Optimal Deposit Insurance

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Banks and the Threat of Runs

A run on American Union Bank, 1931

Banks and the Threat of Runs – Cont'd

- Banks provide maturity and liquidity transformation
- This can improve welfare, but
- It exposes banks to the risk of a run
  - —Many investors demand early withdrawal out of the self fulfilling belief that others will do so
- History of many bank failures around the world

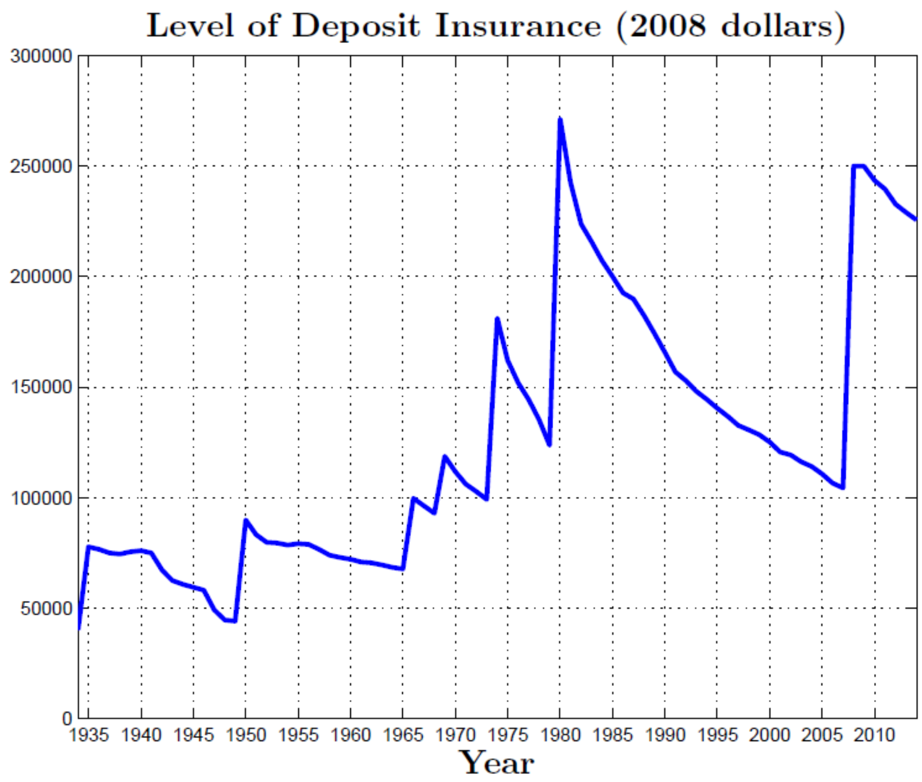
A Leading Solution: Deposit Insurance

- Insurance of deposits may reduce the incentive of investors to run
- Deposit insurance was enacted in the US in 1933 and had a great success in stabilizing the banking system
- Many countries in the world have followed this experience enacting different forms of deposit insurance
- Supported by theoretical literature, going back to Diamond and Dybvig (1983)

Optimal Amount of Coverage

- Key question in design of insurance:
  - —How much should be insured?
- In Diamond and Dybvig (1983):
  - —Unlimited insurance: insurance works to prevent failures altogether and so has no cost
- In the real world:
  - —Insurance always limited; e.g., in US current maximum for insurance is $250,000, which was increased from $100,000 in 2008
- What is different in the real world?
  - —Failures sometimes happen generating costs
  - —Insurance causes frictions
- **How to set the optimal amount?**

