Banking Panics and Policy Responses

Huberto M. Ennis
Federal Reserve Bank of Richmond

Todd Keister
Federal Reserve Bank of New York
& EUI

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Banking panics

- Financial crises often involve:

  (1) a *run* (i.e. large, sustained withdrawals) by depositors/investors

  (2) repeated responses/interventions by policy makers

In the recent crisis:

(1) Many events have resembled a bank run

- much "banking" activity (esp. maturity transformation) now takes place outside of commercial banks

- asset-backed commercial paper, auction-rate securities, money-market funds, investment banks, etc.

- These runs are often thought to be "self-fulfilling" in nature
  - J.P. Morgan during crisis of 1907: *If the people will keep their money in the banks everything will be all right."*
  - Lucas (2008): *"A fractional reserve banking system will always be fragile... with two possible equilibria."*

    "The economics of the 'credit freeze' that happened to Bear Sterns, then to Lehmann Brothers, seems to me identical to the economics of the 1930s bank runs."
  - Also see speeches and testimony of Bernanke, others

⇒ What are the underlying causes of these runs?

  - what features of the environment make self-fulfilling runs possible?

(2) New policy responses/interventions as the crisis worsened

- For example, Federal Reserve reactions included:
  - Fall 2007: large open market operations, Term Auction Facility
  - Spring 2008: Primary Dealer Credit Facility, Term Securities Lending Facility
  - Fall 2008: new credit facilities (AIG, MMIFF, TALF, etc.)

- Policy decisions often appear to be made *ex post*, as events unfold
  - policy makers are not following a pre-specified plan of action

$\Rightarrow$ would like our models to capture this feature

Our approach

- We study a model where the withdrawal decisions of depositors and the responses of policy makers are jointly determined
  - A standard Diamond-Dybvig model, *except* policy maker cannot commit to a plan of action
- Existing literature on bank runs assumes (implicitly) commitment to banking contracts
  - questionable assumption, especially during times of crisis
  - once a run is underway, *ex ante* optimal plans may be *ex post* inefficient (Ennis and Keister, 2009)

- We ask:
  - what do time-consistent banking policies look like during a panic?
  - are such policies consistent with a self-fulfilling run by depositors?
  - how does a lack of commitment by policy makers:
    - affect the *possibility* of self-fulfilling bank runs?
    - shape the *course* of a crisis?

- We show:
  - self-fulfilling runs can occur (with no restrictions on contracts)
  - these runs involve interesting "policy dynamics":
    waves of withdrawals, each followed by a new policy response

Outline

- The model
  - follows Diamond-Dybvig, with updates
- Definitions of equilibrium, with and without commitment
- Equilibrium with commitment (old)
- Equilibrium without commitment (new)
  - construct run equilibria
  - examine the “wave” structure of equilibrium
- Concluding remarks

The model

- 3 time periods, $t = 0, 1, 2$
- Continuum of depositors, $i \in [0, 1]$
  - endowment: 1 at $t = 0$, nothing later
  - utility:
  $$u(c_1, c_2; \theta_i) = \frac{[c_1 + (\theta_i - 1)\, c_2]^{1-\gamma}}{1-\gamma} \qquad \gamma > 1$$
  where $\theta_i \in \Theta \equiv \{1, 2\}$; if $\theta_i = 1$ depositor is "impatient"
  - type θ_i is revealed at $t = 1$; private information
  - ex-ante probability π of being impatient
  - (known) fraction π of depositors will be impatient

- Investment technology
  - investing 1 at $t = 0$ yields $\left\{ \begin{array}{c} 1 \\ R > 1 \end{array} \right\}$ at $t = \left\{ \begin{array}{c} 1 \\ 2 \end{array} \right\}$

- Let $\left(c_1^*, c_2^*\right)$ denote (full information) first-best allocation
  - simple, because there is no aggregate uncertainty
  - $\gamma > 1$ implies $c_1^* > 1$ (potential for *illiquidity* at $t = 1$)
  - $c_2^* > c_1^* \rightarrow$ partial insurance

- Depositors have an incentive to pool their endowments for insurance purposes

Banking

- Banking technology $\longrightarrow$ allows depositors to pool resources and invest at $t = 0$ and receive payments at $t = 1, 2$

- Sequential service constraint (formally): Depositors ...

