Econ 7310: A Review of Bank Runs and Bailouts

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Bailouts

- There are multiple episodes around the world (e.g. US 2008-2009) where government supplying funding to financial intermediaries and other firms was a component of the government's response to a financial crisis.
- Henry Thornton (1802) and Walter Bagehot (1877): it is good public policy for government to lend to firms in a financial crisis.
- Bailouts are usually perceived to be a costly manifestation of time inconsistency on the part of the policymakers.

Recent Works

Theoretical:

- Green, "Bailouts", *Economic Quarterly-Volume 96, Number 1-First Quarter*, 2010
- Wang, "Bailouts and Bank Runs: Theory and Evidence from TARP", *European Economic Review*, 2013
- Farhi and Tirole, "Collective Moral Hazard, Maturity Mismatch, and Systemic Bailouts", *American Economic Review*, 2012
- Chari and Kehoe, "Bailouts, Time Inconsistency, and Optimal Regulation: A Macroeconomic View", *American Economic Review*, 2016
- Bianchi, "Efficient Bailouts?", *American Economic Review*, 2016

Recent Works

Empirical:

- Goldsmith Pinkham and Yorulmazer, "Liquidity, Bank Runs, and Bailouts: Spillover Effects During the Northern Rock Episode", *Journal of Financial Service Research*, 2010
- Johnson and Mamun, "The Failure of Lehman Brothers and Its Impact on Other Financial Institutions", *Applied Financial Economics*, 2012
- Chiu and Tsai, "Government Interventions and Equity Liquidity in the Sub-prime Crisis Period: Evidence from the ETF Market", *International Review of Economics and Finance*, 2017

Recent Works

Other works:

- Rosas, "Bagehot or Bailout? An Analysis of Government Response to Banking Crises", *Journal of Political Science*, 2006
- Stern and Feldman, "Too Big to Fail: The Hazards of Bank Bailouts", *Brookings Institution Press, Washington D.C.*, 2004
- Barofsky, "Bailout: An Inside Account of How Washington Abandoned Main Street While Rescuing Wall Street", *Free Press*, 2012

Diamond-Dybvig Bank Runs Model with Costly Bailouts

- Keister, "Bailouts and Financial Fragility", *Review of Economic Studies*, 2016
- Keister and Narasiman, "Expectations vs. Fundamental-Driven Bank Runs: When Should Bailouts be Permitted?", *Review of Economic Dynamics*, 2016
- Keister and Mitkov, "Bailouts, Bail-ins and Banking Crises", *Working Paper*, 2017

The Model

- Three periods $t = 0, 1, 2$
- A continuum of investors indexed by $i \in [0, 1]$
- Investors' preferences are given by

$$U(c_1, c_2, g; \omega_i) = u(c_1 + \omega_i c_2) + v(g)$$

- In $t = 0$, each investor is endowed with 1 unit of private good
- In $t = 1$, each investor has probability π of being impatient ($\omega_i = 0$), and probability $1 - \pi$ of being patient ($\omega_i = 1$)
- There is a constant returns to scale technology that yields either 1 in $t = 1$ or R in $t = 2$

Sequential Service

- The withdrawals in $t = 1$ follows a sequential service
- Investors arrive at a central location in the order based on a pre-determined index i
- The payment made to an investor can depend only on the information received by the financial intermediaries up to that point

Financial Crises

- Investors condition their actions on a sunspot signal $s \in S$
- $S = \{\alpha, \beta\}$ is the set of possible states with corresponding probabilities $\{1 - q, q\}$
- Investor i chooses a strategy based on her type ω_i and the state s

$$y_i(\omega_i, s) \in \{0, 1\}$$

- $y_i = 0$ corresponds to withdrawing early and $y_i = 1$ corresponds to waiting until $t = 2$

Potential Equilibria

- The model always has an equilibrium where

$$y_i(\omega_i, s) = \omega_i \text{ for all } i \text{ and } s$$

- This is the "good" equilibrium that implements the first-best allocation of resources
- There might also exist other inferior equilibria in which some patient investors run by withdrawing early in some state s
- Without loss of generality, assume run occurs in state β

