Bank Runs and Financial Crises

Diamond and Dybvig (1983) and Kareken and Wallace (1978)

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Introduction

- These notes are inspired by two interviews Tom Sargent gave to the Euro Area Business Cycle Network and the Minneapolis Fed.[1]
- Two models of financial crises (bank runs): Diamond and Dybvig (1983) and Kareken and Wallace (1978).

Key Question(s)

- Why are bank runs so prevalent?
- Why do people hold short-term bank debt (e.g. deposits) if it nevertheless susceptible to runs?
- What type of policies can be used to prevent, reduce, and/or mitigate runs?

Financial Crises

- Bank run: Short-term liability holders "run" *en masse* to liquidate their savings in financial intermediaries, forcing intermediaries to engage in asset sales that could render them insolvent.
- The Diamond-Dybvig model is a celebrated contribution that:
  - Provides a precise definition of liquidity;
  - Explains the benefits of the liquidity transformation that financial intermediaries do;
  - Points out the perils of liquidity transformation – i.e., susceptibility to runs.
- Kareken-Wallace model focuses on risk taking characteristics of financial intermediaries.
- The two models have wildly different policy implications.

Model Basics

- There are three periods indexed by $T = \{0, 1, 2\}$.
- A household (HH) has unit endowment of goods in period 0, $Y_0 = 1$.
- HH's consume, denoted by c_T for $T = 1$ and $T = 2$:
- Can also save in either **cash** (costless storage) or **bonds**, which pays $R > 1$ in $T = 2$.
- Timeline:
  * $T = 0$: Invest Y_0 in bonds.
  * $T = 1$: Choose how much investment to liquidate; consume c_1.
  * $T = 2$: Receive R on matured bonds, consume c_2

Liquidity Needs

- Two types of HH's are revealed in $T = 1$. Ex ante, type is unknown.
  - **Impatient** (m): $u(c_1)$ w.p. θ; and
  - **Patient** (p): $u(c_1) + \rho u(c_2)$ w.p. $1 - \theta$.
- Flexible specification of utility function (e.g. CRRA w/ $\sigma > 1$). Just require that

$$1 \geq \rho > \frac{1}{R},$$

so p-types do not always want to liquidate.

Equilibrium in Period 0

- All consumers invest their endowment.
- Contracts are uncontingent.
- Claims to consumption in periods 1 and 2 will lead to prices of $c_1 = 1$ and $c_2 = R^{-1}$.
- Recall, all HH's are ex ante identical, so no trade of consumption.

Equilibrium in Period 1

- A "shock" occurs and HH types are revealed:
  - m: liquidate investment $\Longrightarrow$ $c_1^m = 1$ and $c_2^m = 0$.
  - p: keep investments $\Longrightarrow$ $c_1^p = 0$ and $c_2^p = R$.
- Allocation same as in autarky.
- Markets have no purpose.
- Note also that:

$$c_1^m < c_2^p \Longrightarrow u(c_1^m) < \rho u(c_2^p).$$

- m-types are plain out of luck and have lower utility than p-types.

Social Planner's Problem

- Competitive equilibrium may not socially optimal.
- Social planner's problem:

$$\max_{\tilde{c}_1^m, \tilde{c}_2^p} \left\{ \theta u(\tilde{c}_1^m) + (1-\theta)\rho u(\tilde{c}_2^p) \right\},$$

s.t.

$$(1-\theta)\tilde{c}_2^p = R(Y_0 - \theta \tilde{c}_1^m).$$

- $\theta \tilde{c}_1^m$ investments are liquidated in period 1, giving the above aggregate resource constraint.

Optimal Allocation

- The FOC's yield:

$$\frac{\rho}{R} u'(\tilde{c}_2^p) = u'(\tilde{c}_1^m).$$

- Recall that we assumed $1 \geq \rho > R^{-1}$. Thus, $\frac{\rho}{R} > 1$.
- This implies:

$$1 < \tilde{c}_1^m < \tilde{c}_2^p < R.$$

- $\implies$ competitive equilibrium not socially optimal.
- Optimal allocation requires more liquididation of investment in $T = 1$.
- Potential p-types should "insure" potential m-types.

Introduce Financial Intermediaries (Banks)

- Bank now accepts deposits in $T = 0$.
  - Offers R_1 for withdrawals in $T = 1$.
  - Offers R_2 for withdrawals in $T = 2$.
- Bank invests with deposited funds.
- Let γ denote fraction of depositors who wish to withdraw in $T = 1$.
  - Banks can honour commitments by liquidating γR_1 investments iff $\gamma < R_1^{-1}$.

