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RISK AVERSION, DEPOSIT INSURANCE, AND COLLECTIVE ACTION PROBLEMS AMONG BANKS

by

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Risk Aversion, Deposit Insurance, and Collective Action Problems Among Banks

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ABSTRACT

Collective action problems are likely to arise in concerted lending situations. The sources of lending structures which hinder collective actions are therefore of policy concern. This paper introduces a monopolistically-competitive model in which risk-averse banks choose a level of concentration ex-ante which hinders their collective action ex-post. Decreases in loan concentration result in an increase in the degree of credit contraction in bad states, an increase in the probability of default, and an increase in the expected burden on FDIC funds.

Both explicit and implicit deposit insurance act to increase further the number of banks participating in lending. Explicit deposit insurance both subsidizes risky loans and diminsihes private sources of market regulation of lending structure. FDIC intervention into system-threatening situations, in which uninsured deposits of failing banks are carried at par subsequent to a merger, provides an additional "implicit deposit insurance." This policy provides additional incentives for a decrease in the level of concentration in lending, as banks attempt to increase the perceived systemic nature of a loan.

1. Introduction

1.1 Motivation

A large literature is emerging in which collective action problems experienced by banks hinder opportunities for mutually-beneficial banking actions. Whether the desirable action is concerted relending by banks, [Cline (1984), Spiegel (1988)], or actual "debt forgiveness" by the banking industry [Helpman (1988), Krugman (1987), Froot (1988)], the implications of this literature are that the sources of bank-lending structures in which collective action problems would arise would be of important policy concern. In this paper, two potential sources of structures ill-suited towards bank collective action are examined: Individual bank risk aversion, and federal deposit insurance policy.

Risk averse banking firms may not wish to carry an entire loan on their own, preferring diversification of their portfolios. Banks find an interior solution between increasing the number of banks in a lending package, and achieving superior diversification, and decreasing the number of banks in a lending package in an effort to lower expected collective action difficulties. Their decision results in a number of banks participating in a lending package, leading to a possibility of collective action difficulties ex-post.

In the case of individual bank risk aversion, a lending structure in which collective action problems arise ex-post may be socially, as well as privately, optimal ex-ante. For example, the source of bank risk aversion may stem from bankruptcy costs. Individual bank failures may also have negative externalities for the system as a whole. In these cases, the policy implications of collective action problems which stemmed from risk aversion among banks would not be clear.

On the other hand, distortions through deposit insurance may affect the structure of lending in a socially undesirable direction. In addition to the impact of explicit and implicit deposit insurance on the levels of lending [Kareken and Wallace (1978)], their impact on lending structure would be of concern if the structure of lending affects the probability of debtor default. One way that lending structure relevantly enters into the lending picture is through its impact on collective actions, such as mutually beneficial lending activities by banks.

This paper introduces a simple lending model in which some probability exists that collective action among banks would be desirable ex-post. The simple example used is that of a debtor nation to whom concerted relending may be globally optimal for monopolistically-competitive banks. Risk aversion by these banks, however, precludes any single bank from taking on the entire loan, resulting in some level of collective action difficulty ex-post.

Both explicit and implicit deposit insurance increase the severity of the collective action problem among banks by increasing the number of banks or the "diffusion" of the lending package. These diffusion increases result in an increased probability of debtor default, an increased probability of bank failure, and an increased expected burden on FDIC funds. These results motivate the conclusion that if deposit insurance is going to be continued in its present form, some regulation of lending structure would seem to be warranted.

1.2 The role of deposit insurance

The impact of deposit insurance on banking behavior has long been a source of concern to policy makers and researchers. The combination of explicit deposit insurance and fixed insurance premia has been shown to result in sub-optimally large levels of risk in bank lending portfolios [Kareken and Wallace (1978), Kareken (1986), Penati and Protopapadakis (1988)]. The implications of these incentives has led some to question the desirability of a fixed-premia insured deposit system.

In addition to their deposit insurance activities, however, concern for the stability of the banking system has led the FDIC to intervene in situations which threaten the system as a whole. Typically, intervention into a system-threatening situation results in the merger of a failing bank with a healthy bank, in which the FDIC either assumes the bad loans of the failing bank or reimburses the acquiring bank for the bad loans. Penati and Protopapadakis (1988) show that implicit insurance on systemic bank risk provides a subsidy to systemic loans in excess to that provided by explicit deposit insurance. In system-threatening situations, the FDIC policy leaves all deposits, including uninsured deposits, carried at par.

The importance of implicit deposit insurance appears to be pervasive. From 1978 through 1984, only 20 percent of failed banks were closed. Moreover, these were largely small banks, representing only 0.2 percent of total deposits.[1]

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[1]Penati and Protopopakdakis, 1988.

Empirical evidence suggests that the value of FDIC insurance, both implicit and explicit, is understood and "priced" by the market. Event studies of the impact of the debt crisis in August 1982 on bank equity showed a consistently lower impact on excess return than that which would be suggested by the magnitude of the news [Penati and Protopapadakis (1988)]. For example, while uninsured bond spreads over LIBOR soared from 2 percent in August 1982 to over 7 percent in November [Edwards (1986)], there was less than a 2 percent decline in average annual excess return of banks exposed to Mexico [Schoder and Vankudre (1986), Bruner and Simms (1987), and Spiegel (1988)].[2]

1.3 Organization

This paper is organized into six sections. Section two introduces a monopolistically-competitive model in which individual banks are risk-averse. Their risk aversion leads to a non-trivial diffusion of the lending package in which some probability of ex-post collective action problems exist. Explicit deposit insurance is introduced in section three. The introduction of explicit deposit insurance increases both individual bank lending and the number of banks participating in the lending package. This secondary effect exacerbates the collective action problem associated with bank risk aversion.