Definition 1: *The financial system is fragile if there exists an equilibrium strategy profilt with* $y_i(1, \beta) = 0$ *for a positive measure of investors.*

Timeline

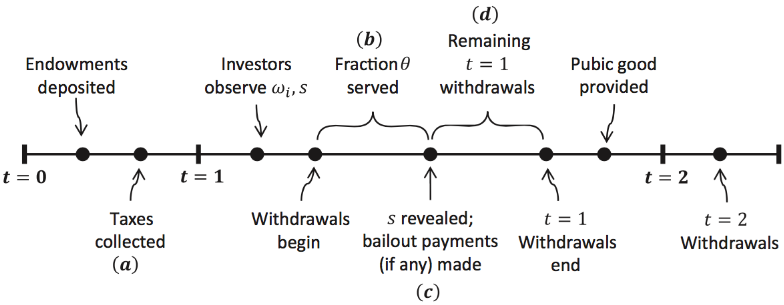


FIGURE 1
Timeline

Backward Induction

- Consider the following strategy profile for investors:

$$y_i(\omega_i, \alpha) = \omega_i \text{ for all } i$$
$$y_i(\omega_i, \beta) = \begin{cases} 0 & \text{for } i \leq \theta \\ \omega_i & \text{for } i > \theta \end{cases}$$

- Based on this strategy by the investors, the decisions of the policy maker and financial intermediaries can be solved using backward induction

The Allocation of Remaining Private Consumption

- Let ψ_s^j denote the quantity of resources intermediary j has available for its remaining investors in state s after θ investors have withdrawn
- Based on the strategy profile, the intermediary can update the fraction $\hat{\pi}_s$ of the remaining investros who are impatient

$$\widehat{\pi}_\alpha \equiv \frac{\pi - \theta}{1 - \theta} \qquad \text{or} \qquad \widehat{\pi}_\beta \equiv \pi$$

- The payments to the remaining investors will be chosen to solve

$$V(\psi_s^j; \widehat{\pi}_s) \equiv \max_{c_{1s}^j, c_{2s}^j} \quad (1-\theta)\left[\widehat{\pi}_s u(c_{1s}^j) + (1-\widehat{\pi}_s) u(c_{2s}^j)\right]$$

$$\text{s.t.} \quad (1-\theta)\left[\widehat{\pi}_s c_{1s}^j + (1-\hat{\pi}_s)\frac{c_{2s}^j}{R}\right] = \psi_s^j$$

- The first-order condition is

$$u'(c_{1s}^j) = R u'(c_{2s}^j) = \mu_s^j$$

Bailout Policy

- In state β, the policy maker has to decide the optimal bailout package $\{b^j\}$
- Let $\sigma(j)$ denote the distribution of investors across intermediaries. The total size of the bailout package is given by

$$b \equiv \int b^j d\sigma(j)$$

- The policy maker will choose the bailout payments to solve

$$\max_{\{b^j\}} \quad \int V(\psi_\beta^j; \widehat{\pi}_\beta) d\sigma(j) + v(\tau - b)$$
$$\text{s.t.} \quad \psi_\beta^j = 1 - \tau - \theta c_1^j + b^j \text{ for all } j$$

- The first order condition requires

$$v'(\tau - b) = \mu_\beta^j$$

Bailout Policy

- The solution to this problem must equalize the marginal value of resources μ^j_β across all intermediaries.
- For a given size of the total bailout package b per investor, this entails

$$b^j = b + \theta(c^j_1 - \bar{c}_j) \text{ for all } j$$

where

$$\bar{c}_1 \equiv \int c^j_1 d\sigma(j)$$

- The remaining resources ψ^j_β available to intermediary j will only depend on aggregate conditions

$$\psi^j_\beta = 1 - \tau - \theta\bar{c}_1 + b$$

Distorted Incentives

- Intermediary j will choose payment c_1^j that solves

$$\max_{c_1^j} \quad \theta u(c_1^j) + (1-q)V(1-\tau-\theta c_1^j; \widehat{\pi}_\alpha) + qV(1-\tau-\theta \bar{c}_1 + b; \widehat{\pi}_\beta)$$

