

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Research Objectives

Existing studies take the banks as inactive agents, and measure the cascading contagion effects:

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2-step agenda:

- Endogenize intervention after the occurrence of defaults,
- Endogenize network formation.
Methods of intervention

**Bailout:** Government provides liquidity through taxpayer money.

Among others, Citigroup, AIG Insurance, and UBS were bailed out by their respective government during the recent crisis.

**Bail-in:** Creditors voluntarily forgive part of the debt in exchange for equity in the reorganized company.

The hedge fund Long Term Capital Management was bailed-in in 1998. Under the supervision of the Federal Reserve Bank of New York, a total of 14 banks agreed to participate in a recapitalization plan.

**Subsidized/assisted bail-in:** Contributions from regulator and banks.

Bear Stearns was sold to JP Morgan Chase for $1.2 billion with a government injection of $30 billion.
Model of Financial Network
Financial network is described by:

- Banks have bilateral exposures $L_{ij}$, denoting $j$’s liability to $i$. Denote
  \[ L^j = \sum_{i=1}^{n} L_{ij}, \quad \pi^j = \frac{L_{ij}}{L^j}. \]

- Each bank $i$ has investment $e^i$ in assets outside the interbank network.
- Each bank $i$ has net cash holdings $c^i$. 

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Welfare losses: Liquidation of assets / bankruptcy costs:

- Liquidation losses are equal to $(1 - \alpha) \times$ liquidated assets.
- Bankruptcy cost is $(1 - \beta) \times$ recovered assets.
Model of Intervention
Stages of the game

The game has the following stages:

1. The government proposes an assisted bail-in \((b, s)\).
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   (a) Proceed with the rescue, but make up for the contributions of defecting banks. Resulting welfare losses are \(w_\lambda(b, s, a)\).
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   (b) Resort to public bailout \((0, s_P)\) with welfare losses \(w_P = w_\lambda(0, s_P)\).
   (c) Abandon the rescue, which leads to welfare losses \(w_N = w_\lambda(0, 0)\).
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An SPE \(\sigma\) is *weakly renegotiation proof (WRP)* if after every history \(h_t\), there exists no continuation SPE, which Pareto-dominates \(\sigma|_{h_t}\).
Suitable equilibrium selection criterion because the coordination of a bail-in is precisely a negotiation

During the bail-in of LTCM, Peter Fisher of the FRBNY sat down with representatives of LTCM’s creditors

Implausible that they would have ever agreed on a bail-in plan that is Pareto-dominated.
Lemma

Let \((b, s)\) be a feasible proposal of a complete bail-in. In an accepting equilibrium \(a\), bank \(i\) with \(b^i > 0\) accepts if and only if

1. \(w_{\lambda}(b, s, (0, a^{-i})) \geq \min (w_N, w_P)\), and

2. \(b^i - s^i \leq \begin{cases} \sum_{j=1}^{n} \pi^{ij}(L^j - p^j_N) & \text{if } w_N \leq w_P, \\ 0 & \text{if } w_P < w_N. \end{cases}\)

Bank \(i\) is willing to contribute only if

- there is no accepting equilibrium without bank \(i\) (no free-riding).
- share of benefits accruing to bank \(i\) outweighs cost of contribution.
Complete rescues

In a complete rescue \((b, s)\) with accepting equilibrium \(a\), \(\bar{p}(b, s, a) = L\). Maximal incentive-compatible net contribution is

\[
\eta^i := \begin{cases} 
\min \left( \sum_{j=1}^{n} \pi^{ij}(L^j - p^j_N), (c^i + \alpha e^i + (\pi L)^i - L^i)^+ \right) & \text{if } \lambda \alpha \geq 1 - \alpha, \\
\min \left( \sum_{j=1}^{n} \pi^{ij}(L^j - p^j_N), (c^i + (\pi L)^i - L^i)^+ \right) & \text{if } \lambda \alpha < 1 - \alpha.
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If \(w_P < w_N\), then \(\bar{p}(s_P) = L\), hence no bank is willing to contribute.

\[\Rightarrow\] No-intervention threat is not credible.
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\[\Rightarrow\] No-intervention threat is not credible.

If \(w_P \geq w_N\), the threat is credible and regulator will aim to include banks whose incentive-compatible contributions have the largest welfare-impact.
Equilibrium bail-in plan

**Theorem**

Let $\nu^i$ denote the welfare-impact of largest incentive-compatible contribution of bank $i$. Let $i_1, \ldots, i_{n-|\mathcal{F}|}$ be a non-increasing ordering of $\nu^i$.

