Banks and Financial Institutions rely heavily on short-term debt to finance their assets. This implies exposure to bank runs or rollover risk. Bank runs play an important role in understanding the Great Depression, perhaps the most recent financial crisis. Why do banks find a fragile capital structure optimal?
Fragility of Bank Capital Structure in Data

- Largest 0.1% of banks finance between 40 and 60% of assets with uninsured short-term liabilities
  - Largest 0.1% of banks now hold 50% of total bank assets (up from 20% in 1992)

- For comparison, largest 0.1% of non-financial firms finance up to 20% of assets with short-term debt
  - Only account for 15% of total non-financial firm assets
This Paper

- Develop theory of optimal capital structure of banks
- Show optimal capital structure of banks is fragile
  - there are states in which bank is inefficiently liquidated (bank runs)
- Show short-term debt is critical for fragility
- Analyze implications of theory for portfolio choices of banks
Key Contributions

- Short-term debt with many small lenders introduces a coordination problem which makes debt-roll over difficult
  - Coordination problem resembles problem of public good provision

- In moral hazard framework with fixed asset portfolio, depositors and banker will optimally choose to use short-term debt
  - Short-term debt allows depositors to commit to bank runs
  - Commitment to bank runs beneficial for resolving moral hazard

- Optimal capital structure features bank runs in equilibrium
Other Findings

- Endogenize asset portfolio decisions in model with multiple banks
  - With independent banks and bank returns, short-term debt may not commit depositors to bank runs
    - Short-term debt not sufficient to resolve commitment problem
  - Commitment problem can be resolved with correlated bank returns

- Optimal financial system features crises

- Planner subject to same constraints cannot improve outcomes $\Rightarrow$ Efficiency of crises
Related Literature

- Bank runs: Diamond and Dybvig (1983)


- Lender Coordination Problems: Bolton and Scharfstein (1990), Brunnermeier and Oehmke (2013)

- Many others on optimal capital structure, crises
Outline

- Example: When debt roll-over resembles a public good problem

- Benchmark Model: Single Bank, Many Depositors, and limited commitment
  - Optimal contracts resemble short-term debt
  - Optimal contracts feature ex-post debt-rollover problems

- Extension: Model with Multiple Banks
  - With limited commitment, correlated and risky returns across banks is optimal

- Policy Implications
Simple Example:
When Debt Rollover Resembles a Public Good Problem
Environment of Simple Example

- **Time**: $t = 1, 2$

- **$N$ Depositors’** each owed $I/N$ in period 1

- **Preferences**:
  - Depositors: $c_1 + v_i c_2$ with $c_t \geq 0$
  - $v_i$ is an i.i.d. with $G_i(v_i)$ and support $[v, \bar{v}]$
  - $v_i$ is private information
  - $v = (v_1, \ldots, v_N)$

- **Debt-Rollover**:
  - Requires $I$ resources in period 1
  - Delivers $Y$ units of output in period 2
The Game Between Depositors

- Each depositor has a right to claim resources $I/N$ in period 1
- A mechanism specifying payments to depositors in period 1 and 2 is proposed
- If each depositor (knowing $v_i$) agrees to waive their right, project is continued
- If any depositor refuses, project is discontinued
Consider designing general (direct) mechanisms \((p_1^i(v), p_2^i(v), x(v))\) which respect:

- Private information of Depositors
- Participation constraints of depositors
- Raise \(I\) resources

Will compare full information and private information outcomes
Full Information Outcomes

• When depositors’ discount factors are observable, rollover dominates no-rollover if and only if there exist payments $p^i_2(v)$ such that

$$v_ip^i_2(v_i, v_{-i}) \geq \frac{I}{N}$$

where $\sum_i p^i_2(v_i, v_{-i}) \leq Y$

• Implies rollover is efficient if

$$I \frac{1}{N} \sum_i \frac{1}{v_i} \leq Y$$

Lemma

If $IE[1/v_i] < Y$ then as $N \to \infty$, the probability rollover is ex-post efficient tends to 1.
Efficient Rollover with Private Information