  – are isolated from each other (as in Wallace, 1988)

  – can visit "the bank" only one at a time

  – must be paid as they arrive (first-come, first-served)

  – order of withdrawal opportunity is given by index i

  – depositors know this order (as in Green and Lin, 2000)

- Each depositor visits the bank in either $t = 1$ or $t = 2$

- Operation of bank is characterized by a *payment schedule*:

$$x : [0,1] \rightarrow \mathbb{R}_+$$

  - μ^{th} depositor to arrive at $t = 1$ receives $x(\mu)$
  - depositors withdrawing at $t = 2$ divide matured assets evenly

- Note: some of the payments may not be made
  - x is a complete contingent plan; the *banking policy*

- Feasibility

$$\int_0^1 x(\mu)\, d\mu \leq 1$$

Strategies and payoffs

- Each depositor chooses a *withdrawal strategy* $y_i : \Theta \to \{1, 2\}$
  - depositors always withdraw at $t = 1$ if impatient $\Rightarrow$ $y_i(1) = 1$
  - depositor i *runs* if $y_i(2) = 1$, does *not* run if $y_i(2) = 2$

- Together, x and y determine $\left(c_{1,i}, c_{2,i}\right)$ for all i
  - individual (indirect) expected utility: $v_i(x, y)$

- Aggregate welfare:

$$U(x, y) = \int_0^1 v_i(x, y)\, di$$

Depositors' game

- Given a banking policy x
  - depositors play a non-cooperative, simultaneous-move game

- Equilibrium of the *depositors' game* is a profile $\widehat{y}(x)$ such that

$$v_i\left(x, (\widehat{y}_{-i}, \widehat{y}_i)\right) \geq v_i\left(x, (\widehat{y}_{-i}, y_i)\right) \;\; \forall \; y_i, \;\; \forall \; i$$

- Let $\widehat{Y}(x) =$ set of equilibria associated with policy x
  - potentially a correspondence due to multiple equilibria

- A *run* occurs if a positive mass of depositors choose $\widehat{y}_i(2) = 1$

Overall banking game

- Policy x chosen by a benevolent banking authority to maximize welfare U
  - the banking authority is a player in the game
  - no restrictions on x other than feasibility
- We allow withdrawals decisions conditioned on extrinsic "sunspot" variable $s \in [0, 1]$
  - observed by depositors, but not by banking authority (Cooper and Ross, 1998, and many others)
  - a type of asymmetric-information correlated equilibrium
- Equilibrium of the overall banking game depends on *when* x is chosen

- Equilibrium with commitment
  - banking authority sets x at $t = 0$; cannot be revised (an ATM)
  - depositors then choose y_i (in a proper subgame) $\Rightarrow$ consider subgame perfect equilibria

- Equilibrium without commitment
  - each payment is determined as the withdrawal occurs
  - in setting $x(\mu)$ the banking authority recognizes that:
    - actions of all previous depositors have been taken
    - decisions of remaining depositors are not influenced by $x(\mu)$
  - in other words: banking authority takes strategy profile y as given when choosing x (as in Cooper's 1999 book)

Definitions of equilibrium

- An *equilibrium with commitment* is a pair $(x^*, y^*(x))$ such that: (1) $y^*(x,s) \in \widehat{Y}(x)$ for all x and s; and (2)

$$x^* = \arg\max \int_0^1 U\left(x, y^*(x,s)\right) ds$$

$\Rightarrow$ the banking authority recognizes the influence of x on the equilibrium play in the depositors' game

- An *equilibrium without commitment* is a pair (x^*, y^*) such that: (1) $y^*(s) \in \widehat{Y}(x^*)$ for all s; and (2)

$$x^* = \arg\max \int_0^1 U\left(x, y^*(s)\right) ds$$

$\Rightarrow$ the banking authority chooses best response to given strategies y^*

Equilibrium with commitment

- Unique equilibrium outcome: first-best allocation; no bank runs

- One equilibrium policy

$$x^*(\mu) = \left\{ \begin{array}{ll} c_1^* & \text{for } \mu \in [0, \pi] \\ 0 & \text{otherwise} \end{array} \right\}$$