- The first-order condition for this problem is

$$u'(c_1^j) = (1-q)V'(1-\tau-\theta c_1^j; \widehat{\pi}_\alpha) = (1-q)\mu_\alpha^j$$

- Notice that the solution to this problem only depends on τ. The solution can then be written as $c_1(\tau)$.
- Also $c_1 < c_{2\alpha}$ is true as long as

$$q < \frac{R-1}{R}$$

Choosing the Tax Rate

- The policy maker will choose the tax rate τ to solve

$$\begin{aligned} \max_{\tau} \quad & \theta u(c_1(\tau)) + (1-q)[V(\psi_\alpha; \widehat{\pi}_\alpha) \\ & \qquad + v(g_\alpha)] + q[V(\psi_\beta; \widehat{\pi}_\beta) + v(g_\beta)] \\ \text{s.t.} \quad & \psi_\alpha = 1 - \tau - \theta c_1(\tau) \\ & \psi_\beta = 1 - \tau\theta a c_1(\tau) + b(\tau) \\ & g_\alpha = \tau \\ & g_\beta = \tau - b(\tau) \end{aligned}$$

- The first-order condition for this problem is

$$v'(\tau) = \mu_\alpha + \frac{q}{1-q}\mu_\beta \theta \frac{dc_1}{d\tau}$$

Equilibrium and Fragility

- Define an economy as $e \equiv (R, \pi, u, v, \theta, q)$
- Let Φ^B denote the set of economies that are fragile under the bailout regime.

Proposition 1: *The financial system is fragile under the bailouts regime if and only if*

$$c_1^B \geq c_{2\beta}^B$$

Proposition 2: *For any $e \in \Phi^B$, we have*

$$(c_{1\beta}^B, c_{2\beta}^B, g_\beta^B) \ll (c_{1\alpha}^B, c_{2\alpha}^B, g_\alpha^B)$$

Equilibrium and Fragility

Numerical Exercise with

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma} \quad \text{and} \quad v(g)\delta\frac{g^{1-\gamma}}{1-\gamma}$$

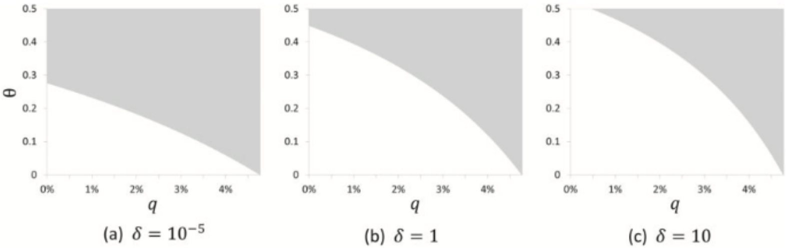


FIGURE 2

The fragile set Φ^B under the bailouts regime

Equilibrium Under No-Bailouts Policy

- The decision for (d) is the same as in the policy with bailouts
- Decision (c) is just

$$b^j = 0 \text{ for all } j$$

Corrected Incentives

- Under a no-bailouts regime, each intermediary must use its own resources to provide consumption to all of its investors in both states.
- Intermediary j will now choose c_1^j to solve

$$\max_{c_1^j} \quad \theta u(c_1^j) + (1-q)V(1-\tau-\tau c_1^j; \widehat{\pi}_\alpha) + qV(1-\tau-\theta c_1^j; \widehat{\pi}_\beta)$$