1. If $w_P < w_N$, the unique SPE outcome is a public bailout.
2. If $w_N \leq w_P$, the unique WRPE outcome is a subsidized bail-in with

$$w_* = \min \left( w_P - \sum_{j=1}^{m} \nu_{ij}, \ w_N - \nu_{im+1} \right),$$

where $m := \min \left( k \mid w_P - \sum_{j=1}^{k} \nu_{ij} < w_N \right)$. 
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where $m \coloneqq \min \left( k \mid w_P - \sum_{j=1}^{k} \nu^{ij} < w_N \right)$. 
Credibility of the Regulator’s Threat
Amplification of the shock

Lemma

Let $\chi_0$ and $\chi_N$ denote the aggregate losses accruing to the financial sector immediately after the initial shock and after a default cascade without intervention, respectively. The threat is credible if and only if

$$\chi_N - \chi_0 \leq \lambda \chi_0 + \min (\lambda \alpha, 1 - \alpha) \sum_{i=1}^{n} \ell^i(\bar{p}(s_P)).$$

Larger weight $\lambda$ to tax-dollars improves credibility of the threat.
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- Larger weight $\lambda$ to tax-dollars improves credibility of the threat.
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Lemma

For fixed $L, c, e, \alpha, \beta$, the equilibrium welfare losses after intervention are smaller in network $\pi_1$ than in network $\pi_2$ if the regulator’s threat is credible in network $\pi_1$ but not in network $\pi_2$. 
Consider two financial systems \((L, \pi, c, e), (L, \pi', c, e)\). For any \(m < n\), interbank losses are strongly \(m\) more concentrated in network \(\pi\) than in \(\pi'\) if

(i) \(\eta^{(i)}(\pi) \geq \eta^{(i)}(\pi')\) for every \(i \leq m + 1\), where \(x^{(i)}\) denotes the \(i^{th}\)-largest entry of vector \(x\),

(ii) \(w_N(\pi) \geq w_N(\pi')\).

- Welfare losses in \(\pi\) equal the sum of the banks’ incentive compatible contributions: \(w_N(\pi) = \sum_{i=1}^{n} \eta^{i}(\pi)\).
- Largest \(m + 1\) losses in network \(\pi\) are higher than the corresponding losses in \(\pi'\).
Welfare Losses and Concentration

**Proposition**

Consider two financial systems $(L, \pi, c, e), (L, \pi', c, e)$ with homogeneous cash holdings such that $L = \pi L$. Suppose

$$w_N(\pi') \leq w_N(\pi) \leq w_N(\pi') + \lambda(\eta^{i_{m(\pi)}+1}(\pi) - \eta^{i_{m(\pi)}+1}(\pi')).$$  

If interbank losses are strongly $m(\pi)$ more concentrated in network $\pi$ than in $\pi'$, then equilibrium welfare losses are lower in $\pi$ than in $\pi'$.

- Even if welfare losses are higher in the least concentrated network in the absence of intervention, they become lower in the presence of intervention.
A model for financial intervention, where

- the structure of the intervention plan arises endogenously as the result of the strategic interaction between regulator and banks,
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- the structure of the intervention plan arises endogenously as the result of the strategic interaction between regulator and banks,
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Equilibrium intervention plan:

- Prior studies have shown that, if shocks are not too high, dense interconnections are preferable to sparser interconnections
- The presence of intervention enlarges the range of shocks for which sparser networks are socially preferrable:
  - Bail-ins can be tailored in a way that the benefits accrue more strongly to the contributor
  - Lowers the banks’ incentive to free-ride and increases the sizes of the bank’s incentive compatible contribution.
  - As the amplification of a shock is smaller in a more concentrated network, the government can more credibly stand by idly
Thank you!
Assisted Bail-ins

Each bank $i$ receives a subsidy $s^i$ to purchase a part $b^i$ of debt from fundamentally defaulting banks.

This is essentially a set of centralized transfers between banks:

- $b^i 1_{\{a^i=1\}} - s^i$ is bank $i$’s net contribution to the bail-in.
- $\sum_i (s^i - b^i 1_{\{a^i=1\}})$ is the government’s contribution.
- Includes public bailouts and privately backed bail-ins as special cases.

After transfers:

- Liabilities are cleared as before with $c^i(b, s, a) = c^i + s^i - b^i 1_{\{a^i=1\}}$.
- Bank $i$’s value is $V^i(b, s, a) := V^i(\bar{p}(b, s, a))$ and welfare losses are

$$w_\lambda(b, s, a) := w_\lambda(\bar{p}(b, s, a)) + \lambda \sum_{i=1}^{n} (s^i - b^i 1_{\{a^i=1\}}).$$
Regulator minimizes welfare losses over subsets $B$ of banks to be rescued.

For a fixed $B$, coordination of bail-in works analogously:

- Only banks contribute, for which the threat is credible,
- Largest contributors are added first.
Numerical Example
Specific choice of network topologies

(a) The complete network.  
(b) The ring network.

We compare the credibility in the ring network $\pi_R$ and the complete network $\pi_C$ in a financial system with $L^i = L$ and $c^i = c$ for every bank $i$.

