Information Acquisition in Rumor-Based Bank Runs

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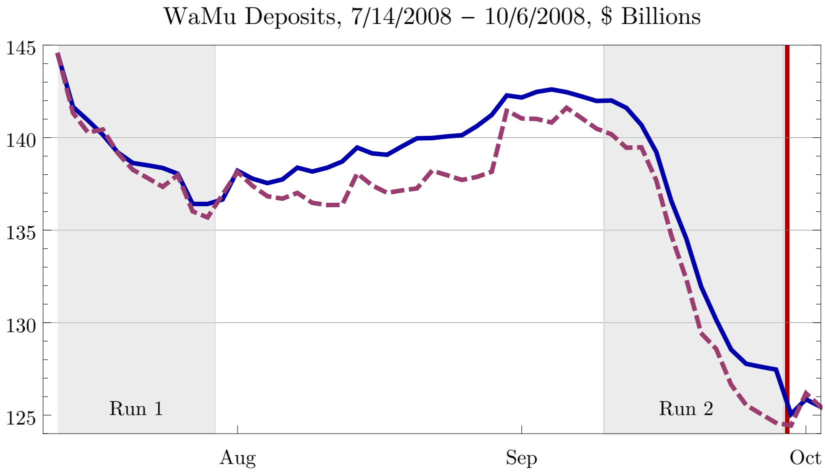
Bank Runs on WaMu in 2008



Stylized Features of Bank Runs in Modern Age

- Stylized features of Wamu bank runs:
  - First run July 2008, lasting about 20 days. **Rumor** is spreading online, but never made public
  - Wamu survived the first run, followed by deposit inflows
  - In the second fatal run in September 2008, **uncertainty** about bank liquidity played a key role
  - Deposit withdrawals are gradual
  - Worried depositors (even covered by FDIC insurance) scramble for information; then some withdrew immediately while others wait
- Same empirical features in recent runs on shadow banks (ABCP runs in 2007, European Debt Crisis in 2011)

Overview of the Result

- A dynamic bank run model with endogenous information acquisition about liquidity
  - **rumor**: signal about bank liquidity lacking a discernible source
  - additional information acquisition upon hearing the rumor
- We emphasize the role of acquiring informative but noisy information
  - Without information acquisition, either there is no run, or in run equilibrium depositors never wait (i.e. withdraw immediately) upon hearing the rumor
  - With information acquisition, in bank run equilibrium depositors with medium signal withdraw after an endogenous amount of time

Overview of the Result

- Information acquisition about liquidity may lead to bank run equilibrium thus inefficient
  - Suppose without information acquisition bank run equilibrium does not exist⇒ depositors never withdraw
  - With information acquisition, medium-signal depositors worry about some depositors who get bad signal and runs immediately
  - This "fear-of-bad-signal-agents" pushes medium-signal agents to withdraw after certain endogenous time
- Public information provision can crowd out inefficient private information acquisition

Related Literature

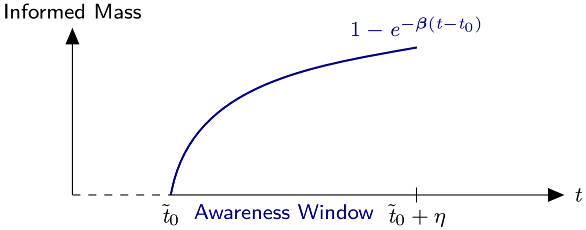
- Diamond and Dybvig (1983), Chari and Jagannathan (1988), Goldstein and Pauzner (2005), Ennis and Keister (2008), Nikitin and Smith (2008), etc
- Green and Lin (2003), Peck and Shell (2003), Gu (2011), etc
- He and Xiong (2012), Achaya, Gale, and Yorulmazer (2011), Martin, Skeie, and von Thadden (2011) etc
- Abreu and Brunnermeier (2002, 2003)

Bank Deposits

- Infinitely lived risk-neutral depositors with measure 1
- Bank deposits grow at a positive rate r, while cash under the mattress yields zero
  - r can be broadly interpreted as a convenience yield
  - to ensure bounded values, bank assets mature at Poisson event with rate δ
- Bank is solvent, but fails if $\tilde{\kappa}$ measure of depositors withdraw
  - we introduce uncertainty in $\tilde{\kappa}$ to capture uncertain bank liquidity
- If bank fails, each dollar inside the bank recovers $\gamma \in (0, 1)$