• When depositors’ discount factors are unobservable, incentive compatibility requires

\[
\int_{v_{-i}} \left[ x(v_i, v_{-i}) v_i p^i_2(v_i, v_{-i}) + (1 - x(v_i, v_{-i})) \frac{I}{N} \right] dG_{-i}(v_{-i})
\]

\[
\geq \int_{v_{-i}} \left[ x(\hat{v}_i, v_{-i}) v_i p^i_2(\hat{v}_i, v_{-i}) + (1 - x(\hat{v}_i, v_{-i})) \frac{I}{N} \right] dG_{-i}(v_{-i})
\]

• Participation requires

\[
\int_{v_{-i}} \left[ x(v_i, v_{-i}) v_i p^i_2(v_i, v_{-i}) + (1 - x(v_i, v_{-i})) \frac{I}{N} \right] dG_{-i}(v_{-i}) \geq \frac{I}{N}
\]

• Resources (in ex-ante terms)

\[
\int_v x(v) \left[ Y - \sum_i p^i_2(v) \right] dG(v) \geq 0
\]
Efficient Rollover with Private Information

- Can show: a rollover rule, $x(v)$ is implementable if and only if $x(v)$ is increasing and

$$\int x(v) \left[ Y - \frac{I}{N} \sum_i \left[ \frac{1 - G_i(v_i)}{v_i^2 g_i(v_i)} + \frac{1}{v_i} \right] \right] dG(v) \geq 0.$$ 

**Lemma**

*If discount factors are such that $\bar{v}Y < I$ and $(1 - G_i(v_i))/(v_i^2 g_i(v_i))$ is decreasing, then $x(v) \to 0$ as $N \to \infty$*

- For large $N$, difficult to construct mechanisms which get all depositors to agree to waive rights

- Similar to standard results from public goods literature (Rob (1989) and Mailath and Postlewaite (1990))
Efficient Rollover with Private Information

- Reason difficult to construct rollover contracts
  - Most impatient type requires more than pro-rata share to participate
  - Implies rollover contract must subsidize impatient types in favor of patient types
  - Implies patient types have incentives to under-report discount factor:
    - Benefit: receive larger share of future returns
    - Cost: lower probability of roll-over
  - Costs tend to 0 as $N \to \infty$, Benefits do not

- For large $N$, not rolling over debt is ex-post inefficient and resembles runs or panics

- Next, show depositors endogenously choose capital structure with these outcomes
Benchmark Model with Single Bank and Many Depositors
Model Ingredients

- Standard repeated moral hazard environment (Holmstrom (1979))
  - Banker must be provided incentives to exert effort
  - Effort affects distribution of future returns

- Depositors experience private discount factor shocks (Diamond and Dybvig (1983))
  - Depositors must be provided incentives to report discount factor truthfully

- Limited enforcement of contracts
Environment

- **Agents:** $N$ depositors, 1 banker

- **Time:** $t = 0, 1, 2$

- **Depositors’ Endowments:** identical, $(\frac{I}{N}, 0, 0)$

- **Preferences:**
  - **Banker:** $c_0 + c_1 + \beta c_2$
  - **Depositors:** $c_0 + c_1 + v_i c_2$

  - $v_i$ is i.i.d., distribution $G_i(v_i)$, support $[v, \bar{v}]$ and $\beta < \bar{v}$

  - $v_i$ is **private information**, $v = (v_1, \ldots, v_N)$

  - $c_t \geq 0$
Investment Technology

- Investment in period $t = 0, 1$ requires $I$ goods and banker’s effort, $e \in \{\pi_l, \pi_h\}$ with cost $\bar{q} = q(\pi_h), 0 = q(\pi_l)$

- Output:
  - Period 1:
    - Output: $I + y_1$
      $$y_1 = \begin{cases} 
      y_h & \text{w/ prob } e_0 \\
      0 & \text{w/ prob } 1 - e_0 
      \end{cases}$$
    - Continuation requires $I$ re-invested and effort $e_1$

  - Period 2 (if continued)
    - Output: $I + \rho y_1 + z_2$
      $$z_2 = \begin{cases} 
      y_h & \text{w/ prob } e_1 \\
      0 & \text{w/ prob } 1 - e_1 
      \end{cases}$$
    - $\rho > 0$
Investment Contracts