Section 4 introduces implicit deposit insurance into the model. Given that "free insurance" exists on systemic loans, one would expect the banks to

[2]Beebe (1985) and Cornell and Shapiro (1986) show larger declines over the long run, but it is clear that the bond market was evaluating the default risk in Mexico by a different crierion than bank equity holders over the second half of 1982.

respond by structuring a lending package in such a way as to "qualify," under the FDIC's policy, for implicit deposit insurance. Subject to the expected number of participating banks necessary for a loan to be considered "systemic" by the FDIC,[3] increasing the number of participating banks in a lending package will increase the probability that a loan will qualify. This will decrease the cost of funds to a representative bank by lowering the cost of acquiring uninsured deposits. This response decreases further the ability of banks to pursue collective action activities ex-post.

Sections 5 contains some simulations concerning the empirical predictions of the effects discussed in the theory. Finally, section 6 provides some conclusions.

2. A Monopolistically-Competitive Model of Bank Lending

2.1 The Structure of the Model

In this section, a model of banking behavior is developed in terms of a representative bank. Bank are monopolistic competitors because they carry some level of fixed cost associated with participating in lending to the debtor nation which is treated as exogenous. It is assumed that there are n identical banks in the system.

The model is 3-period. Banks make loans L_1 and L_2 in the first and second periods. Since banks are homogeneous, total lending, $\bar{L}_j$ is equal to n

[3]The implications of alternative measurements of the "systemic riskiness" in a lending package are discussed below.

times L_j (= 1,2). These are one-period loans which come due in periods 2 and 3 respectively. Second period lending can be interpreted as rolling over the first-period loan for an additional period.

The extensive form of the model is as follows:

Stage 1: Banks choose n, L_1

Stage 2: Nature chooses s

Stage 3: Banks choose L_2, π_1

Stage 4: Nature chooses s'

Stage 5: Debtor chooses D_1

Stage 6: Nature chooses s''

Stage 7: Debtor chooses D_2

D_1 and D_2 are zero-one variables depending on the presence or absence of default respectively on first and second period lending. The probability of default is π_1.

s, s', and s'' are states of nature. The states are assumed to be drawn at random and are normally distributed:

$$(1) \qquad s \sim N(\bar{s}, \sigma_s^2)$$

for s, s', and s''.

It is useful to divide the possible realizations of s into three ranges. Letting s_1 and s_2 represent borderline values,[4] the ranges can be described as:

State Range	Probability	Range Characteristic	Description
$s < s_1$	P_1	$D_1=1;\ L_2=0$	"Default"
$s_1 < s < s_2$	P_2	$0 < D_1^e < 1;\ L_2>0$	"Rescheduling"
$s > s_2$	P_3	$D_1=0;\ L_2>0$	"Normal"

Note: The three ranges' probabilities sum to one.

The values of s_1 and s_2 are derived in the appendix. The first two columns of the table above describe the ranges of realizations of s and the probabilities associated with those ranges. The realization of s determines Q(s), the value of the debtor's output, which is stochastic, but is taken as

[4]The values of s_1 and s_2 are assumed to be exogenous. This is a simplifying assumption as increased exposure is likely to widen the range in which conciliatory relending is rational. However, for each individual bank the effect is likely to be small and the assumption allows for great simplification without changing any qualitative results. In addition, the realization of s anywhere within the range $s_1 < s < s_2$ is assumed to have identical effects on the borrowers ability to pay. This also simplifies the analysis without changing any qualitative results.

exogenous for simplicity.[5] The second two columns describe the outcomes associated with realizations of s within the prescribed ranges, given creditor maximization as derived below. The boundary points are relevant in that lending decisions given realizations of s less than s_1 or greater than s_2 do not enter into the first period zero profit condition, as determined below.

$s < s_1$ defines the range of "default states." In these states, $D_1 = 1$ and L_2 is equal to zero. As derived in the appendix, the expected rate of return on new lending falls sufficiently short of the banks' cost of funds, to make further relending irrational, both from the point of view of individual creditors, and the banking industry as a whole. In particular, the low realization of s makes the negative rate of return on new lending outweigh the risk-adjusted positive impact new lending may have on outstanding debt.

$s > s_2$ defines the range of "normal states." The realization of $s > s_2$ implies that the debtor nation completely services its debt burden and the level of default on first period lending, D_1, is equal to zero. No collective action problem appears in this range since new lending has no impact on outstanding loan performance. Monopolistic competition in the second period assures that the expected return on new lending is equal to the banks' cost of funds, adjusted for risk.[6]

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[5]This simplfying assumption changes none of the qualitative results. It implies that investment opportunities exist in the debtor country which are expected to cover the cost of financing new lending given the spread.

[6]By assuming perfect competition on new lending, I am ruling out any advantage first-period lenders may have in lending in the second period. This is obviously a simplification.

$s_1 < s < s_2$, however, represents the range of partial defaults or reschedulings in which opportunities for beneficial collective action appear. In this period additional bank lending increases the liquidity of the debtor nation and lowers the level of default on first period loans, as discussed below. In this state the discounted rate of return on new lending, $R_2(s)$ is assumed to be greater than that level at which new lending would cease being globally optimal. This boundary value is derived in the appendix as well.

Banks act as Stackelberg leaders, taking the reaction function of the debtor as given. It is assumed that the debtor faces a timing-inconsistency problem which precludes it from committing itself to a sub-optimally large degree of debt service ex-post. The finite horizon nature of the model then simplifies the debtor decision and allows for concentration on lender behavior.