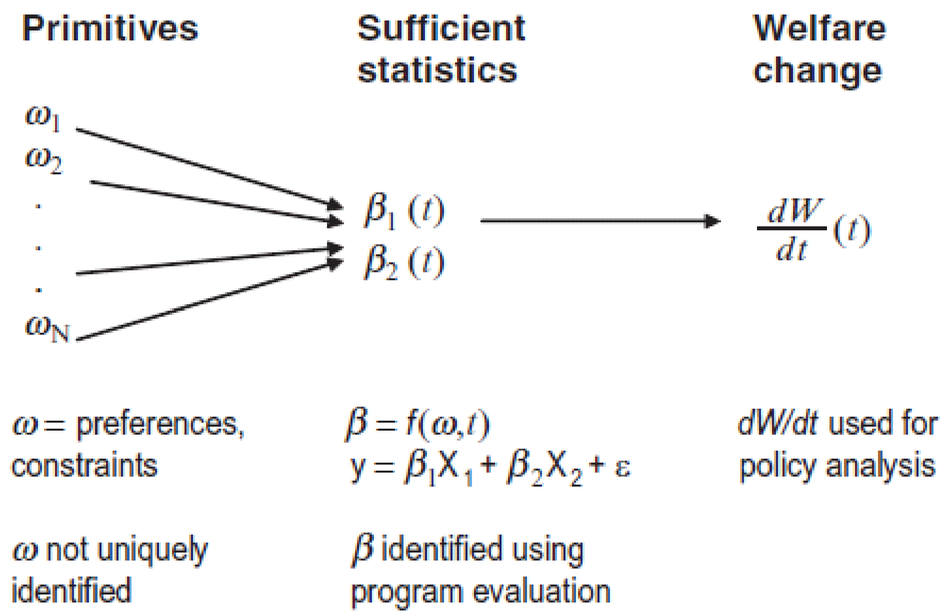
History of Deposit Insurance Amount in the US



Sufficient Statistic Approach

- Rich theoretical literature on bank runs and government guarantees (e.g., Allen, Carletti, Goldstein, Leonello, 2015), but not much quantitative
- Usually, getting quantitative prescriptions from a model requires calibration and estimation of **exogenous deep parameters** of the model
  - —This is a difficult task
- The sufficient statistic approach targets **endogenous high level variables that are potentially observable**
- Illustration in next slide is based on Chetty (2009)

Sufficient Statistic Approach – Cont'd



Optimal Level of Deposit Insurance Based on Sufficient Statistic

Optimal level of DI $$\delta^* = \frac{\boxed{A} \times \boxed{B}}{\boxed{C} \times \boxed{D}}$$

- Marginal benefit
  - $\boxed{A}$ Sensitivity of bank failure probability to DI change
  - $\boxed{B}$ Drop in depositors consumption at failure threshold
- Marginal cost
  - $\boxed{C}$ Probability of bank failure
  - $\boxed{D}$ Expected marginal social cost of intervention in case of bank failure

Intuition

- **Benefit from deposit insurance:** reducing the probability of a run and increasing consumption as a result
- **Cost of deposit insurance:** causes fiscal costs in case a failure does happen
- **Note:** moral hazard concerns associated with banks' behavior only enter the fiscal cost (which is not internalized by banks)
  - —Other implications of banks' behavior are internalized (envelope theorem, competition)

Model Description

Environment

- Three dates: 0, 1, 2
- Continuum of states: $s \in [\underline{s}, \overline{s}]$, distributed according to a cdf $F(\cdot)$, becomes known at t=1
- Double continuum of depositors deposit money in perfectly competitive banks
- Banks receive deposit insurance from government
- Government finances insurance from continuum of taxpayers

Model Description – Cont'd

Depositors and Banks

- At t=0, depositors hold deposit in the bank $D_{0i} \in [0, \overline{D}]$
- At t=1, proportion λ of depositors find out they are impatient and need to consume immediately; Proportion $1 - \lambda$ can wait till t=2
- Utility within a period is $U(c)$, where $U'(c) > 0$ and $U''(c) < 0$
- The bank offers a return R_1 on deposits at t=1
- At t=1, depositors decide how much deposit to keep in the bank $D_{1i}(s) \in [0, D_{0i}R_1]$

Model Description – Cont'd

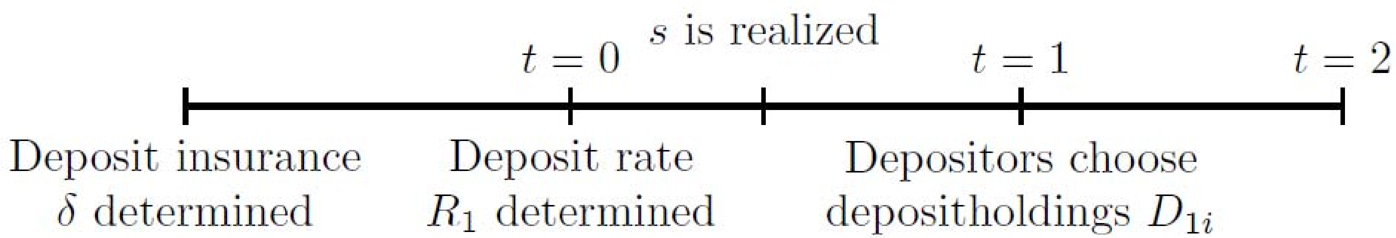
Technology

- The technology that the bank has provides a return of $\rho_1(s)$ at t=1 and $\rho_2(s)$ at t=2