- Focus on direct mechanisms

- Investment contract specifies: banker’s effort, transfers, continuation rule

  - Payments to depositors, $p_i^d$:
    \[ P^d = \left\{ \left( p_1^i(y_1), p_1^w(y_1, v), p_1^p(y_1, v), p_1^b(y_1, z_2, v) \right) \right\}_{i \in \{1, \ldots, N\}} \]

  - Payments to the banker, $p_i^b$:
    \[ P^b = \{ p_1^b(y_1), p_2^b(y_1, z_2, v) \} \]

  - Continuation rule: $x(y_1, v)$

  - Recommended effort: $e_0, e_1(y_1, v)$
### Timing of Events

<table>
<thead>
<tr>
<th>$e_0$</th>
<th>$y_1$</th>
<th>$v, e_1$</th>
<th>$z_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t = 0$</td>
<td>$t = 1^-$</td>
<td>$t = 1^+$</td>
<td>$t = 2$</td>
</tr>
<tr>
<td>initial effort</td>
<td>project returns &amp; early payments, $p^i_1(y_1), p^b_1(y_1)$</td>
<td>New continuation contracts proposed, Investment cost, &amp; effort</td>
<td>project returns if continued</td>
</tr>
</tbody>
</table>
Constraints on Investment Contracts

- Resource Constraints

- Non-negativity constraints

- Banker’s incentive constraints (to exert high effort)

- Depositors’ incentive constraints (to report $v_i$ truthfully)

- Depositors’ participation constraints

- Enforcement constraints (to not re-negotiate the contract)
Constraints on Investment Contracts

- Resource Constraints

\[
p^b_1(y_1) + \sum_{i=1}^{N} \left[ p^i_1(y_1) + x(y_1, v)p^i_{1c}(y_1, v) + (1 - x(y_1, v))p^i_{1n}(y_1, v) \right] \\
\leq I + y_1 - Ix(y_1, v)
\]

\[
E_{e_1}(y_1, v) \sum_{i=1}^{N} p^i_2(y_1, z_2, v) \leq I + \rho y_1 + E_{e_1}(y_1, v) \left( z_2 - p^b_2(y_1, z_2, v) \right)
\]
Constraints on Investment Contracts

- Banker’s Incentives in period 1

\[
\beta \left[ \pi_h p^b_2(y_1, z_h, v) + (1 - \pi_h) p^b_2(y_1, z_l, v) \right] - \bar{q} \\
\geq \beta \left[ \pi_l p^b_2(y_1, z_h, v) + (1 - \pi_l) p^b_2(y_1, z_l, v) \right]
\]

\[
p^b_2(y_1, z_h, v) \geq \frac{\bar{q}}{\beta (\pi_h - \pi_l)} + p^b_2(y_1, z_l, v)
\]

- Let \( U_1(y_1, v) = x(y_1, v) \left[ \beta E_{\pi_h} p^b_2(y_1, z_2, v) - \bar{q} \right] \)

- Banker’s incentives in period 0

\[
p^b_1(y_h) + \int_v U_1(y_h, v) dG(v) \geq \frac{\bar{q}}{\pi_h - \pi_l} + p^b_1(y_l) + \int_v U_1(y_l, v) dG(v) \quad (1)
\]
Constraints on Investment Contracts

- Define $w(y_1, \hat{v}_i, v_i)$ as value of reporting $\hat{v}_i$ when true discount factor is $v_i$:

$$w_i(y_1, \hat{v}_i, v_i) = \int_{v_i}^{v_i} x(y_1, \hat{v}_i, v_i) \left( p_{1c}^i(y_1, \hat{v}_i, v_i) + v_i p_{2}^i(y_1, \hat{v}_i, v_i) \right) dG_{-i}(v_{-i})$$

$$+ \int_{v_i}^{v_i} (1 - x(y_1, \hat{v}_i, v_i)) p_{1n}^i(y_1, \hat{v}_i, v_i) dG_{-i}(v_{-i}).$$

