Banking Panics and Policy Responses

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EUI Macro Workshop  
January 2010
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 \textit{ex post}, as events unfold
  
  – policy makers are not following a pre-specified plan of action

⇒ 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:
    $$u(c_1, c_2; \theta_i) = \frac{[c_1 + (\theta_i - 1)c_2]^{1-\gamma}}{1 - \gamma} \quad \gamma > 1$$
    where $\theta_i \in \Theta \equiv \{1, 2\}$; if $\theta_i = 1$ depositor is “impatient”
  - type $\theta_i$ is revealed at $t = 1$; private information
  - ex-ante probability $\pi$ of being impatient
  - (known) fraction $\pi$ of depositors will be impatient
• Investment technology

  – investing 1 at \( t = 0 \) yields \( \left\{ \frac{1}{R > 1} \right\} \) at \( t = \begin{pmatrix} 1 \\ 2 \end{pmatrix} \)

• Let \( (c_1^*, c_2^*) \) denote (full information) first-best allocation

  – simple, because there is no aggregate uncertainty

  – \( \gamma > 1 \) implies \( c_1^* > 1 \) (potential for illiquidity at \( t = 1 \))

  – \( c_2^* > c_1^* \rightarrow \text{partial insurance} \)

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

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Banking

• Banking technology → 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:

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

- \( \mu^{th} \) 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 $y_i : \Theta \rightarrow \{1, 2\}$
  - 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 $(c_{1,i}, c_{2,i})$ 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 \( \hat{\gamma}(x) \) such that

\[
v_i \left( x, \left( \hat{\gamma}_{-i}, \hat{\gamma}_i \right) \right) \geq v_i \left( x, \left( \hat{\gamma}_{-i}, y_i \right) \right) \ \forall \ y_i, \ \forall \ i
\]

• Let \( \hat{\gamma}(x) \) = set of equilibria associated with policy \( x \)
  
  – potentially a correspondence due to multiple equilibria

• A run occurs if a positive mass of depositors choose \( \hat{\gamma}_i(2) = 1 \)
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. \(y^*(x, s) \in \hat{Y}(x)\) for all \(x\) and \(s\); and
  2. \(x^* = \arg \max \int_0^1 U(x, y^*(x, s)) \, ds\)

  \(\Rightarrow\) 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. \(y^*(s) \in \hat{Y}(x^*)\) for all \(s\); and
  2. \(x^* = \arg \max \int_0^1 U(x, y^*(s)) \, ds\)

  \(\Rightarrow\) 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

\[ x^* (\mu) = \begin{cases} 
  c_1^* & \text{for } \mu \in [0, \pi] \\
  0 & \text{otherwise}
\end{cases} \]

  – suspension of payments after \( \pi \) 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 $\mu$
  - 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:

\[ y_i(\theta_i, s) = \begin{cases} 
\theta_i & \text{for } s > \alpha \\
1 & \text{for } s \leq \alpha 
\end{cases} \]

for some \( \alpha \), for all \( i \)

- depositors run if \( s \leq \alpha \), but not if \( s > \alpha \)

\[ \Rightarrow \text{run occurs with probability } \alpha \]

- 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 $\pi$ withdrawals, a run is underway

$\Rightarrow$ divide remaining resources evenly (reschedule payments)

$$x(\mu) = \begin{cases} 
\frac{c_1}{1-\pi} & \text{for } \mu \in [0, \pi] \\
\frac{1-\pi c_1}{1-\pi} & \text{if } \mu > \pi
\end{cases}$$

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

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

- waiting is better $\Rightarrow$ this is not an equilibrium

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• 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:

For \( s > \alpha \) : \( y_n = \theta_i \) for all \( i \)

For \( s \leq \alpha \) : \( y_n = \left\{ \begin{array}{ll}
1 \\
\theta_i \\
i \leq \pi \\
i > \pi
\end{array} \right. \) for \( \left\{ \begin{array}{l}
i \leq \pi \\
i > \pi
\end{array} \right. \)

• Then banking authority’s best response is:

\[
x(\mu) = \left\{ \begin{array}{ll}
c_1 \\
\hat{c}_1 \end{array} \right. \quad \text{for} \quad \left\{ \begin{array}{l}
\mu \in [0, \pi] \\
\mu > \pi
\end{array} \right. 
\]

– where \((\hat{c}_1, \hat{c}_2)\) is the best \textit{continuation} payment schedule

– note: \(\hat{c}_1 > \frac{1-\pi c_1}{1-\pi}\) (liquidity insurance)
• The partial-run strategy profile is an equilibrium if

\[ c_1 > \hat{c}_2 (> \hat{c}_1) \]

**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]
  

⇒ 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 \( \pi \) withdrawals

- After \( \pi \) 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 $\pi$ withdrawals, run continues with some (small) probability
  
  - banking authority is optimistic run has stopped
    
    $\Rightarrow$ sets $\hat{c}_1$ 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 $\lambda$ with positive probability.

- The value of $\lambda$ 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