- The first order condition for this problem is

$$u'(c_1^j) = (1-q)\mu_\alpha + q\mu_\beta$$

Tax Decision

- Since there is no bailout, the entire amount of tax revenue will go into public good in both states

$$g_\alpha = g_\beta = \tau$$

- The first order condition for the tax problem is

$$v'(\tau) = (1-q)\mu_\alpha + q\mu_\beta$$

Equilibrium and Fragility

Proposition 3: *The financial system is fragile under the no-bailouts regime if and only if* $c_1^N \geq c_{2\beta}^N$ *holds.*

Proposition 4: $\rho^N < \rho^B$ *holds for all* $q > 0$*, where*

$$\rho \equiv \frac{\theta c_1}{1 - \tau}$$

Propisition 5: *There exist economies in* Φ^N *that are not in* Φ^B *and vice versa.*

Equilibrium and Fragility

Numerical Exercise with

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma} \quad \text{and} \quad v(g)\delta\frac{g^{1-\gamma}}{1-\gamma}$$

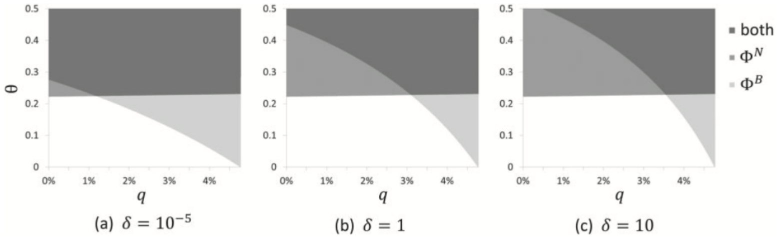


FIGURE 3

Comparing the sets Φ^B and Φ^N

Conclusion

- A strict no-bailouts policy cannot achieve an efficient allocation of resources.
- If bailouts is permitted, policy makers should use prudential policy measures to offset the resulting distortion in incentives (e.g. taxing short term liabilities).

Extensions:

- Keister and Mitkov (2017): Shocks on bank assets
- Keister and Narasiman (2016): Stochastic demand for liquidity

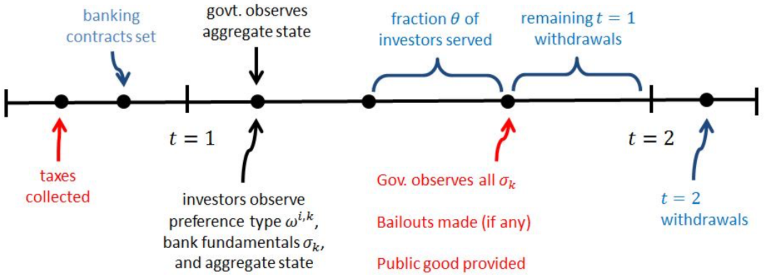
Shocks on Bank Assets

- There is a continuum of banks indexed by $k \in [0, 1]$
- At $t = 1$, $\sigma_k \in \Sigma \equiv \{0, \bar{\sigma}\}$ of the assets by bank k will be revealed to be imparied.
- A bank with $\sigma_k = 0$ is said to have sounds fundamental. A bank with $\sigma_k = \bar{\sigma}$ is said to have weak fundamental.

Aggregate Uncertainty

- There are two aggregate state of the economy: *good* and *bad*.
- In the good state, all banks have sound fundamentals
- In the bad state, a fraction $n \in [0, 1]$ of banks have weak fundamental. The total losses in the financial system are $n\bar{\sigma}$.
- The probability of bad state is q.
- The ex-ante probability that a given bank's fundamental will be weak is qn.

Timeline



Slight modification on sequential service:

- The banks are able to condition payments to all investors on the total demand for early withdrawal.