- Incentive and Participation Constraints:

$$w_i(y_1, v_i, v_i) \geq \max_{\hat{v}_i} w_i(y_1, \hat{v}_i, v_i)$$

$$\pi_h \int_{v_i}^{v_i} w_i(y_h, v_i, v_i) dG_i(v_i) + (1 - \pi_h) \int_{v_i}^{v_i} w_i(y_l, v_i, v_i) dG_i(v_i) \geq I/N$$
Nature of Limited Commitment Problem

- Allow depositors to construct new continuation contracts after $p^i_1(y_1)$ paid and $v$ realized

- New continuation contracts must be *incentive feasible*
  - non-negativity of depositor’s and banker’s consumption
  - Depositors’ incentive and participation constraints
  - Banker’s incentive constraint
  - Resource constraints
Enforceable Contracts

- Contract is *enforceable* if no other continuation contract improves ex-ante welfare and is incentive feasible:

\[
\sum_i \int_v \left[ \hat{x}(v) (\hat{p}^i_{1c}(v) + v_i \hat{p}^i_2(v)) + (1 - \hat{x}(v)) \hat{p}^i_{1n}(v) \right] dG(v) > \sum_i \int_v \left[ x(y_1, v)(p^i_{1c}(y_1, v) + v_i p^i_2(y_1, v)) + (1 - x(y_1, v)) p^i_{1n}(y_1, v) \right] dG(v)
\]

Non-neg consumption

\[
p^i_1(y_1) + \hat{x}(v) \hat{p}^i_{1c}(v) + (1 - \hat{x}(v)) \hat{p}^i_{1n}(v) \geq 0
\]

- Do not require pareto improvements
Benchmark Model: Characterizing Optimal Contracts and Bank Runs
Characterizing Optimal Contracts

- Outcomes under Full Commitment if moral hazard is severe
  - Liquidate project after low period 1 output
  - Continue project after high period 1 output
  - Many state-contingent plans implement optimum
  - Liquidation Outcomes resemble bank runs

- Outcomes under limited commitment mimic commitment outcomes
  - With full info of discount factors, cannot commit to liquidate
  - Short-term debt-like claims with private info needed
  - Long-term debt-like claims with private info do not work
Characterizing Optimal Contracts

• Outcomes under Full Commitment if moral hazard is severe
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  ○ Short-term debt-like claims with private info needed
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Incentive Benefits of Liquidation

• Recall banker’s effort constraints

\[ p_2^b(y_1, z_h, v) \geq \frac{\bar{q}}{\beta(\pi_h - \pi_l)} + p_2^b(y_1, z_l, v) \]

\[ p_1^b(y_h) + \int_v U_1(y_h, v)dG(v) \geq \frac{\bar{q}}{\pi_h - \pi_l} + p_1^b(y_l) + \int_v U_1(y_l, v)dG(v) \]

• Moral hazard plus limited liability imply

\[ U_1(y_l, v) = x(y_l, v) \frac{\pi_l \bar{q}}{\pi_h - \pi_l} \]

or \( U_1(y_l, v) > 0 \) if \( x(y_l, v) > 0 \)

• Implies banker earns rents if project is continued

• Liquidating after low output reduces \( U_1(y_l, v) \), relaxes banker’s period 0 incentive constraint

• Liquidating after low output potentially costly for depositors (forgone surplus)
**Liquidation After Low Output**

- Tradeoff involving reductions in $x(y_l, v)$:
  
  - Ex-ante benefit from reducing payment to banker, $p^b_1(y_h)$
    
    $$\pi_h \frac{\pi_l \bar{q}}{\pi_h - \pi_l}$$
    
    banker's rent
  
  - Ex-ante *maximal cost* from forgone surplus
    
    $$(1 - \pi_h) \left[-I + \bar{v} \left(I + \pi_h z_h - \frac{\pi_h \bar{q}}{\beta(\pi_h - \pi_l)}\right)\right]$$
    
    maximum ($\bar{v}$) potential surplus

**Lemma (Liquidate after Low Output)**

*The optimal contract satisfies $x(y_l, v) = 0$ for all $v$ if*

$$\frac{\pi_h \pi_l \bar{q}}{\pi_h - \pi_l} - (1 - \pi_h) \left[-I + \bar{v} \left(I + \pi_h z_h - \frac{\pi_h \bar{q}}{\beta(\pi_h - \pi_l)}\right)\right] > 0$$
Continuation After High Output