The debtor weighs the cost of debt service against the penalty charged for default. The timing-inconsistency problem forces the to only minimize this period's loss function:

$$(2) \quad \text{Min } L = \begin{cases} g(Q(s), L_2) \text{ if } D = 0 \\ P(s') \text{ if } D = 1 \end{cases}$$

where $g'(Q(s)) < 0$, $g'(L_2) < 0$, $d''g(\cdot)/dQ(s)\ dL_2 < 0$, and $P'(s') > 0$. An increase in the level of new lending is assumed to lower the cost of any level of debt service through its positive effect on the debtor's liquidity position. As a result, increased bank lending can lower the probability of default in the rescheduling range. In addition, the specification of the cross-partial term implies that new lending does more good the worse the realized state.[7]

$$(3) \qquad \pi_1 = \pi_1(L_2, s) \qquad \pi_1'(L_2|s) < 0;\ \pi_1''(L_2|s) > 0;\ 0 < \pi_1 < 1$$

2.2 Second period bank Lending Decision

Assume n monopolistically-competitive banks each loaned L_1 to the debtor nation in the first period. Each bank individually chooses the level of new lending in the second period. In states $s < s_1$, the solution of the representative bank is trivial, $L_2 = 0$. In state $s > s_2$, additional lending has no impact on the default level so the level of new lending is that consistent with zero expected profits. Since both outcomes yield zero net profits on new lending, outcomes given states $s < s_1$ and $s > s_2$ do not enter into the optimization problem of the banks in the first period.

Given $s_1 < s < s_2$, however, the banks will choose a positive level of lending even though the net rate of return on new lending is negative. A representative bank solves the following optimization problem:

Maximize over L_2:

$$(4) \quad U(\Pi_{2i}) = \theta_0 + [1 - \pi_1(\bar{L}_2)]\hat{r}L_1 + R_2L_2 - \beta[\sigma^2_{\pi 1}L_1^2 + \sigma^2_{R2}L_2^2]$$

[7]The statement that concerted relending is beneficial to creditors within any range not uncontroversial (See Lindert (1988)). The situation is used here as an example of a potential expected collective action problem, and is not intended to suggest that the merits of concerted relending policies have been settled.

where θ_0 is the bank's fixed cost, R_2 is the discounted rate of profit on new lending in the second period (assumed to be negative within the rescheduling range), $\pi_1(L_2,s)$ is the probability of debtor default on outstanding first period loans, and $\hat{r}$ is the interest rate charged to the debtor nation in the first period.

The $\beta[\cdot]$ term specifies individual bank risk aversion. Banks are risk averse in the variance of returns, both on new and old lending. The σ_i^2 terms are taken as constants.[8] Maximization yields the first-order condition:

$$(5) \quad -\pi_1'(L_2)\hat{r}L_1 + R_2 - 2\beta\sigma_{R2}^2 L_2 = 0$$

Solving for L_2 yields:

$$(6) \qquad L_2 = \frac{R_2 - \pi_1'(L_2)\hat{r}L_1}{2\beta\sigma_{R2}^2}$$

It follows that the level of conciliatory relending will be increasing in the level of individual bank first period outstanding loans. Totally differentiating L_2 with respect to L_1:

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[8]If $\sigma^2_{\pi 1}$ were allowed to be an increasing function of the default probability within the relevant range (which is likely to be the case), the result that risk aversion leads to a collective action problem would only be strengthened. It is treated as a constant for simplicity.

$$(7) \qquad \frac{dL_2}{dL_1} = \frac{-\pi_1'(L_2)\hat{r}}{1 + \pi_1''(L_2)\hat{r}L_1} > 0$$

Total lending satisifes:

$$(8) \qquad \bar{L}_2 = \frac{nR_2 - n\pi_1'(L_{2i})\hat{r}}{2\beta\sigma^2_{R2}}$$

Totally differentiating L_2 with respect to n:

$$(9) \qquad \frac{d\bar{L}_2}{dn} = \frac{R_2 - \dfrac{d^2\pi_1}{dL_2 dn}\hat{r} - \pi_1'(L_2)\hat{r}}{2\beta\sigma^2_{R2} + \dfrac{d^2\pi_1}{dL_2 d\bar{L}_2}}$$

The denominator is unambiguously positive. A sufficient but not necessary condition for the relationship to be unambiguously negative would be:

$$(10) \qquad \frac{d^2\pi_1}{dL_2 dn} > \pi_1'(L_2)$$

Intuitively, this condition requires the additional crowding out of other banks' lending which would result from adding a bank to the lending package to outweigh the additional lending which would come from that bank. This condition is sufficient but not necessary since a sufficiently negative value of R_2, would ease the condition greatly. I proceed under the assumption that the condition holds. It follows that an increase in the number of lending banks results in a decreased level of lending in the rescheduling range.

The result is driven by the specification that individual banks only take into account the positive impact of lending on the default level of their outstanding loans. A public good problem exists concerning bank lending as long as the number of banks exceeds one. Moreover, this public good problem increases in severity as each banks' share of the total lending package declines, i.e. as the number of banks lending to the debtor nation increases.

Given these results, an increase in the number of banks lending to the debtor country results in a decline in second period lending in state s_3. This leads to proposition 1:

PROPOSITION 1: An increase in the number of banks in the lending package, holding L_1 constant, results in an increase in the probability of debtor default in state s_3.

Proof:

By equation (3), $\pi_1'(\bar{L}_2) < 0$. By equation (9), $\bar{L}_2'(n) < 0$. It follows that:

$$(11) \quad \pi_1'(n) = \frac{\partial \pi_1}{\partial L_2} \frac{\partial L_2}{\partial n} > 0$$

2.3 First period lending decision of banks

Banks consider their expected response to state outcomes in the second period when making their first-period lending decisions. However, second period decisions are only relevant given a state outcome in range $s_1 < s < s_2$. Without changing the qualitative results, I simplify the results of the previous section by specifying that the expected second period rate of return given n is negatively linear in first period lending, reflecting the possibility of concerted lending in the rescheduling range:

$$(12) \quad P_2R_2(L_2 \mid L_1,\ n) = (\hat{R}_2/n)\cdot L_1$$

where $\hat{R}_2$ is an exogenous constant and $L_2|L_1 = k\cdot L_1$, k also exogenous.