Liquidity Event and Spreading Rumors

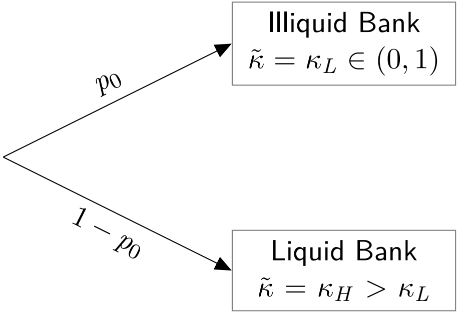
- *Liquidity event* hits at an unobservable random time $\tilde{t}_0$ exponentially distributed: $\phi(t_0) = \theta e^{-\theta t_0}$
  - 2007/08 crisis, banks have opaque exposure to MBS and hit by adverse shocks of real estate
- Bank **may** become illiquid and a ***rumor*** starts spreading:
  - "the liquidity event $\tilde{t}_0$ has occurred so the bank might be illiquid;" but nobody knows the exact time of $\tilde{t}_0$



  - rumor: unverified info of uncertain origin that spreads gradually

Uncertainty about Bank Liquidity

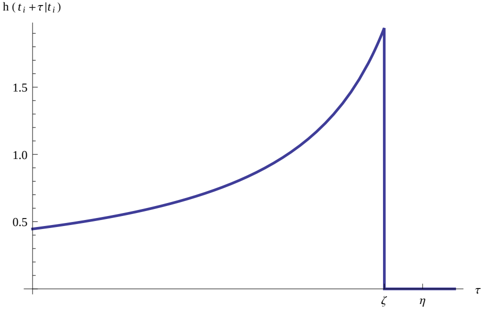
- Bank initially liquid, but may become illiquid after $\tilde{t}_0$
  - Uninformed agents not running the bank (verified later)
- Bank liquidity $\tilde{\kappa}$ can take two values:



  - $\kappa_H < 1$ but sufficiently high to rule out rumor-based runs
- Once revealed to be liquid, agents *redeposit* their funds

Learning and Withdrawal

- Agent t_i's information set at t: $\mathcal{F}_t^{t_i} = \left\{ t_i, t, \tilde{y}_{t_i}, \mathbf{1}_t^{BF} \right\}$
  - $\mathbf{1}_t^{BF}$ is bank failure indicator, $\tilde{y}_{t_i}$ is agent specific signal
- $\tau = t - t_i$, ζ: equilibrium survival time of illiquid bank
- Failure hazard rate $h(\tau) = \Pr(fail\ at\,[\tau, \tau + dt] | \text{survive at } \tau)$



- Proposition. *Given survival time ζ, threshold strategy, i.e. withdraw after τ_w, is optimal.*

Individual Optimality: When to Withdraw?

- Withdrawal decision trades-off bank failure vs growth
- Optimal withdrawal time $\tau_w \geq 0$ satisfies FOC:

$$\underbrace{h\left(\tau_w\right)}_{\text{failure hazard}} \times \underbrace{(1-\gamma)}_{\text{expected loss}} = \underbrace{r}_{\text{convenience yield}} \times \underbrace{V_O\left(\tau_w\right)}_{\text{value of a dollar outside the bank}}$$

- Given conjectured bank survival time ζ, the above FOC only depends on $\zeta - \tau_w$:

$$g\left(\zeta - \tau_w\right) = 0$$

  - If ζ goes up by Δ, τ_w goes up by Δ: if banks survive longer, why don't I wait longer?
  - Stationarity: my extra waiting time is exactly the incresed bank survival time

Aggregate Withdrawal Condition

- Failure occurs when aggregate withdrawals reach the illiquid bank's capacity:

$$\int_{t_0}^{t_0+\zeta-\tau_w} \beta e^{-\beta(t_i-t_0)} dt_i = 1 - e^{-\beta(\zeta-\tau_w)} = \kappa_L.$$