Government

- The government guarantees an amount of δ of deposits
- Upon bank failure, government takes over the bank and recovers $\chi \in [0,1]$ of the resources
- The government finances any shortfall with taxes $T(s)$ causing a resource loss of $\kappa\big(T(s)\big) \geq 0$

Timeline


s is realized
$t = 0$
$t = 1$
$t = 2$
Deposit insurance
δ determined
Deposit rate
R_1 determined
Depositors choose
depositholdings D_{1i}

Equilibrium

- The bank fails if total remaining deposits are below a threshold such that the bank cannot pay back to the depositors in t=1 or 2:

$$\begin{array}{ll} \text{Bank Failure,} & \text{if } \tilde{D}_1(s) > D_1 \\ \text{No Bank Failure,} & \text{if } \tilde{D}_1(s) \leq D_1, \end{array}$$

  —Threshold decreases in state *s*

- In a run equilibrium, everyone withdraws their uninsured deposits; remaining deposits increase in δ:

$$D_1 = D_1^-(\delta, R_1) = (1-\lambda)\int_0^{\overline{D}} \min\{D_{0i}R_1, \delta\}\, dG(i).$$

Equilibrium – Cont'd

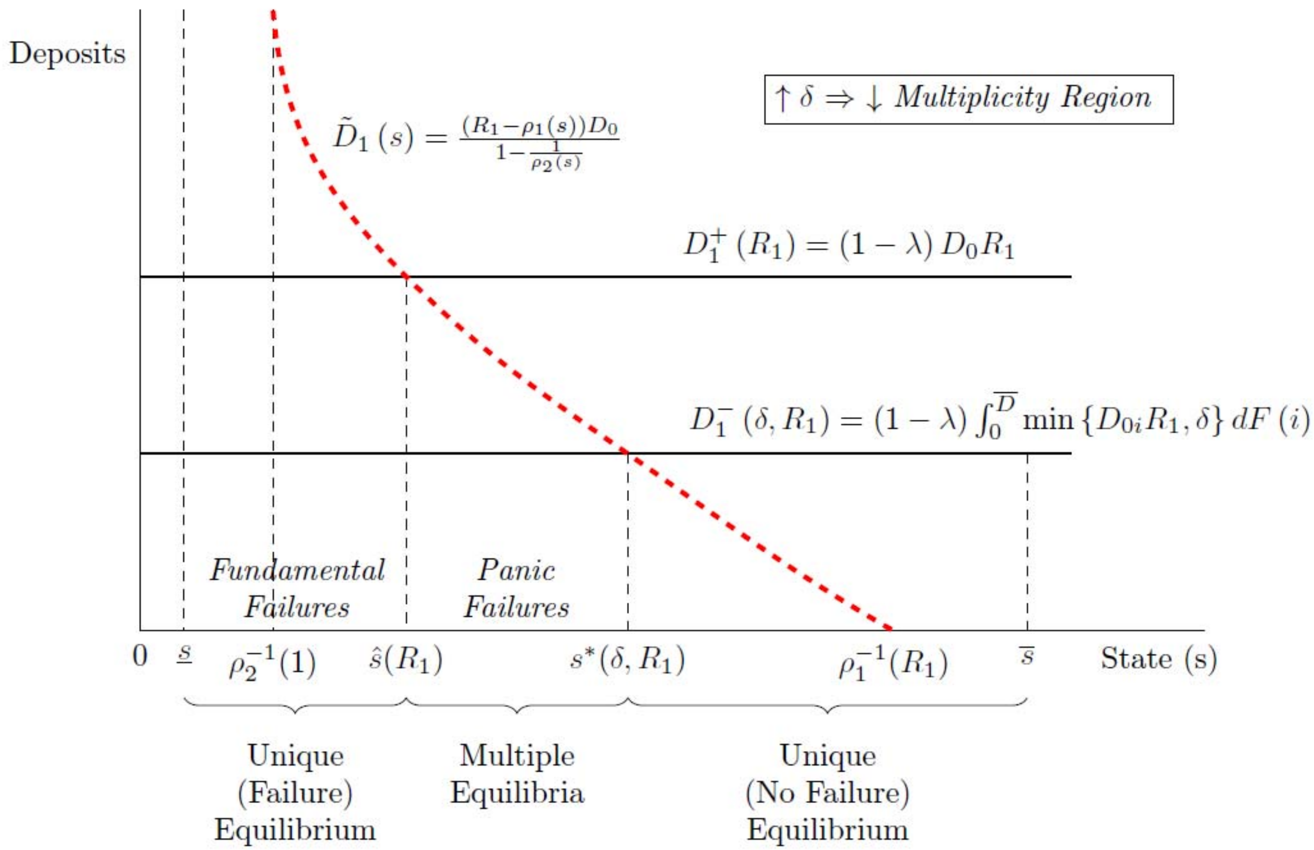
- In a no-run equilibrium, only impatient agents withdraw, so remaining deposits are:

$$D_1 = D_1^+ (R_1) = (1 - \lambda) D_0 R_1 .$$

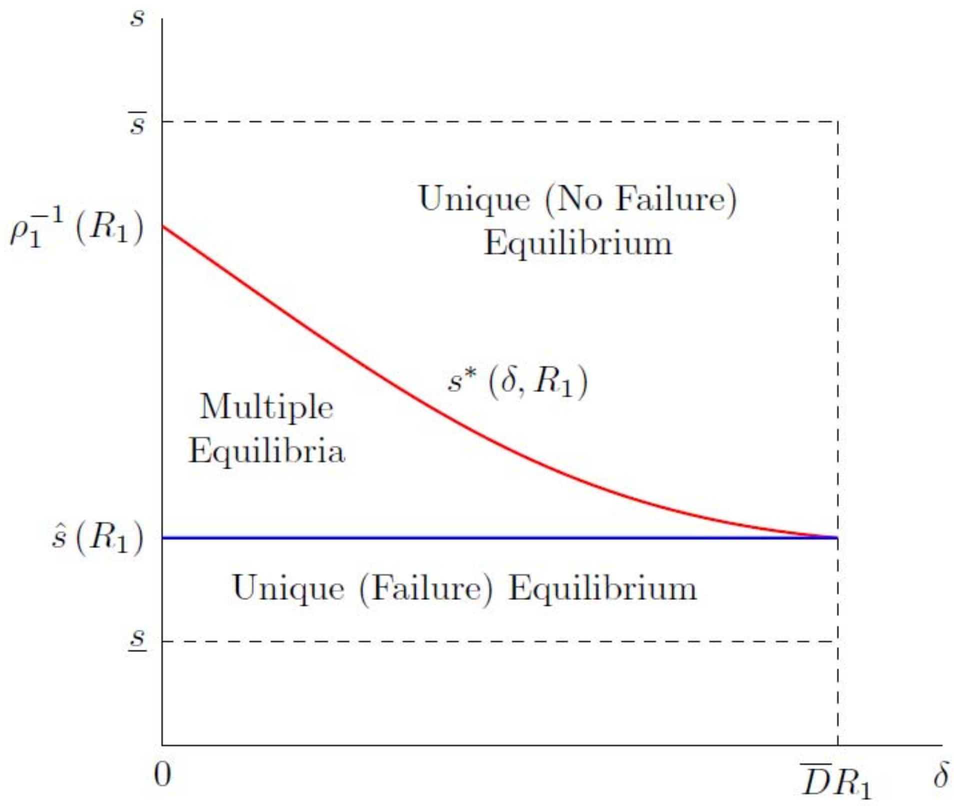
- Given these properties of deposits in the two equilibria and threshold for failure, we get:

$$\begin{array}{ll} \text{Unique (Failure) equilibrium,} & \text{if } \underline{s} \leq s < \hat{s}(R_1) \\ \text{Multiple equilibria,} & \text{if } \hat{s}(R_1) \leq s < s^*(\delta, R_1) \\ \text{Unique (No Failure) equilibrium,} & \text{if } s^*(\delta, R_1) \leq s \leq \overline{s}, \end{array}$$

Equilibrium Outcome for given δ



The Effect of δ on Equilibrium Outcome



Run Probabilities

- Assume that in the multiple-equilibria range, failure happens with probability π:
- Failure probability q^F decreases in deposit insurance δ and increases in deposit rate R_1:

$$\frac{\partial q^F}{\partial \delta} = \pi f\left(s^*\left(\delta, R_1\right)\right)\frac{\partial s^*}{\partial \delta} \leq 0$$

$$\frac{\partial q^F}{\partial R_1} = (1-\pi)\, f\left(\hat{s}(R_1)\right)\frac{\partial \hat{s}}{\partial R_1} + \pi f\left(s^*\left(\delta, R_1\right)\right)\frac{\partial s^*}{\partial R_1} \geq 0.$$