  – suspension of payments after π withdrawals

- Patient depositors are assured $c_2^* > c_1^*$, regardless of actions of others

  – waiting to withdraw is a dominant choice: $y_i^*(\theta_i) = \theta_i$

  – suspension never occurs (off-equilibrium)

Why commitment might matter (Ennis and Keister, 2009)

- With commitment, banking authority can threaten drastic response to a run
  - suspend all payments; save resources for $t = 2$
  - threat never needs to be carried out in equilibrium
- Without commitment, response to a run must be *ex post* optimal
  - some depositors still in line are (truly) impatient
  - temptation to make additional payments at $t = 1$
  - but ... additional payments threaten solvency

Suspension in the U.S. in 1933

- Policy makers seemed reluctant to suspend payments as crisis unfolded
  - fear that suspension would further disrupt real activity
  - directors of NY Fed urged Hoover to declare a nationwide banking holiday, but Hoover refused

- Payments were eventually suspended, but ...

  "Suspension occurred after, rather than before, liquidity pressures had produced a wave of bank failures without precedent."
  (Friedman & Schwartz, 1963)

Suspension in Argentina in 2001

- System-wide run occurred on November 28-30, 2001
  - Total deposits fell 4.3% ($3.1 billion)

- Suspension of payments declared on December 1, but...
  - depositors could withdraw up to 1000 pesos/month/account
  - could also petition courts citing "special needs"

- Over next 6 months: 25% of remaining deposits withdrawn

Point:

- Suspending payments may be difficult/undesirable *ex post*

Equilibrium without commitment

- The first-best allocation is still *an* equilibrium outcome
  - if $y_i^*(\theta_i) = \theta_i$ then best response is $x^*(\mu) = c_1^*$ for $\mu \in [0, \pi]$
    - ◦ patient depositors receive $c_2^* > c_1^*$ at $t = 2$

$\Rightarrow$ lack of commitment does not affect the "no run" equilibrium

- ◦ different from "standard" time-inconsistency problem

Q: Are there other equilibria?

No full-run equilibrium

- There is no equilibrium with $y_i = 1$ for all i and all s
  - banking authority would set $x(\mu) = 1$ for all μ
  - then a patient depositor who waits would receive $R > 1$

$\Rightarrow$ A full run cannot occur if the banking authority expects one

- Need to capture:
  - banking authority is initially uncertain if depositors are running
  - makes inferences from "flow" of withdrawals

Q: Can there be an equilibrium where *all* depositors run with some probability?

- Suppose:

$$y_i(\theta_i, s) = \left\{ \begin{array}{cc} \theta_i & \text{for } s > \alpha \\ 1 & \text{for } s \leq \alpha \end{array} \right\} \text{ for some } \alpha, \text{ for all } i$$

  – depositors run if $s \leq \alpha$, but not if $s > \alpha$

  $\Rightarrow$ run occurs with probability α

  – type of strategy studied in Cooper & Ross (1998), Peck & Shell (2003) and others

A: No. Banking authority's best response:

- initially uncertain if depositors are running, choose some c_1
- if more than π withdrawals, a run is underway

⇒ divide remaining resources evenly (*reschedule* payments)

$$x(\mu) = \left\{ \begin{array}{c} c_1 \\ \frac{1-\pi c_1}{1-\pi} \end{array} \right\} \text{ for } \left\{ \begin{array}{c} \mu \in [0,\pi] \\ \mu > \pi \end{array} \right\}$$

- But the a patient depositor with $i > \pi$ receives

$$\left\{ \begin{array}{c} \frac{1-\pi c_1}{1-\pi} \\ R\left(\frac{1-\pi c_1}{1-\pi}\right) \end{array} \right\} \text{ if she } \left\{ \begin{array}{c} \text{runs} \\ \text{waits} \end{array} \right\}$$

  - waiting is better ⇒ this is <u>not</u> an equilibrium

- There cannot be an equilibrium in which *all* depositors run in some state
  - eventually the banking authority will find out
  - reacts in a way that removes the incentive to run
    - different from “run-proof contracts” in existing literature
  - note the interplay between withdrawal decisions and policy responses
- An equilibrium bank run must be *partial*, with only some depositors participating