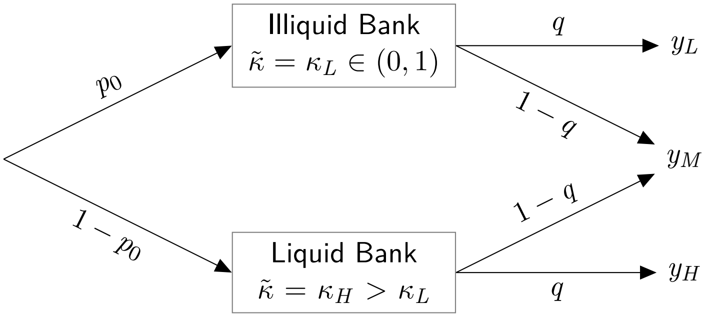
- Again, as in individual optimality condition, the aggregate withdrawal condition only depends on $\zeta - \tau_w$
- Except in knife-edge cases, "aggregate withdrawal" and "individual optimality" conditions have different solutions for $\zeta - \tau_w$
- It has important implications for bank run equilibrium without information acquisition

No Endogenous Waiting in Bank Runs

- Generically, either bank runs never occur, or bank runs occur without waiting so $\tau_w = 0$
  - Suppose the conjectured bank survival time is ζ. Aggregate withdrawal condition gives $\zeta - \tau_w$
  - Suppose individual optimality condition $g\left(\zeta - \tau_w\right) > 0$ so that every agent postpones withdrawal. Say$\tau_w + \Delta$ is optimal
  - Aggregate withdrawal condition says the new survival time becomes $\zeta + \Delta$!
  - Then the individual optimality condition says agents should wait $\tau_w + 2\Delta$, and so on so forth...
  - In equilibrium, no bank run occurs
  - If $g\left(\zeta - \tau_w\right) < 0$, then bank run occurs, but the above argument pushes $\tau_w = 0$

The Model with Information Acquisition

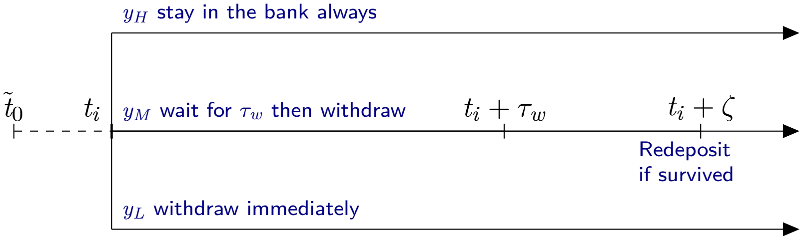
- Each agent, upon hearing the rumor, acquires an additional signal with quality q at some cost $\chi > 0$



- Pr. q perfect signals (y_H or y_L); Pr. $1 - q$ uninformative (y_M)

Individually Optimal Withdrawal

- y_L agents immediately withdraw upon hearing the rumor, y_H agents never withdraw
- y_M agents wait some endogenous time $\tau_w > 0$



Modified Aggregate Withdrawal Condition

- Introduction of noisy signals changes the aggregate withdrawal condition

$$q\left(1-e^{-\beta\zeta}\right)+(1-q)\left(1-e^{-\beta(\zeta-\tau_w)}\right)=\kappa_L$$

- Conditional on illiquid bank, y_L agents are running over $[0,\zeta]$ but y_M agents running over $[\tau_w,\zeta]$
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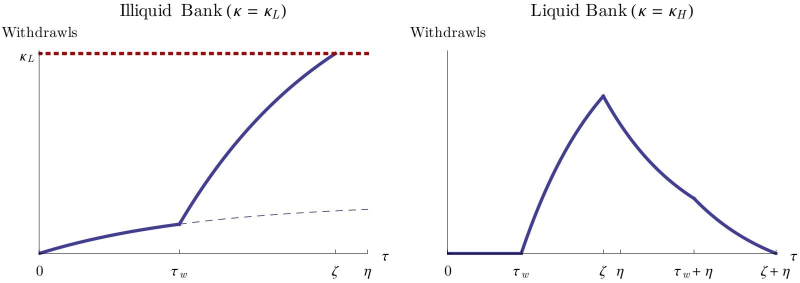
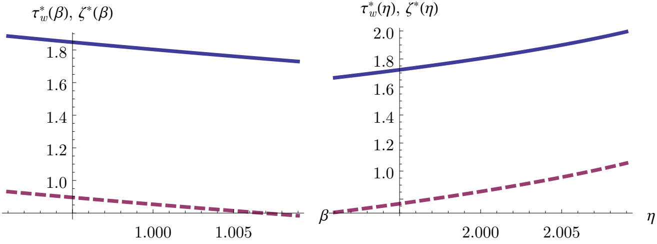


Bank Run Equilibrium with Waiting

- y_M's withdrawal decision: bank failure vs. r growth
- Suppose all y_M agents withdraw immediately ($\tau_w = 0$), then
  - few y_L agents have withdrawn, takes longer to fail
  - longer remaining survival time $\zeta - \tau_w$, lower failure hazard
- When wait longer $\tau_w \uparrow$, y_M agents know that more and more y_L agents have withdrawn before them
  - shorter remaining survival time $\zeta - \tau_w$, higher failure hazard
  - the effect of "fear-of-bad-signal-agents"

Comparative Statics

- Suppose agent can choose precision q at some convex cost
- What is the impact of rumor spreading rate β and awareness window η on equilibrium outcomes?