- Increasing $x(y_h, v)$ reduces payment to banker and (potentially) increases surplus
  - Incentive benefit: $\beta \pi_h p^b_2(y_h, z_h, v) - \bar{q}$
  - Surplus benefit: $-I + \sum_i v_i \tilde{p}^i_2(v)$

- Surplus maximizing rule $x(y_h, v) = 1$ if and only if
  \[ \sum_i v_i \tilde{p}^i_2(y_h, v) + \beta \pi_h p^b_2(y_h, z_h, v) - I - \bar{q} \geq 0 \]

**Lemma (Continute after High Output)**

The optimal contract satisfies $x(y_h, v) = 1$ for all $v$ if

\[ \beta (I + \rho y_h + \pi_h z) \geq I + \bar{q} \]

- Assumption requires project to yield higher total surplus following high output under banker’s discount factor than resource and effort cost
Optimal Contracts

- Have found optimal continuation rule

- Can solve for optimal payments

- Focusing on period 1 payments
  - Following low output, set $p^i_1(y_l) = I/N$ or $p^i_{1n}(y_l, v) = I/N$ (or any combination)
  - Following high output, depositors willing to pay $I/N$ for pro-rata share if
    \[ I < v \left[ I + \rho y_h + \pi_h z_h - \frac{\pi_h \bar{q}}{\beta (\pi_h - \pi_l)} \right] \]
    (optimum more complicated typically)

- Optimum resembles short-term debt with liquidations, or long-term debt with bankruptcy, etc
Inefficient Liquidations

- Will say liquidations resemble bank runs if they are ex-post inefficient
- Ex-post inefficient if under full info, depositor welfare can be improved (ex-post) by continuing

Lemma (Ex-Post Inefficient Liquidations, Bank Runs)

If

\[
IE \left[ \frac{1}{v_i} \right] < I + \pi_h z_h - \frac{\pi_h \bar{q}}{\beta (\pi_h - \pi_l)}
\]

then the probability that liquidation resembles a bank run tends to 1 as \( N \to \infty \).
Characterizing Optimal Contracts

- Outcomes under Full Commitment if moral hazard is severe
  - Liquidate project after low period 1 output
  - Continue project after high period 1 output
  - Many state-contingent plans implement optimum
  - Liquidation Outcomes resemble bank runs

- Outcomes under limited commitment mimic commitment outcomes
  - With full info of discount factors, cannot commit to liquidate
  - Short-term debt-like claims with private info needed
  - Long-term debt-like claims with private info do not work
Efficient Liquidations and Bank Runs

- If liquidations ex-post inefficient, for any long-term contract, depositors will re-negotiate (with high probability)

Proposition (Time Inconsistency)

If liquidations resemble banks runs, or,

\[ IE\left[\frac{1}{v_i}\right] < I + \pi_h z_h - \frac{\pi_h \bar{q}}{\beta (\pi_h - \pi_l)}, \]

then under full information of discount factors as \(N \rightarrow \infty\), no contract implements optimum with commitment. Equilibrium outcomes feature no liquidation.

- Proposition implies that if \(v_i\) is observable, optimal continuation rule is not enforceable for large \(N\)
Proposition (Sufficiency of Short-Term Debt)

Suppose \((1 - G_i(v_i))/(v_i^2 g_i(v_i))\) is decreasing in \(v_i\) and

\[
\nu \left[ I + \pi_h z_h - \frac{\pi_h \bar{q}}{\beta(\pi_h - \pi_l)} \right] < I.
\]

As \(N \to \infty\), the optimal continuation rule is enforceable if \(p^*_1(y_1) = I/N\).