Optimal Bank Contracts

- Suppose that $R_1 = \tilde{c}_1^m$.
- If only m-types withdraw in $T = 1$ then $\gamma = \theta$.
- Leftover resources in $T = 2$ are $R(1 - \theta \tilde{c}_1^m)$, and so

$$\tilde{c}_2^p = \frac{R(1 - \theta \tilde{c}_1^m)}{1 - \theta}.$$

- Optimal allocation is a sustainable equilibrium iff:
  - HH's have incentive to deposit in $T = 0$.
    - True by welfare properties of optimal allocation.
  - m-types prefer to withdraw in $T = 1$.
    - True by definition of utility function of m-types.
  - p-types prefer to withdraw in $T = 2$ and not $T = 1$.
    - True because $\tilde{c}_1^m < \tilde{c}_2^p$.

Social Optimum

- Social optimum sustained by deposit contract.
- Banks are useful. Allow us to achieve social planner's optimal allocation.
- Equilibrium is a Nash equilibrium (note: not a sufficient condition for uniqueness).
    - Everyone has an incentive to deposit.
    - If only the m-types withdraw in $T = 1$, p-types have no incentive to withdraw.

A Bank Run

- Socially optimal equilibrium is not the only equilibrium.
- What if all p type HH's try to withdraw in period 1? Suppose they wish to withdraw and store in $T = 1$, then consume in $T = 2$.
  * Even if bank liquidates all its investments, it can only at most service R_1^{-1} claims for $\tilde{c}_1^m$.
  * R_1^{-1} get $\tilde{c}_1^m$.
  * $1 - R_1^{-1}$ get nothing.
- Is this a Nash equilibrium?

Bank Run Equilibrium

- m-types will always withdraw in $T = 1$.
- If all other p-types withdraw in $T = 1$, a p-type HH also has an incentive to withdraw in $T = 1$.
- From the perspective of a p-type, it's better to roll the dice to perhaps withdraw rather than be guaranteed to get nothing.
  - Perhaps have something to gain; nothing to lose.
  - Bank run equilibrium is also a Nash equilibrium.
- Suppose μ is the probability of a bank run equilibrium occurring.
- Still a sufficient incentive for HH's to deposit into banks in $T = 0$ so long as μ is sufficiently small, since

$$(1-\mu)\left[\theta u(\tilde{c}_1) + \rho(1-\theta)u(\tilde{c}_2)\right] + \mu\left[\theta + \rho(1-\theta)\right]\left[\frac{1}{R_1}u(\tilde{c}_1) + \left(Y_0 - \frac{1}{R_1}\right)u(c_2 = 0)\right]$$
$$\geq \theta u(c_1 = Y_0) + \rho(1-\theta)u(c_2 = R).$$

Multiple Equilibria

- Bank run equilibrium is worse (from a social welfare perspective) than even the competitive equilibrium.
- Introduction of banks and deposits has led to the existence of multiple equilibria.
- Need to somehow eliminate the bad equilibrium while retaining the qualities of the good equilibrium.

Deposit Insurance

- Now suppose a policymaker insures deposits of HH's.
- Withdrawals in $T = 1$ can be taxed.
- A HH is promised $(1 - \tau)\tilde{c}_1^m$ if withdraw in $T = 1$.
- Assume that:
  - $\tau = 0$ if only m-types withdraw.
  - $\tau = 1 - R_1^{-1}$ if some p-types withdraw.
- p-types promised $\tilde{c}_2^p$ if withdraw in $T = 2$.

Impatient Households

- Payoff for m-types are:
  - If only m-types withdraw in $T = 1$ then get $\tilde{c}_1^m$.
  - If some p-types withdraw get

$$(1 - \tau)\tilde{c}_1^m = \left[1 - \left(1 - \frac{1}{R_1}\right)\right]\tilde{c}_1^m = 1.$$

- Deposits are insured for the m-types.

Patient Households

- Recall that γ is total fraction of HH's wanting to withdraw in $T = 1$.
- If only m-types withdraw $\gamma = \theta$ and $\tau = 0$.
- p-type trades off c_1 against c_2.
- But we know that $\tilde{c}_2 > \tilde{c}_1$.
- If some p-types withdraw $\gamma > \theta$ and $\tau > 0$.
    - p-type trades off $(1 - \tau)\tilde{c}_1$ against $\frac{R(1-\gamma)}{1-\gamma} = R > 1$.
    - p-type prefers to wait.
- Deposits are insured so p-types will wait.