- Counter-intuitive: when the awareness window widens and potentially more agents run, the illiquid bank survives longer

Key *The agent who hears the rumor also observes the bank is alive*

- Conditional on the bank surviving this long, the bank is more likely to be liquid

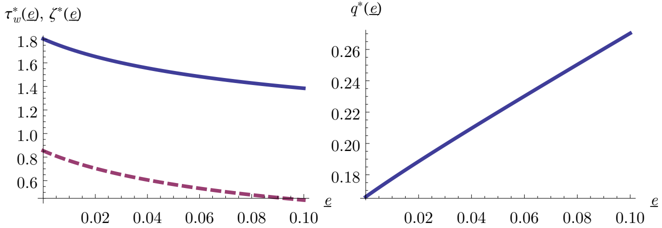
Strategic Substitution vs Strategic Complementarity

- Our model features strategic complementarity between information acquisition
  - Two equilibria: either no-acquisition-no-run, or acquisition-and-run
- Strategic complementarities in bank runs!
- But, we have strategic substitution in information acquisition as well
  - The mere bank survival is a public signal in our dynamic model
  - When other agents learn more, bank survival becomes a better information for bank liquidity
  - Thus individual agents acquire less information
- This strategic substitution effect is behind the counter-intuitive awareness window result

Extension: Insolvent Banks and Stress Tests

- Suppose that bank can also be insolvent
- Upon hearing the rumor, the agent can spend effort $\underline{e}$ to know whether the bank is solvent (full revelation)
- Studying *solvency* inevitably tells us something about *liquidity*
  - the baseline quality of liquidity signals $\tilde{y}$ becomes $\underline{e}$ by uncovering insolvency
  - then, agents can further choose $q > \underline{e}$ with cost $\frac{\alpha}{2}\left(q - \underline{e}\right)^2$
- A high $\underline{e}$ triggers the bank run equilibrium
  - agents study hard to detect insolvent banks, but also learn something about bank liquidity
  - if others know a lot about liquidity, bank runs are possible and I want to learn more as well

Policy Implication: Stress Tests



- Public provision of solvency information (lower $\underline{e}$) can mitigate bank runs by crowding-out individual depositors' effort to acquire liquidity information

Extension: Switching between Two Banks

- Often agents move funds from weak banks to stronger ones. Highly inefficient.
  - instead of keeping cash under the mattress (with zero return), the outside option is endogenous
- Suppose we have two banks one of which is illiquid with probability $\frac{1}{2}$
- The whole analysis goes through with only y_L agents withdrawing

Policy Implication: Injecting Noise about Solvent Banks

- Injecting noise about solvent banks increases the cost of liquidity information (a higher α) can eliminate the run
- October 13, 2008: Bailout of Big 9 Banks
- Paulson forces strongest banks to participate
- The government was in fact injecting noise about the liquidity of competing solvent banks into the economy

Conclusion

- Individuals acquire information about bank liquidity excessively when bank runs are a concern
  - gradual withdrawal and dynamically learning bank liquidity is new to the literature
- Government can play an active role in information policy
- We consider other theoretical issues
  - uninformed agents' problems, what if choosing acquisition timing, etc
- Our dynamic model can be taken to data, when available

Nonexistence of DD Pure-Strategy Sunspot Runs

- Interestingly, we can rule out the following Diamond-Dybvig pure-strategy bank runs triggered by sunspot
- Say that all agents, both those have heard the rumor and those have not, coordinate to run on the bank on some arbitrary time T
  - As bank could be illiquid when time elapses, running could be incentive compatible
- However, if $T > 0$, every agent would like to preempt and withdraw at $T - \epsilon$
- Therefore $T = 0$. But it is common knowledge that the bank at $T = 0$ is liquid (so will not fail even if others are running)!
- Of course, equilibria with mixed strategies may exist