The Constrained Efficient Allocation

The constrained efficient allocation $(c_{10}^*, c_{20}^*, c_{1S}^*, c_{2S}^*, c_{1W}^*, c_{2W}^*, b_S^*, b_W^*)$ is chosen to maximize

$$\begin{aligned}&(1-q)\big[\pi u(c_{10}) + (1-\pi)u(c_{20}) + v(\tau)\big]\\&+ q\big[(1-n)(\pi u(c_{1S}) + (1-\pi)u(c_{2S})) + n(\pi u(c_{1W}) + (1-\pi)u(c_{2W}))\\&\qquad + v(\tau - (1-n)b_S - nb_W)\big]\end{aligned}$$

subject to feasibility constraints

$$\pi c_{10} + (1-\pi)\frac{c_{20}}{R} \leq 1-\tau$$
$$\pi c_{1S} + (1-\pi)\frac{c_{2S}}{R} \leq 1-\tau + b_S$$
$$\pi c_{1W} + (1-\pi)\frac{c_{2W}}{R} \leq 1-\tau + b_W$$

and restrictions on further taxation

$$b_S \geq 0 \quad \text{and} \quad b_W \geq 0$$

The Constrained Efficient Allocation

Proposition 1: *The constrained efficient allocation satisfies*

$$(c_{10}^*, c_{20}^*) = (c_{1S}^*, c_{2S}^*) \quad \text{and} \quad b_S^* = 0$$

Proposition 2: *The constrained efficient allocation satisfies*

$$(c_{1S}^*, c_{2S}^*) \gg (c_{1W}^*, c_{2W}^*) \quad \text{and} \quad b_W^* > 0$$

Moral Hazard

- Similar to Keister (2016), the bailout amount b_W^k given to a bank with weak fundamental is an increasing function of the payment c_{1W}^k made by the bank.
- When banks with weak fundamentals are expecting a bailout from the policy maker, they have an additional incentive to make higher payments c_{1W}^k.
- This is referred to as "bailouts crowding out bail-ins".

Moral Hazard

Proposition 8: *The equilibrium allocation of resources is never constrained efficient.*

Macroprudential Policies

- Restricting early payments
- Increasing the tax rate
- Eliminating bailouts

Stochastic Demand for Liquidity

Keister and Narasiman (2016):

- The probability of each investor being impatient π is stochastic.

$$\pi = \begin{cases} \pi_L & \text{in state Ł} \\ \pi_H & \text{in state } H \end{cases}$$

- There are four states $S = \{L_\alpha, L_\beta, H_\alpha, H_\beta\}$.
- The policy maker can monitor a fraction $\sigma \in [0, 1]$ of the payments in $t = 1$.

Timeline

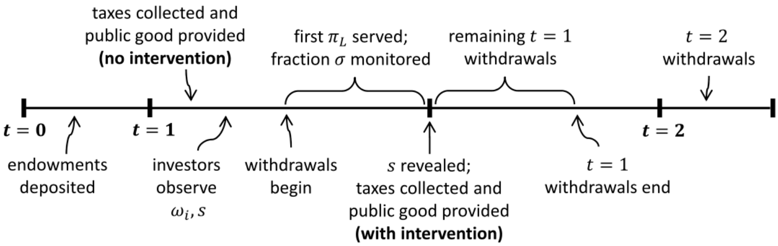


Fig. 1. Timeline of events.

Runs and Fragility

Definition 1: *An economy is weakly fragile if there is an equilibrium in which depositors play strategy profile*

$$y_i(\omega_i, s) = \begin{cases} \omega_i & \text{for } s = L, H_\alpha \\ 0 & \text{for } s = H_\beta \end{cases}$$

Definition 2: *An economy is strongly fragile if the only equilibrium profile of withdrawal strategies is*

$$y_i(\omega_i, s) = \begin{cases} \omega_i & \text{for } s = L \\ 0 & \text{for } s = H \end{cases}$$

Definition 3: *An economy is not fragile if the only equilibrium profile of withdrawal strategies is the no-run profile*

$$y_i(\omega_i, s) = \omega_i \text{ for all } s$$

Utility Functions

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma}$$

$$v(g) = \delta \frac{g^{1-\gamma}}{1-\gamma}$$

Comparing Policy Regimes

Proposition 6: *For any e with* $\delta > 0$*, there exists* $\bar{\sigma} < 1$ *such that allowing intervention strictly increases equilibrium welfare for all economies* (e, σ) *with* $\sigma > \bar{\sigma}$*.*