It is assumed that free entry in a Chamberlinian model of monopolistic competition results in zero expected profits in lending, adjusted for risk aversion:

$$(13) \qquad U(\Pi^e) = \theta_0 + \left[\ P_3 + (P_2)[1 - \pi_1^e(L_1,n)]\hat{r} - \hat{i}(n)\ \right] L_1 + P_2R_2(L_2^e|L_1,n) - \beta[\sigma_{\pi 1}^2 L_1^2 + \sigma_{R2}^2(L_2^e|L_1)^2] = 0$$

$$= \theta_0 + [v_1 + v_2]\ L_1 - [\beta_1 + \beta_2](L_1)^2$$

where:

$$v_1 = \left[\ \left[P_3 + P_2[1 - \pi_1(L_1,n)]\ \right]\hat{r} - \hat{i}(n)\ \right] > 0$$

$$v_2 = (\hat{R}_2/n) < 0$$

$$\beta_1 = \beta\sigma_{\pi 1}^2$$

$$\beta_2 = \beta\sigma_{R2}^2\cdot k^2$$

$\pi_1(L_1,n)$ is determined as discussed above. $\hat{i}(n)$ is the banks' cost of funds which is determined below. Solving for L_1:

(14) $$L_1 = \frac{1}{\beta_1 + \beta_2} \left\{ v_1 + v_2 + \frac{\theta_2}{L_1} \right\}$$

In addition to the zero-profit condition associated with entry, individual banks choose L_1 to maximize their expected profits. This leads to the first order condition:[9]

(15) $$L_1 = \frac{1}{2(\beta_1 + \beta_2)} \left\{ v_1 + v_2 \right\}$$

Substituting (14) into (15) yields the equilibrium solution for the model:

(16) $$(v_1 + v_2)^2 = -4[\theta_0 \cdot (\beta_1 + \beta_2)]$$

Equation (16) provides a solution for n, the number of banks in the system, given the functional form of v_1.

2.4 Individual bank risk aversion.

The existence of individual bank risk aversion is sufficient to yield some probability of collective action difficulty in the second period. Risk

[9]An additional term, $v_1'(L_{1i})$ is assumed to be zero. This term reflects the positive impact additional first-period lending will have on a banks' second period lending because the individual bank will lend more if it is more heavily exposed. Even with a relatively small value of n the number will be trivial, and so is left out of the analysis for expository reasons.

aversion leads individual banks to avoid taking on the entire loan package, assuring that ex-post the number of banks in the system will exceed one:

PROPOSITION 2: Increases in individual bank risk aversion raise the probability of default in the second period.

Proof:

Totally differentiating equation (16) yields:

$$(17) \quad \frac{dn}{d\beta} = \frac{-4\theta(\sigma_{\pi 1}^2 + \sigma_{R2}^2 \cdot k^2)}{2(v_1 + v_2)[v_1'(n) + v_2'(n)]} > 0$$

An increase in n has two effects. It lowers the return on first period investment due to increased collective action difficulty, and lowers the expected contribution of any individual bank in second period lending. As a result, the sign of $v_2'(n)$ is positive. The denominator is therefore of uncertain sign. A sufficient but not necessary condition for $d\beta/dn > 0$ is:

$$(18) \quad | v_1'(n) | > | v_2'(n) |.$$

Satisfaction of equation (18) requires conciliatory relending to be sufficiently powerful that the increased collective action problem associated with an increase in n outweighs the benefits experienced by a single bank associated with lower relending in the second period. This is implicit in the assumption that relending is globally optimal, which is assumed in range $s_1 < s < s_2$.

Given equation (17), Proposition 1 implies that the increase in the number of banks in the lending package resulting from an increase in β

decreases the expected level of bank lending in the rescheduling state. By Proposition 2, this effect increases the probability of debtor default.

3. Explicit deposit insurance and banking organization

The existence of deposit insurance acts as a subsidy on lending. Deposit insurance enters into the bank lending decision through its effect on the bank's cost of funds. The impact of explicit deposit insurance enters into the bank's cost of funds in two ways.

First, since insured depositors are indifferent to the riskiness of their assets, their interest charge is not tied to the riskiness of the bank lending structure. This removes the regulating activity provided by uninsured deposits from a large portion of a bank's liabilities [Kareken (1986)]. As shown below, increased probability of collective action problems ex-post are "priced" by uninsured depositors, giving banks an incentive to avoid risky lending structures.

With the additional assumption of bank risk aversion, explicit deposit insurance will lead to entry by another avenue. Increased lending levels lead to entry because individual risk-averse banks participating in the loan will not wish to take on all of the additional lending.

3.1 Borrowing costs without deposit insurance

Consider a model in which depositors earn the expected equivalent of the risk-free rate on their deposits. In the absence of deposit insurance, deposits can be considered equivalent to an option issued by the bank [Penati and Protopapadakis (1988)]. With some probability, P_3, there is no default and the depositor obtains his return. Alternatively, with probability $P_2 \cdot [1 - \pi_1(L_1,n)]$, the rescheduling range is reached but no bank failure results. In these cases the depositor "exercises" his option and receives his return. Alternatively, the bank may fail and depositors would lose the value of their deposits.[10] The probability of bank failure is:

$$(19) \quad P_f = P_1 + P_2 \cdot \pi_1(L_1,n)$$

Given that banks pay some rate $\hat{i}$ on deposits ($\hat{i} = 1 + i$), this would leave the expected rate of return on deposits:

$$(20) \quad i^e = \Big[1 - P_1 - (P_2 \cdot \pi_1(L_1,n)) \Big] \hat{i}$$

For uninsured depositors to earn the expected equivalent of the risk-free rate ex-ante, $\hat{i}$ must satisfy:

$$(21) \quad \hat{i} = \Big[1 - P_1 - (P_2 \cdot \pi_1(L_1,n)) \Big]^{-1} \cdot r_f$$

where r_f is the risk-free rate.