- One possibility:

$$\text{For } s > \alpha: \quad y_n = \theta_i \qquad \text{for all } i$$

$$\text{For } s \leq \alpha: \quad y_n = \begin{Bmatrix} 1 \\ \theta_i \end{Bmatrix} \quad \text{for} \begin{Bmatrix} i \leq \pi \\ i > \pi \end{Bmatrix}$$

- Then banking authority's best response is:

$$x(\mu) = \begin{Bmatrix} c_1 \\ \widehat{c}_1 \end{Bmatrix} \text{ for } \begin{Bmatrix} \mu \in [0, \pi] \\ \mu > \pi \end{Bmatrix}$$

  - where $(\widehat{c}_1, \ \widehat{c}_2)$ is the best *continuation* payment schedule
  - note: $\widehat{c}_1 > \frac{1-\pi c_1}{1-\pi}$ (liquidity insurance)

- The partial-run strategy profile is an equilibrium if

$$c_1 > \widehat{c}_2 \ \ (> \widehat{c}_1)$$

Prop. 1: A partial run equilibrium exists (under some conditions)

- A "wave" of withdrawals, then policy response halts the run

- Note: a self-fulfilling bank run equilibrium exists without either:
  - restrictions on the banking policy [as in Cooper & Ross (1998), Chang & Velasco (2000), Ennis & Keister (2003), many others]
  - aggregate uncertainty about withdrawal demand [as in Peck & Shell (2003), Green & Lin (2003), Ennis & Keister (2008)]

  $\Rightarrow$ this is NEW

Key elements:

- Banking authority is initially "optimistic"
  - probability of run is not too large
  - sets $x(\mu) = c_1 > 1$ for $\mu \in [0, \pi]$
- Bank remains optimistic through π withdrawals
- After π withdrawals, discovers a run is underway
  - responds by adjusting payments
  - at that point run halts, but ...
  - all remaining depositors receive less than c_1

Waves of withdrawals and policy responses

- Other, richer equilibria exist under *same* conditions

- After π withdrawals, run continues with some (small) probability

  – banking authority is optimistic run has stopped

    $\Rightarrow$ sets $\widehat{c}_1$ relatively high; banking system is illiquid (again)

    $\Rightarrow$ opens the door to the possibility that the run continues

- After $\pi + \pi(1 - \pi)$ withdrawals, discovers whether run has stopped

  – if not, reduces early payment further

- Could repeat any number of times

Prop. 2: Given any $\lambda < 1$, there exists an equilibrium where $t = 1$ withdrawals exceed λ with positive probability.

- The value of λ determines the number of waves

- Interesting "dynamics":
  - crisis develops gradually, in waves
  - each wave of withdrawals provokes a policy reaction
  - after each reaction, run may end or may deepen
  - the bank never completely fails at $t = 1$; some payments made at $t = 2$

- Small crises are more frequent than large crises

- Note: the banking authority is always “optimistic”
  - initially believes a run is unlikely
  - at each decision point, is optimistic that the run has ended
- Reminiscent of the summer 2008
  - Mishkin in July 2008: “The period of extreme stress seems to have abated, and financial markets are showing some tentative signs of revival.”
- This is an *inherent* feature of equilibrium
  - policy maker correctly anticipates the probability that conditions will worsen; responds appropriately.
  - when (and only when) this probability is small enough, the response leaves the door open for the crisis to deepen

Conclusion

- Removing the assumption of commitment from the canonical banking model shows:
  - self-fulfilling bank runs can occur
  - these runs involve waves of withdrawals and policy responses
  - interplay between depositors' decisions and policy makers' responses shapes the course of the crisis

- Main insight: lack of commitment combined with (rational) optimism may be at the root of the "bank run" problem

Open questions:

- Are government guarantees (incl. deposit insurance) a good solution to the problem?

- What are the effects of bailout policies on incentives and behavior?

- How important are dynamic considerations (i.e., reputation)?

Future work: Institutions and “credibility” in banking policy