Proposition 7: *For any economy with* $\delta = 0$ *and* $\sigma < 1$*, allowing intervention strictly decreases equilibrium welfare.*

Numerical Exercises

An economy that is weakly fragile with no intervention:
$R = 1.05, \pi_L = 0.45, \pi_H = 0.55, q_{H_\alpha} = q_{H_\beta} = 0.02, \gamma = 4$

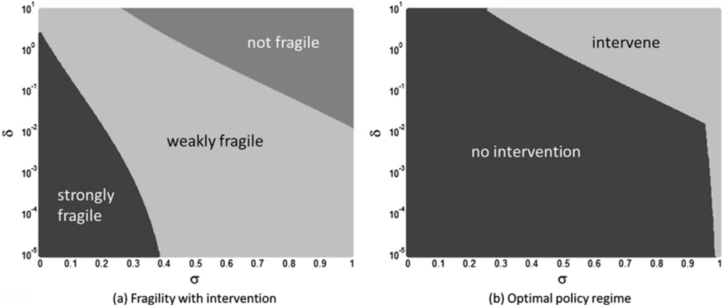
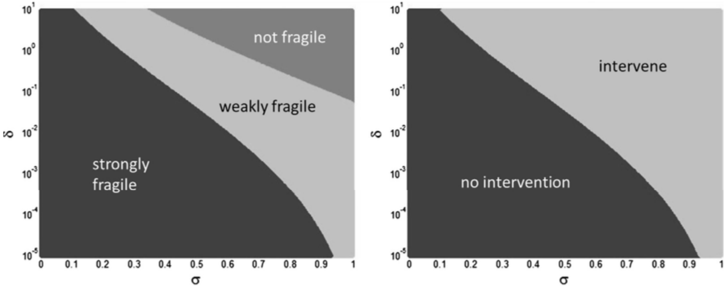


Fig. 2. An economy that is weakly fragile with no intervention.

Numerical Exercises

An economy that is strongly fragile with no intervention:
$R = 1.05, \pi_L = 0.45, \pi_H = 0.65, q_{H_\alpha} = q_{H_\beta} = 0.02, \gamma = 4$



(a) Fragility with intervention
(b) Optimal policy regime

Fig. 3. An economy that is strongly fragile with no intervention.

Numerical Exercises

An economy that is not fragile with no intervention:
$R = 1.05, \pi_L = 0.45, \pi_H = 0.55, q_{H_\alpha} = q_{H_\beta} = 0.02, \gamma = 2$

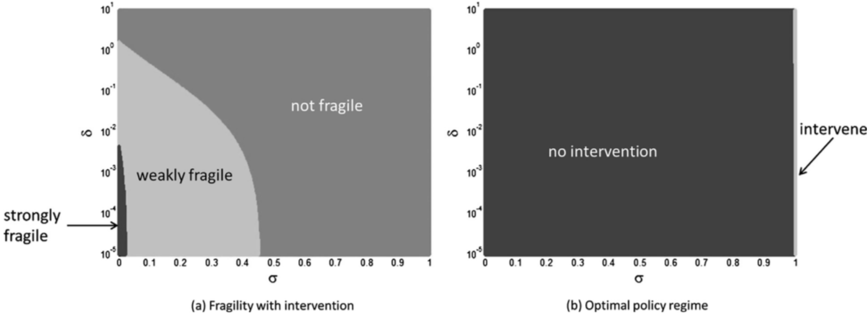


Fig. 4. An economy that is not fragile with no intervention.

Conclusion

- The model captures the fact that a bank run may be driven by expectations or fundamentals.
- Regardless of the cause of the bank run, there is no definite answer as to which policy regime works better.
- Intervension should be permitted only when prudential regulation and supervision are sufficiently effective.
- In particular, this is when the insurance benefit from bailouts outweighs the resulting incentive distortion.