Notice that i is an increasing function of n. An increase in n results in an increase in the probability of debtor default due to the increased

[10]Depositors would retain their claim to the residual value of the bank. This is assumed to be zero in this simple model.

probability of collective action problems among lenders in the rescheduling state. In this sense, uninsured deposits provide another reason for $v_1'(n)$ to be negative. In addition to the banks' taking their losses as a result of default into account, the increased probability of default raises the banks' cost of funds due to increased probability of uninsured depositor loss.

3.2 Borrowing costs with deposit insurance

With the introduction of deposit insurance, one portion of the bank's borrowing costs are shielded from the prospect of depositor loss in the event of bank failure. Deposit insurance therefore provides two incentives for entry into the lending package. First, the deposit insurance acts as a subsidy on the level of lending, entering directly into the bank's profit function by lowering the bank's cost of funds on insured deposits. Given risk averse banks, this leads to some level of entry as a substitute for increased exposure of already-participating banks.

Secondly, the cost of insured deposits are independent of the number of banks in the system, since depositors are insured against loss even in the event of a failure. This removes the restriction on entry provided by uninsured depositors. Uninsured depositors "price" increases in the number of banks, since these increases raise the probability of loss of their deposits. With deposit insurance, the majority of deposits do not perform this regulating role.[11]

[11]From 1980 to 1985, the average share of insured deposits in the banking system was 65% to 35% uninsured.

Consider the case where banks obtain insured and uninsured deposits in fixed proportions: ϕ_i and ϕ_u respectively. Given equation (18), the cost of financing L_1 satisfies:

$$(22) \quad \hat{i} = \left\{ \phi_i + \phi_u \left[1 - P_1 - (P_2 \cdot \pi_1(L_1, n)) \right]^{-1} \right\} \cdot r_f$$

As in Penati and Protopapadakis (1988), the fixed proportion assumption is not crucial to the qualitative results. Notice that $\hat{i}$ is larger the larger is the share of ϕ_u relative to ϕ_i. This represents the simple subsidy effect of explicit deposit insurance on lending levels.

In addition, the cross-partial between ϕ_u and n is positive:

$$(23) \quad \frac{d_2\hat{i}}{d\phi_u \; dn} > 0.$$

This secondary effect reflects the positive effect the share of uninsured deposits has on the importance of collective action problems in the bank's cost of funds. Uninsured depositors "price" increased default probability, giving banks an incentive to lower the number of banks in the system. These two effects work in the same direction, leading to the following proposition:

PROPOSITION 3: The number of banks in the lending package is increasing in the share of deposits which are explicitly insured.

Proof:

Totally differentiating equation (16) with respect to n and ϕ_u yields the following:

$$(24) \quad \frac{dn}{d\phi_u} = - \frac{v_1'(\phi_u)}{v_1'(n) + v_2'(n)} < 0$$

The denominator term is unambiguously negative. As above, the ambiguity in the denominator can be solved by alluding to equation (18), the condition which holds in the rescheduling range.

4. Implicit deposit insurance and banking organization.

4.1 Lending diffusion and implicit deposit insurance

In this section, I examine the additional distortion associated with implicit deposit insurance policy. Following Penati and Protopapadakis (1988), assume that loans take either of 2 forms ex-post: "Local loans" whose failure would only harm the banks holding the loans, and "systemic loans," whose failure is perceived by the FDIC as threatening to the stability of the banking system. The FDIC responds to a local loan default by closing banks which fail. The FDIC responds to systemic loan defaults, however, by merging the failing banks with other banks. The difference is that subsequent to a merger, uninsured deposits are carried at par, while subsequent to a closing, uninsured depositors lose the value of their deposits.[12]

Unlike Penati and Protopapadakis, I do not assume that the designation of loans as "local" or "systemic" is exogenous to the decisions of the banking

[12] I assume for simplicity that the residual value of the bank subsequent to a bankruptcy is zero.

agents. Instead, I assume that agents have some expectation of the percentage of banks in the system necessary for their loan to "qualify" under the criterion of regulators as a systemic loan. Resulting lending structures reflect the banks' ability to increase the probability that their loans will qualify for implicit deposit insurance.

Assume that if a certain percentage of the total banking industry, α, or higher were involved in the lending package, the loan would be considered a systemic loan:[13]

$$n/N > \alpha \text{ implies loan is a systemic loan}$$

$$n/N < \alpha \text{ implies loan is a local loan}$$

α is a random variable each period, which varies with the degree of concern of regulators about the stability of the banking system. Assume that α is determined in Stage 2 of the game's extensive form. Define $P_s(n)$ as the probability that the loan is considered systemic by the FDIC. It is clear that $P_s'(n) > 0$ in Stage 1 when the number of banks in the system is determined.

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[13]This is the criterion found in Penati and Protopapadakis (1988). The intuition is that the greater the share of banks participating in the lending package, the lower will be the availability of interbank lending ex-post. However, one might alternatively suggest that the share of total banking system assets would be another criterion, which would allow for one large bank experiencing difficulty to be considered systemic. This sort of a criterion would enter into the bank's decision function identically to that of explicit deposit insurance, as a subsidy on risky lending.