Agents' Consumption

- Given these equilibrium outcomes, depositors' consumption in case of failure (F) and no failure (N) for early (1) and late (2) consumers is determined as follows:

$$C_{1i}^{N}(s) - C_{1i}^{F}(s) = \underbrace{(1-\alpha_F(s))\max\{D_{0i}R_1 - \delta, 0\}}_{\text{Partially Recovered Uninsured Deposits}} \qquad \text{(Early Depositors)}$$

$$C_{2i}^{N}(s) - C_{2i}^{F}(s) = \underbrace{(\alpha_N(s) - 1)D_{0i}R_1}_{\text{Net Return}} + \underbrace{(1-\alpha_F(s))\max\{D_{0i}R_1 - \delta, 0\}}_{\text{Partially Recovered Uninsured Deposits}}. \qquad \text{(Late Depositors)}$$

—Where,

$$\alpha_F(s) = \frac{\max\left\{\chi(s)\rho_1(s)D_0 - \int_0^{\overline{D}} \min\{D_{0i}R_1, \delta\}\, dG(i), 0\right\}}{\int_0^{\overline{D}} \max\{D_{0i}R_1 - \delta, 0\}\, dG(i)} \quad \text{and} \quad \alpha_N(s) = \rho_2(s)\frac{\rho_1(s) - \lambda R_1}{(1-\lambda)R_1}.$$

Government Problem

- Government sets deposit insurance δ to maximize welfare of depositors and taxpayers:

$$W(\delta) = \int V_j(R_1;\delta)\,dj = \underbrace{\int V_i(R_1;\delta)\,dG(i)}_{\text{Depositors}} + \underbrace{V_\tau(R_1;\delta)}_{\text{Taxpayers}},$$

- Taxpayers are affected by taxes, given by:

$$T(s) = \max\left\{\int_0^{\overline{D}} \min\{D_{0i}R_1, \delta\}\,dG(i) - \chi(s)\rho_1(s)D_0, 0\right\}. \qquad \text{(Fiscal Shortfall)}$$

Determining the Optimal Deposit Insurance

- Suppose that R_1 is exogenous:

$$\frac{dW}{d\delta} = -\frac{\partial q^F}{\partial \delta} \int \left[U\left(C_j^N(s^*) \right) - U\left(C_j^F(s^*) \right) \right] dj + q^F \mathbb{E}_s^F \left[\int U'\left(C_j^F \right) \frac{\partial C_j^F}{\partial \delta} dj \right]$$

- Or, under an approximation (eliminate dependence on utility specification):

$$\frac{dW}{d\delta} \approx -\frac{\partial q^F}{\partial \delta} \int \left[C_j^N(s^*) - C_j^F(s^*) \right] dj + q^F \int \frac{\partial C_j^F}{\partial \delta} dj,$$

Sufficient Statistics

Four sufficient statistics are needed to determine if an increase in deposit insurance limit is desirable:

- Decrease in consumption following a failure (+):

$$\mathbb{E}_j\left[C_j^N(s^*) - C_j^F(s^*)\right] = \underbrace{(\rho_2(s^*) - 1)(\rho_1(s^*) - \lambda R_1) D_0}_{\text{Net Return Loss}} + \underbrace{(1 - \chi(s))\rho_1(s^*) D_0}_{\substack{\text{Bank Failure} \\ \text{Deadweight Loss}}} + \underbrace{\kappa(T(s^*))}_{\substack{\text{Total Net Cost} \\ \text{of Public Funds}}}$$

- Effect of deposit insurance on failure probability (+):

$$\left(-\frac{\partial q^F}{\partial \delta}\right)$$

Sufficient Statistics – Cont'd

- Probability of a failure (-):

$$q^F$$

- Net cost of taxation as a result of fiscal shortfall (-):

$$\mathbb{E}_s^F\left[\mathbb{E}_j\left[\frac{\partial C_j^F}{\partial \delta}\right]\right] = \overbrace{\kappa}^{\substack{\text{Mg. Cost} \\ \text{of Public Funds}}} \overbrace{\int_{\frac{\delta}{R_1}}^{\overline{D}} dG(i)}^{\substack{\text{Fraction of} \\ \text{Partially Insured}}}$$

Measurement

- The variables in the formula are either observable or could be inferred from the data
- The one that is most challenging is the effect of deposit insurance on failure probability
  - —Need more data to figure out historical sensitivity
  - —Theory tells us what we need to measure
  - —Ideally, regression of failures on deposit insurance amount