- Main result: choosing high first period transfers when depositors’ discount factors are unobservable introduces a “public goods” problem that resolves the time-inconsistency problem

- Enforcement constraint slack (in terms of welfare) but determines timing of payments
How Short-Term Debt Replicates Commitment

- Suppose $p_i^y(y) = I/N$

- Look for re-negotiation contracts that feature continuation with positive probability

- Aggregate Resources:

  $$p^b_1(y) + \sum_i p_i^y(y) + \sum_i [\hat{x}(v)\hat{p}_{1c}^i(v) + (1 - \hat{x}(v))\hat{p}_{1n}^i(v)] \leq I - \hat{x}(v)I$$

  $$\sum_i [\hat{x}(v)\hat{p}_{1c}^i(v) + (1 - \hat{x}(v))\hat{p}_{1n}^i(v)] \leq -\hat{x}(v)I$$

- Limited Liability:

  $$\frac{I}{N} + \hat{x}(v)\hat{p}_{1c}^i(v) + (1 - \hat{x}(v))\hat{p}_{1n}^i(v) \geq 0$$

- Implies $\hat{p}_{1c}^i(v) = -I/N$
• Then, the participation constraint (to waive right to $I/N$) is

$$\frac{I}{N} + \int_{v_{-i}} \hat{x}(v_i, v_{-i}) \left[ -\frac{I}{N} + v_i \hat{p}_2(v_i, v_{-i}) \right] dG_{-i}(v_{-i}) \geq \frac{I}{N}$$

• Re-negotiation faces exact public good problem as above

• Choosing $p_1^i(y_l) = I/N$ makes it difficult to get depositors to waive right

• Implies depositors can commit to liquidate after low output
Why Long-Term Debt Does Not Work

• Suppose $p^i_1(y_l) = 0$ but $p^i_{1n}(y_l, v) = I/N$

• Look for re-negotiation contracts that feature continuation with positive probability

• Aggregate Resources:

$$\sum_i [\hat{x}(v)\hat{p}^i_{1c}(v) + (1 - \hat{x}(v))\hat{p}^i_{1n}(v)] \leq I - \hat{x}(v)I$$

Note: $I$ still “in the bank”

• Limited Liability: $\hat{x}(v)\hat{p}^i_{1c}(v) + (1 - \hat{x}(v))\hat{p}^i_{1n}(v) \geq 0$

• Participation:

$$\int_{v_{-i}} [\hat{x}(v_i, v_{-i}) (\hat{p}^i_{1c}(v_i, v_{-i}) + v_i\hat{p}^i_{2}(v_i, v_{-i})) + (1 - \hat{x}(v_i, v_{-i}))\hat{p}^i_{1n}(v_i, v_{-i})] dG_{-i}(v_{-i}) \geq 0$$
Why Long-Term Debt Does Not Work

- Can choose $\hat{x}(v) = 1, \hat{p}_{1c}^i(v) = \hat{p}_{1n}^i(v) = 0$ and $\hat{p}_2^i(v) = Y/N$ where

$$Y = I + \pi_h z_h - \frac{\pi_h \bar{q}}{\beta(\pi_h - \pi_l)}$$

- Clearly, this alternative contract is IC, feasible, and satisfies participation

- Status quo welfare $= I$

- Re-negotiated welfare $= \frac{Y}{N} \sum_i E[v_i]$

- Since $I < E[v_i]Y$, as $N \to \infty$, $\hat{x}(v) \to 1$ (such a re-negotiation is successful)

- Long-term debt (or equity) with bankruptcy does not work
Optimal Bank Maturity

- Constrained efficiency requires promising to re-pay entire principal ($\sum_i p_1^i(y_1) \geq I$)

- Contracts which do not promise to re-pay entire principal are worse
  - Such contracts do not commit depositors to liquidate the bank ex-post

- Contracts which do not promise to re-pay entire principal resemble long-term debt or equity

- In this sense, optimal for banks to use short-term debt over longer-term contracts

- In paper, show this in decentralized economy with explicit short, long-term debt contracts
Extended Model with Multiple Banks & Policy Implications
Crises vs. Individual Bank Failures

- Commitment to liquidate individual bank requires limited availability of external resources

- Show in environment with multiple banks, depositors and bankers also have incentives to choose investments that ensure limited availability of external resources

- Will consider two extreme examples:
  - Replica economy of above with 2 bankers, $2N$ depositors, fully independent
  - Economy with perfectly correlated, riskier returns