4.2 Bank borrowing costs with implicit deposit insurance

The cost of financing a loan L_1 with implicit deposit insurance is:

$$(25) \quad \hat{i} = \left\{ \phi_i + \left[\phi_u \; [\; 1 - P_1 - \{P_2 \cdot \pi_1(L_1, n)\} \;] \cdot P_s(n) \right]^{-1} \right\} \cdot r_f$$

Comparing equation (25) to equation (22), one can see that an additional term, $P_s(n)$ enters to lower the cost of funds to the bank. Even if default occurs and the bank fails, uninsured depositors still retain their deposit value if a merger results. Depositor loss therefore requires both bank failure and lack of FDIC intervention.

The addition of implicit deposit insurance mitigates the rate at which $\hat{i}$ increases with n:

$$(26) \quad \hat{i}'(n) = - \left\{ \phi_i + \left[\phi_u \; [\; 1 - {}_{P1 - \{P2 \cdot \pi 1(L1,n)\}} \;] \cdot P_s(n) \right]^{-2} \right.$$

$$\underset{(+)}{}$$

$$\cdot \; \underset{(+)}{\phi_u P_2 r_f} \; [\pi_1'(n) P_s(n) + \underset{(?)}{\pi_1(n) P_s'(n)}]$$

It can be seen that a range exists in which $\hat{i}'(n) < 0$. This requires:

$$(27) \quad |\pi_1'(n) P_s(n)| < |\pi_1(n) P_s'(n)|.$$

Intuitively, the cost of bank funds will be decreasing in n if the positive impact increasing n has on the probability of an FDIC bailout exceeds costs associated with increasing the probability of default ex-post due to enhanced collective action problems. Moreover, even outside this range the second term lowers the sensitivity of $\hat{i}(n)$ to increasing n relative to the model with only explicit deposit insurance. This leads to the final proposition:

PROPOSITION 4: The addition of implicit deposit insurance results in a further increase in the number of banks in the lending package, and an increased default probability.

Proof:

Let $\hat{i}_{E\&I}'(n)$ describe the solution for both explicit and implicit deposit insurance given in equation (24). With only explicit deposit insurance, $\hat{i}_E'(n)$ will be greater for any value of n:

$$(28)\quad \hat{i}_E'(n) = -\left\{ \phi_i + \Big[\phi_u \left[1 - P_1 - \underset{(+)}{P_2\cdot[\pi_1(L_1,n)]} \right]\cdot P_s(n) \Big]^{-2} \cdot \underset{(+)}{\phi_u P_2 r_f}\ \underset{(+)}{[\pi_1'(n)P_s(n)]}.\right.$$

In order to investigate the impact of introducing implicit deposit insurance, a specific functional form is needed. Let $i(n) = c\cdot g(n)$ where c is a constant, $g'(n) > 0$ and the introduction of implicit deposit insurance is treated as an increase in c. Totally differentiating equation (16) with respect to n and c yields:

$$(29)\quad \frac{dn}{dc} = - \frac{[\, v_1'(c) + v_2'(c)\,]}{\left\{ v_1'(n) - v_2'(n) \right\}} > 0$$

Again, a restriction must be placed on the relative size of the denominator term. The sufficient condition in equation (18) will suffice here as well.

It can be seen that implicit deposit insurance provides further incentive for diffusion in the lending. Within some range, as discussed above, the cost of funds to banks may actually be decreasing in increasing n. When combined with a risk-averse banking system in which individual banks desire diversification, this provides an incentive for banks to weigh potential future coordination problems less heavily when determining their lending structure.

7. Some simulations

In this section, I use numerical simulations to investigate the impact of alternative lending regimes on the endogenous variables in the lending system. This requires the assumption of two specific functional forms: To allow for analytic solution, I assume a simple linear relationships between both the level of second period lending and the probability of debtor default in range $s_1 < s < s_2$, and for the equations relating the number of banks in the lending package to the probability of an FDIC bail-out ex-post in the implicit deposit insurance regime.[14] The simulations are an investigation into

[14]The use of these linear specifications are simplifications of the theory above, but do not drive the results which follow. They are intended only to allow for analytic solution of the model while retaining the assumption of quadratic firm risk aversion.

the predictions of the model, and are not intended as a test of the model's validity.

The probability of default in range $s_1 < s < s_2$ is specified as:

$$(30) \qquad \pi_1 = 1 - (0.04)n(L_2)$$

where the constant term is inserted to keep $0 < \pi_1 < 1$, and to satisfy the profit conditions requiring positive first period lending.

The share of insured and uninsured deposits is assumed to be roughly equal to that which existed on average from 1980 to 1985:[15] $\phi_u = 0.35$ and $\phi_i = 0.65$.

The probability that the loan will be considered system-threatening under the implicit deposit insurance regime is specified as:

$$(31) \qquad P_s = 0.02 \cdot n$$

where the constant term is again set to allow positive first period lending while constraining the probability to lie between 0 and 1 within the relevant range.

The specifications of the exogenous parameters are as follows: $\phi_u = 0.35$; $\phi_i = 0.65$; $r_f = 0.10$; $r = 0.20$; $\hat{R}_2 = -0.20$; $P(s_1) = 0.05$; $P(s_2) = 0.05$; $P(s_3) = 0.90$; $\sigma^2_{R2} = \sigma^2_{\pi 1} = 0.01$. Given these specifications, simulations were run for a large variety of possible β values under three

[15]Penati and Protopapadakis (1988).

alternative regimes: 1. A risk averse monopolistically-competitive model with no deposit insurance. 2. A model of risk averse banks and explicit deposit insurance, and 3. A model of risk averse banks in the presence of both explicit and implicit deposit insurance. The results are summarized in Table 1, and shown in more detail in Tables 2,3, and 4.