Measurement - Example

Variable	Description	Value
	Marginal Benefit	
$\mathbb{E}_j\left[C_j^N(s^*) - C_j^F(s^*)\right]$	Marginal resource drop induced by bank failure	75% of total deposits
ε_δ^q	Semi-elasticity of bank failure to change in coverage	Inferred
	Marginal cost	
q^F	Probability of bank failure	0.436%
$\kappa'(\cdot)$	Net marginal cost of public funds	11%
$\int_{\overline{R_1}}^{\frac{\overline{D}}{\delta}} dG(i)$	Share of partially insured depositors	7%

Optimal Deposit Insurance in Explicit Form

- The previous arguments are used to investigate optimality of increasing or decreasing deposit insurance
- One can develop above first-order condition to show explicit formula:

$$\delta^* = \frac{\varepsilon_\delta^q \mathbb{E}_j \left[U\left(C_j^F(s^*) \right) - U\left(C_j^N(s^*) \right) \right]}{q^F \mathbb{E}_s^F \left[\mathbb{E}_j \left[U'\left(C_j^F \right) \frac{\partial C_j^F}{\partial \delta} \right] \right]} \approx \frac{\varepsilon_\delta^q \mathbb{E}_j \left[C_j^F(s^*) - C_j^N(s^*) \right]}{q^F \mathbb{E}_s^F \left[\mathbb{E}_j \left[\frac{\partial C_j^F}{\partial \delta} \right] \right]},$$

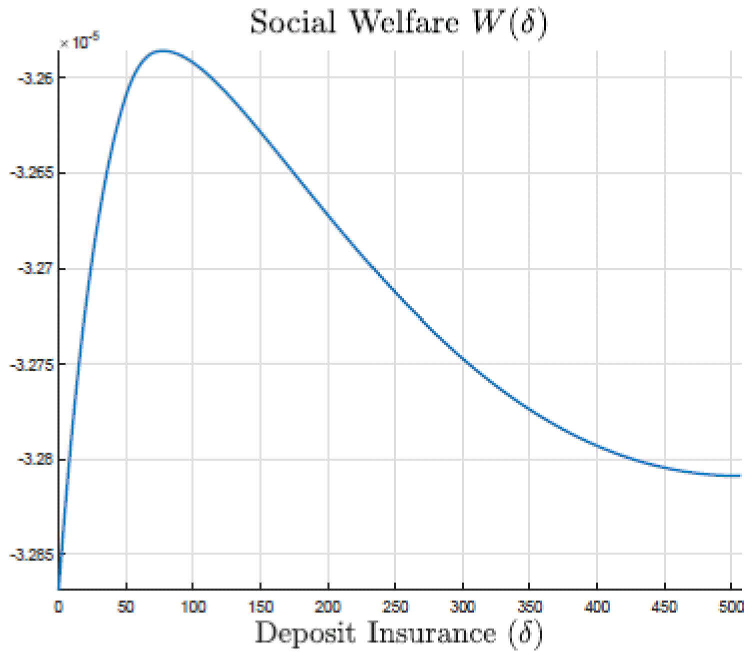
- Where:

$$\varepsilon_\delta^q = \frac{\partial q^F}{\partial \log(\delta)}$$

Summary of Uses of Formula

- Use formula to find optimal amount
  - —Usually interim maximum (see example on the next slide)
  - —Too ambitious?
- Use cost vs. benefit to tell whether an increase or a decrease is desirable at current level of coverage
- Back out change in failure probability or sensitivity that would rationalize recent insurance coverage increases

Global Effect of Deposit Insurance - Example



Endogenizing Deposit Rate and Deposit Insurance Premium

- Formula does not change much when R_1 is endogenized:
  - —Banks internalize effect on run probability
  - —Only additional effect to be taken into account in setting deposit insurance comes through the fiscal externality
- One can consider deposit insurance premium:
  - —Used to make banks internalize the effect of their deposit rates on fiscal costs
  - —Formula can be adjusted to tell optimal coverage given the pricing of premiums

Conclusion

- Optimal amount of deposit insurance is first-order question with little quantitative guidance to date
- Paper provides characterization of optimal deposit insurance as a function of a few sufficient statistics
  - —For a wide range of environments
  - —Additional characterization of optimal ex-ante policies, such as insurance premium
- Paper provides guidance for what we need to measure in the data