- Will show strict preference for correlated, risky return economy
  - Implies optimality of crises
Independent Replica Economies

• 2 bankers, 2N depositors

• Project returns and depositor discount factors drawn independently

• Immediate that optimal continuation rule under commitment is identical to one bank outcome $x(y_h, v) = 1$ and $x(y_l, v) = 0$ for both banks

• Ask, under limited commitment, can depositors enforce $x(y_l, v) = 0$?
Independent Replica Economies

- **Answer:**
  - If \( y^1, y^2 = y_h, y_l \), then enforcement is possible
  - If \( y^1, y^2 = y_l, y_l \), then enforcement is **not** possible

- Focus on case where both bank earn low returns

- Aggregate resources \( 2I \), aggregate welfare from status quo = \( 2I \)

- Construct re-negotiation contract with pro-rata shares:
  \[
  \hat{p}_{1c}^i(v) = -\frac{I}{N} \quad \text{and} \quad \hat{p}_2^i(v) = \frac{1}{N} \left( I + \pi_h z_h - \pi_h \bar{q} / (\beta (\pi_h - \pi_l)) \right)
  \]

- Do \( N \) most patient depositors want to undertake such a deviation?
Independent Replica Economies

- If depositor with median patience under $G_i$ accepts, then for $N$ large, $N$ depositors will accept

- Implies exist incentive compatible continuation contracts which strictly improve depositor’s welfare

- Consider incentives of a single banker
  - From ex-ante perspective, under low effort, with probability $(1 - \pi_l)(1 - \pi_h)$, both banks will realize $y_1 = y_l$
  - For $N$ large, with probability $1/2$, $x(v) = 1$
  - Implies incentive constraint of banker given by
    $$p_1^b(y_h) + \int_v U_1(y_h, v) dG(v) \geq \frac{\bar{q}}{\pi_h - \pi_l} + \frac{1}{2} (1 - \pi_h) \frac{\pi_l \bar{q}}{\pi_h - \pi_l}$$
    which is strictly tighter than the commitment outcome
Correlated Return Economy

- Assume project returns are perfectly correlated and effort is leontief:
  \[ Pr \left[ (y^1, y^2) \in \{(y_l, y_h), (y_h, y_l)\} \right] = 0 \]

and

\[ Pr \left[ (y^1, y^2) = (y_h, y_h) \right] = \min\{e^1_0, e^2_0\} \]

and similarly in period 2

- Leontief implies no added advantage in terms of incentive provision in commitment outcome

- Also assume \( y_1 = -I/2 \) so that if \( y^1, y^2 = y_l, y_l \), aggregate resources are \( I \)

- Increase \( y_h \) so that planner under commitment with \( x(y_h, v) = 1 \) and \( x(y_l, v) = 0 \) indifferent between independent projects and correlated, risky projects
Correlated Return Economy

- After high outcomes, continuation is feasible, optimal as before
- After low outcomes, each of $2N$ depositors need to finance a single bank operation
- If financed with short-term debt, exact same public goods problem implies no incentive feasible continuation contract has $x(y_l, \upsilon) > 0$ for either bank
- Implies commitment outcome enforceable
Efficiency of Financial Crises

Proposition (Efficient Crises)

*If returns are perfectly correlated and sufficiently risky, then commitment outcomes are enforceable.*

- Strict preference for aggregate crises (all banks earn low returns, all banks are liquidated)
- Suggests fragile banks should undertake riskier returns more correlated with aggregate outcomes than non-fragile banks
- Besides forgone profits, no additional external cost to crises
Policy Implications

- In absence of external costs, crises are efficient

- Optimal bank maturity responds to policies that distort moral hazard problem or income process of banks

- Implications for securitization and mortgage modification programs:
  - Securitization creates a disperse group of debtors
  - Inability to re-negotiate ex-post may be a feature of the system
Conclusion

- Developed model and conditions under which banks prefer fragile capital structure

- Along equilibrium path, bank runs occur

- Short-term debt allows small depositors to commit to ex-post inefficient runs

- Long-term debt/equity may not attain same level of commitment

- Limited commitment problems imply preference for correlated, risky outcomes in financial sector