Table 1

Summary of simulation results

I. n, the number of banks

β	No Deposit Insurance	Explicit D.I.	Exp. & Imp. D.I.
0.01	13.207	17.464	19.814
0.10	14.736	19.486	22.101
0.50	17.500	23.140	26.234
1.00	19.571	25.879	29.331
10.00	34.866	46.097	52.194

II. L_1, total first period lending

β	No Deposit Insurance	Explicit D.I.	Exp. & Imp. D.I.
0.01	91.436	120.907	136.933
0.10	9.560	12.641	14.310
0.50	1.995	2.638	2.984
1.00	1.000	1.322	1.495
10.00	0.026	0.035	0.039

III. π, default probability, and EB, expected FDIC burden

β	No Deposit Insurance		Explicit D.I.		Exp. & Imp. D.I.	
	π	EB	π	EB	π	EB
0.01	0.116	—	0.137	10.791	0.149	16.577
0.10	0.124	—	0.147	1.211	0.161	1.859
0.50	0.138	—	0.166	0.284	0.181	0.436
1.00	0.148	—	0.179	0.154	0.197	0.237
10.00	0.224	—	0.280	0.006	0.311	0.009

It can be seen that risk aversion alone suffices in obtaining an equilibrium in which a number of banks participate in the lending process. At β=1, for example, approximately 19 banks participate in lending even without the deposit insurance distortion.[16] However, the additional diffusion of lending resulting from deposit insurance, even given relatively high risk aversion by banks, is not trivial. At β=1 again, explicit deposit insurance raises the number of banks in the lending package to almost 26, while the further addition of implicit insurance on uninsured deposits would raise n to 29.

These increases have implications for the level of lending and the resulting probability of default. Lending units in Table 1 are indexed to equal 1 at β=1 in the no deposit insurance case. Given that index and maintaining β=1, it can be seen that explicit deposit insurance would raise lending by 32%. The further addition of implicit deposit insurance at β=1 would raise the level of lending 49% higher than that in the no insurance regime.

The increased diffusion in lending results in an increased probability of collective action problems ex-post. Again, using the example of β=1, the introduction of explicit deposit insurance raises the probability of default from 14.8% to 17.9%. The further addition of implicit deposit insurance would raise it to 19.7%.

Recall the assumption that the probability of default is independent of lending levels. This was done to cast the deposit insurance in its most

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[16]To ease analytic solution of the simulations, n is treated as a continuous rather than discrete variable.

favorable light. If the increased lending levels resulted in an increased default probability, as would seem the likely case, the impact on π of introducing deposit insurance would be even stronger.

Associated with these default probabilities and lending levels are expected FDIC burdens for the two deposit insurance regimes. At $\beta=1$, the expected burden on the FDIC is 0.154 with explicit deposit insurance, 0.237 with the addition of implicit deposit insurance. The numbers are normalized to the same value units as the lending levels to allow for comparability.

The simulations yielded conclusions similar in spirit to the model above. The introduction of risk aversion, explicit deposit insurance, and implicit deposit insurance each increase the number of banks participating in the lending package. As the number of banks in the system increases, the resulting decline in collective action in the rescheduling range increases the probability of borrower default and the expected burden on the FDIC.

6. Conclusion

Creditor difficulties in coordinating concerted lending towards Latin America have increased awareness of potential collective action problems among banks, spawning a rather large literature on the topic. Given that some probability exists that collective action will be desirable ex-post, however, one would question of banks choosing a lending structure which yield these ex-post collective action problems.

In this paper, a simple model of international lending is introduced in which a probability exists ex-ante that collective action among banks will be desired ex post. The model is one with a rational relending range in which monopolistically-competitive banks lend at sub-optimal levels. The degree to which their lending falls short of the global optimum, and hence the expected probability of default in the rescheduling range, is increasing in the number of banks in the system.

Given this framework, the paper examines three potential sources of diffusion in bank lending structure:

1. Risk aversion by individual banks leads to a sub-optimally large level of banks in the lending portfolio. Sub-optimality exists in the sense that the number of banks exceeds that which would emerge in a system with similar risk-aversion properties if side payments across banks were costless.

2. Explicit deposit insurance raises the number of banks participating in lending beyond that obtained with mere risk aversion. This is accomplished through two effects: First, deposit insurance acts as a subsidy on the level of lending, resulting in entry since already-participating risk averse banks avoid carrying the entire increased exposure. Secondly, uninsured depositors act as a private regulator in pricing their deposits. Structures which lead to higher collective action difficulties, and hence higher default probabilities, result in higher deposit costs ex-ante. Consequently, uninsured deposits lower the number of banks in the lending package. Lowering the share of deposits which are uninsured removes this regulating device.[17]

3. Lastly, the further addition of implicit deposit insurance removes much of the remaining liability side of the bank balance sheet from a private

[17]Note that this structural result mirrors results already found in the literature concerning deposit insurance effects on the riskiness of assets. See Kareken and Wallace (1978) and Penati and Protopapadakis (1988).

regulating role. Consequently, the addition of implicit deposit insurance raises the number of banks participating in the lending package. In addition, if the criteria of loan systemic risk is the share of banks in the system, as in Penati and Protopapadakis (1988), banks have a further incentive to increase their diffusion levels. As shown above, a range may even exist in which the banks' cost of funds are declining in the number of banks in the system.

These sources of bank diffusion are not exclusive. As shown in the simulations above, the addition of deposit insurance to a system in which banks are already risk averse can increase the probability of default in the system dramatically.

Both private creditors and government officials of lending and borrowing countries have argued that the level of loan provision subsequent to the debt crisis was sub-optimally small from the point of view of the banking industry as a whole. Previous discussions of bank lending behavior explain underlending through "herd behavior" followed by banks [Herring and Guttentag (1985)]. This paper shows bank risk aversion and FDIC intervention as a possible source of sub-optimal credit contraction during bad periods. The model above suggests that a sub-optimally large level of banking diffusion, rationally introduced to avoid firm risk and take advantage of FDIC deposit insurance, may have increased the magnitude of this contraction. This scenario can reconcile empirically-observed bank behavior subsequent to 1982 with rational bank decision-making, avoiding allusions to herd behavior found in the literature.