A shock hits the financial system such that

- there is 1 fundamentally defaulting bank with shortfall $\chi_0$,
- $n_l$ banks are lowly capitalized with value of outside asset $e_l$,
- $n_h$ banks are highly capitalized with $e_h > e_l$.  

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Comparison of welfare losses

Welfare losses of optimal bail-in is of the form

$$WP - \eta^i_1 - \eta^i_2 - \ldots - \eta^i_m,$$

where $\eta^i$ is the maximal incentive-compatible contribution of bank $i$, related to $i$’s losses in absence of intervention.

- In densely connected network: shock distributed among many banks. Incentive to free-ride is large $\rightarrow$ small contributions.
- In sparsely connected network: few creditors who would suffer large losses in case of no intervention $\rightarrow$ large contributions.
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![Diagram showing shock sizes and beta values](image)
Without intervention: clearing payments

A clearing payment vector $p$ is a solution to

$$p^i = \begin{cases} L^i & \text{if } c^i + \alpha e^i + \sum_j \pi_{ij} p^j \geq L^i, \\ \beta(c^i + \alpha e^i + \sum_j \pi_{ij} p^j)^+ & \text{otherwise.} \end{cases}$$

- Banks in $D(p) := \{ i \mid p^i < L^i \}$ default.
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\end{cases}$$

- Banks in $\mathcal{D}(p) := \{ i \mid p^i < L^i \}$ default.
- Bank $i$ has to liquidate $\ell^i(p) = \min \left( \frac{1}{\alpha} \left( L^i - c^i - \sum_j \pi^{ij} p^j \right)^+, e^i \right)$.
- Senior creditors (depositors) of $i$ lose $\delta^i(p) = \left( c^i + \alpha e^i + \sum_j \pi^{ij} p^j \right)^-$. 
Without intervention: clearing payments

With clearing payment vector $p$, the value of each bank $i$ is

$$V^i(p) = \begin{cases} 0 & \text{if } i \in D(p), \\ c^i + e^i - (1 - \alpha)\ell^i(p) + (\pi p)^i - p^i & \text{otherwise.} \end{cases}$$

Welfare losses are equal to

$$w_\lambda(p) = (1 - \alpha) \sum_{i=1}^{n} \ell^i(p) + \frac{1 - \beta}{\beta} \sum_{i \in D(p)} p^i + \lambda \sum_{i \in D(p)} \delta^i(p).$$
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- **deadweight losses**
- **depositor’s losses**
Without intervention: clearing payments

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$$V^i(p) = \begin{cases} 
0 & \text{if } i \in \mathcal{D}(p), \\
\kappa^i + \epsilon^i - (1 - \alpha)\ell^i(p) + (\pi p)^i - p^i & \text{otherwise.}
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**Lemma**

Set of clearing payments forms a (non-empty) complete lattice. Greatest clearing payment $\bar{p}$ Pareto-dominates all other clearing payments.
Weak renegotiation proofness

Government makes a proposal such that at least 5 banks need to accept for the government to proceed.

- Any response where at most 3 banks accept is a trivial SPE.
- Outcome is identical to all banks rejecting the proposal.
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- Outcome is identical to all banks rejecting the proposal.

For given proposal \((b, s)\), a continuation equilibrium \(a = (a^0, a^1, \ldots, a^n)\) is called an accepting equilibrium if \(a^0(b, s, a^1, \ldots, a^n) = \text{"proceed"}\).

Lemma

All accepting equilibria are WRP. Rejecting equilibria are WRP if and only if there exists no accepting equilibrium.
Comparison of credibility in different networks

If threat is credible in $\pi$ and $\pi'$, two counteracting forces:

- incentive-compatible contributions are larger in $\pi$ than in $\pi'$,
- since $w_N(\pi) \geq w_N(\pi')$, the no free-riding condition implies fewer banks included in bail-in in $\pi$.

Interbank losses are *strongly more concentrated* in $\pi$ than in $\pi'$ if incentive compatible contributions are larger in $\pi$ than in $\pi'$

**Lemma**

Let $(L, \pi, c, e)$ and $(L, \pi', c, e)$ be regular with $w_N(\pi) = w_N(\pi')$. If losses are strongly more concentrated in $\pi$ than in $\pi'$, then $w_*(\pi) \leq w_*(\pi')$. 
Comparison of credibility in different networks

- Prior studies have shown that dense interconnections may amplify rather than absorb initial losses (Acemoglu et al. (2015), Haldane (2009))
- Our results suggest that this phenomenon is strengthened in the presence of intervention:
  - In a more concentrated network, bail-ins can be tailored in a way that the benefits accrue more strongly to the contributor
  - Lowers the banks’ incentive to free-ride and increases the sizes of the bank’s incentive compatible contribution.
  - As the amplification of a shock is smaller in a more concentrated network, the government can more credibly stand by idly
  - Enlarge the region of shock sizes, for which a bail-in strategy is credible.