Key Insight of Diamond-Dybvig

- Deposit insurance works by taxing withdrawals of all HH's in $T = 1$ if there is a bank run.
- Tax has no effect on m-types since they have to withdraw the consume in $T = 1$.
- But tax depresses the return to withdrawing early for the p-types sufficiently enough.
- Deposit insurance supports the good Nash equilibrium

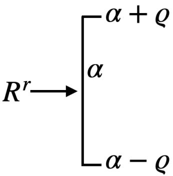
Introduction

- In contrast to Diamond-Dybvig, Kareken-Wallace argues that the provision of deposit insurance is potentially problematic.
- Policymaker introducing deposit insurance also needs to regulate portfolio positions of financial intermediaries.
- Deposit insurance introduces moral hazard and too much risk taking.
- Kareken and Wallace (1978) is a difficult paper to read. What follows is a simplified setup.

Model Setup

- HH has an endowment of 1 in period 1 which they wish to transfer to period 2 for consumption.
- Access to two assets: i) Safe assets and ii) Risky assets.
- Safe assets pay a certain [gross] return of $R > 1$ in period 2. The risky asset pays a return of:

$$R^r = \begin{cases} \alpha + \varrho & \text{w.p. } \frac{1}{2}, \\ \alpha - \varrho & \text{w.p. } \frac{1}{2}. \end{cases}$$



- $\alpha > R$ so risky asset has higher expected return.

Households and Optimal Portfolio

- HH invests proportion $1-\mu$ of endowment in safe asset and μ in risky asset.
- HH preference is:

$$u(c) = -(c-\bar{c})^2,$$

over consumption in period 2.

- Thus, HH problem is:

$$\max_{\mu} \left\{ -\frac{1}{2}\left[(1-\mu)R + \mu(\alpha-\varrho) - \bar{c}\right]^2 - \frac{1}{2}\left[(1-\mu)R + \mu(\alpha+\varrho) - \bar{c}\right]^2 \right\}.$$

- Giving the FOC:

$$\mu^* = \frac{(\bar{c}-R)(\alpha-R)}{\varrho^2 + (\alpha-R)^2} < 1,$$

if $\bar{c}-R$ is small.

Introducing Deposit Insurance

- Now introduce deposit insurance to guarantee a return of at least R in either state.
- Insurance only kicks in when return on risky asset is bad, $\alpha - \varrho$.
- This transforms the HH's optimisation problem:

$$\max_{\mu}\left\{-\frac{1}{2}\left[(1-\mu)R+\mu\underbrace{R}_{\text{insurance}}-\bar{c}\right]^2-\frac{1}{2}\left[(1-\mu)R+\mu(\alpha+\varrho)-\bar{c}\right]^2\right\}.$$

- Now, the FOC is:

$$\mu^* = 1.$$

Implications

- Clearly, the portfolio share in risky assets has increased with deposit insurance – incentivised HH to take riskier portfolio decisions
- Kareken and Wallace extend intuition to a model in which deposit insurance induces bankers to take positions that lead to bankruptcy with positive probability in equilibrium.
- The focus of Basel II (and III) on risk-adjusted capital requirements can be seen as a response to this problem.
- This model framework does not feature moral hazard problem until deposit insurance is introduced.
    - Banks take positions that do not allow bankruptcy in equilibrium if they face the full consequences of their actions.
- Deposit insurance in this model, unlike Diamond and Dybvig, is unambiguously bad.

Conclusion

- Many factors lead to a financial crisis, such as the GFC/Great Recession.
    - Ultimately, I like to believe it was the systematic incentives and rewards to excessive greed.
- Contrary to popular opinion, many economists were not shocked or surprised by the GFC – in fact, in the lead up the GFC, many macroeconomists were concerned about financial conditions.
    - Even now, many economists' warnings over inequality and lack of financial regulations fall on deaf ears.
- An excerpt from an interview with Tom Sargent:

  This is 1978 so what Kareken and Wallace concluded is if you are going to have deposit insurance then you are going to have to regulate bank portfolios. Or else you are going to have to price it right. So this was a warning against deregulation. Kareken and Wallace's message was ignored for various reasons although I do not think it is really the fault of economists that it was.

References I

Diamond, Douglas W., and Philip H. Dybvig. 1983. "Bank Runs, Deposit Insurance, and Liquidity." *Journal of Political Economy* 91 (3): 401–419.

Kareken, John H., and Neil Wallace. 1978. "Deposit Insurance and Bank Regulation: A Partial-Equilibrium Exposition." *The Journal of Business* 51 (3): 413–438.