Appendix

In this appendix, the debtor's response function is determined, from which the values of s_1 and s_2, the boundaries of the "rescheduling range" can be obtained.

Assume the debtor has utility function:

$$(A.1) \qquad U_d = U[f(Q_2(s), L_2), P(s'), D]$$

where $U'f(\cdot) < 0$ and $U'P(\cdot) < 0$. Utility maximization implies that:

$$(A.2) \qquad D = 1 \text{ if } f(Q_2(s), L_2) > P(s')$$

$$D = 0 \text{ if } f(Q_2(s), L_2) < P(s')$$

It follows that:

$$(A.3) \qquad E(D) = \text{Prob.}\left\{ f(Q_2(s), L_2) - E[P(s')] > 0 \right\}$$

Let $\text{Prob.}[\cdot] = \pi_1(L_2, s)$ as specified in equation (3). Global maximization of creditor profits would then require each bank's decision to satisfy:

$$(A.4) \qquad -\pi_1'(L_2)\hat{r}\bar{L}_1 + R_2 - 2\beta\sigma^2_{R2}L_2 = 0$$

as derived from equation (4) in the text.

As shown above, $R_2 < 0$ implies that a collective action problem exists, i.e. the level of lending falls short of the optimum. It follows that in the neighborhood of $R_2 = 0$ the level of lending will still be sub-optimal. Only when no positive externality results from new lending will no collective action problem exists. This occurs when the realization of s is high enough to result in the debtor choosing $D = 0$ even if $L_2 = 0$. s_2 then satisfies:

$$(A.5) \qquad f(Q_2(s_2), L_2 \mid L_2 = 0) > E[P(s')]$$

s_1 is the boundary at which relnding becomes globally optimal. This requires the benefits on new loans to outweigh the negative expected returns new loans yield in the following period. From equation (A.4) the globally-optimal level of L_2 satisfies:

$$(A.6) \qquad L_2 = \frac{-\pi_1'(L_2, s)\hat{r}\bar{L}_1 + R_2}{2\beta\sigma^2_{R2}}$$

Optimal $L_2 \leq 0$ would then require:

$$(A.7) \qquad -\pi_1'(L_2, s)\hat{r}\bar{L}_1 + R_2 < 0.$$

This fixes the value of s_1. s_1 satisfies:

(A.8) $$- \pi_1'(L_2, s_1)\hat{r}\bar{L}_1 + R_2 < 0.$$

Intuitively, s_1 is defined as the boundary state at which the positive benefits of even the first dollar of concerted relending fails to outweigh the cost of next period's negative expected return.

Table 1

Risk averse banks without deposit insurance

β	n	L_1	Prob. Def.
0.01	13.207	91.436	0.116
0.02	13.500	46.169	0.118
0.03	13.725	30.998	0.119
0.04	13.914	23.382	0.120
0.05	14.081	18.796	0.120
0.10	14.736	9.560	0.124
0.20	15.662	4.874	0.128
0.25	16.036	3.924	0.130
0.30	16.373	3.286	0.132
0.40	16.972	2.482	0.135
0.50	17.500	1.995	0.138
0.60	17.977	1.667	0.140
0.70	18.416	1.431	0.142
0.75	18.624	1.336	0.143
0.80	18.825	1.252	0.144
0.90	19.208	1.113	0.146
1.00	19.571	1.000	0.148
2.00	22.500	0.481	0.163
5.00	28.313	0.148	0.192
10.00	34.866	0.026	0.224

Table 2

Risk averse banks with explicit deposit insurance

β	n	L_1	Prob. Def.	Exp. FDIC Burden
0.01	17.464	120.907	0.137	10.791
0.02	17.851	61.049	0.139	5.525
0.03	18.148	40.990	0.141	3.750
0.04	18.399	30.918	0.142	2.854
0.05	18.620	24.854	0.143	2.312
0.10	19.486	12.641	0.147	1.211
0.20	20.710	6.445	0.154	0.643
0.25	21.204	5.188	0.156	0.526
0.30	21.650	4.345	0.158	0.447
0.40	22.442	3.282	0.162	0.346
0.50	23.140	2.638	0.166	0.284
0.60	23.771	2.204	0.169	0.242
0.70	24.352	1.892	0.172	0.211
0.75	24.626	1.766	0.173	0.199
0.80	24.892	1.656	0.174	0.188
0.90	25.399	1.471	0.177	0.169
1.00	25.879	1.322	0.179	0.154
2.00	29.752	0.636	0.199	0.082
5.00	37.437	0.196	0.237	0.030
10.00	46.097	0.035	0.280	0.006

Table 3

Risk averse banks with explicit and implicit deposit insurance

β	n	L_1	Prob. Def.	Exp. FDIC Burden
0.01	19.814	136.933	0.149	16.557
0.02	20.252	69.135	0.151	8.479
0.03	20.588	46.415	0.153	5.754
0.04	20.872	35.008	0.154	4.379
0.05	21.121	28.141	0.156	3.548
0.10	22.101	14.310	0.161	1.859
0.20	23.486	7.294	0.167	0.987
0.25	24.044	5.871	0.170	0.808
0.30	24.548	4.917	0.173	0.686
0.40	25.444	3.713	0.177	0.531
0.50	26.234	2.984	0.181	0.436
0.60	26.947	2.493	0.185	0.371
0.70	27.603	2.140	0.188	0.324
0.75	27.914	1.998	0.190	0.305
0.80	28.214	1.873	0.191	0.288
0.90	28.788	1.663	0.194	0.260
1.00	29.331	1.495	0.197	0.237
2.00	33.710	0.718	0.219	0.126
5.00	42.400	0.221	0.262	0.046
10.00	52.194	0.039	0.311	0.009

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