# Fixed-Premium Deposit Insurance and International Credit Crunches


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*This article introduces a monopolistically competitive model of foreign lending in which both explicit and implicit fixed-premium deposit insurance increase the degree to which bank participation in relending to problem debtors falls below its globally optimal level. This provides a channel for fixed-premium deposit insurance to inhibit credit extension in bad states, resulting in an increase in the expected default percentage and an increase in the expected burden on the deposit insurance institution.*


While the perverse incentives faced by banks due to fixed-premium deposit insurance have been well-documented,[1] the literature has largely ignored the potential of deposit insurance to distort the organization of the banking industry. This paper introduces a simple model to fill this gap, in which fixed-premium deposit insurance plays a role in determining the structure of bank lending. To the extent that banking organization affects the ability of banks to act in concert, the paper introduces a new channel through which deposit insurance may have an adverse impact on lending outcomes.

The impact of deposit insurance on bank behavior has long been a source of concern to policymakers and researchers. A large literature exists which argues that fixed-premium deposit insurance increases the riskiness of bank lending portfolios (Kareken and Wallace 1978, Kareken 1986, Penati and Protopapadakis 1988, Jaffee 1989, Kane 1989, Duan, et al., 1992). In addition, Penati and Protopapadakis argue that "implicit deposit insurance," where regulators merge rather than close failing banks out of concern for the stability of the financial system, provides an additional subsidy. For example, from 1978 through 1984, only 20 percent of failed U.S. banks were closed. Moreover, these were largely small banks, representing only 0.2 percent of total deposits.

This paper demonstrates that the introduction of fixed-premium deposit insurance, both explicit and implicit, can magnify the degree to which credit extension is sub-optimal by increasing the number of banks participating in the lending package. The analysis is conducted through a monopolistically competitive two-period model of foreign lending, introduced in Section II.

The interesting decision in the two-period model comes at the end of the first period. Banks are confronted with the ability to increase the performance of their outstanding loans by rolling over debt at terms that would not appear to be profitable to unexposed creditors. However, there are positive spillovers associated with new lending, which implies that the disparity between the magnitude of new lending and that which is globally optimal will be increasing in the number of exposed banks. The incentive to avoid this

1. See Santomero (1984) for an extensive survey of this literature.

public good problem limits the number of participating banks in equilibrium. However, fixed-premium deposit insurance mitigates this incentive, increasing the number of participating banks and exacerbating the public good problem. This reduces the expected percentage of debt service, increases the probability of bank failure, and increases the expected burden on the deposit insurance institution. Simulation results below indicate that fixed-premium deposit insurance can have a relatively large impact on default probabilities.

While our qualitative results apply equally well to any situation where externalities among creditors may exist,[2] foreign lending provides a particularly clean example of lending externalities across banks. In domestic lending situations, creditors can partially deal with anticipated future renegotiation difficulties through debt covenants and other contract instruments[3] which are not binding in an international lending context. In addition, rescheduling negotiations in international lending take place under the auspices of the Paris Club, which applies the constraint of equal sharing rules, such that all loans have equal seniority. Finally, episodes of perceived sub-optimal credit extension are well documented in international lending, such as the failure of the Baker Plan to deal with the Latin American debt crisis (Cline 1989).

There is considerable evidence that the deposit insurance subsidy affected bank incentives in foreign lending. Event studies of the impact of the debt crisis in August 1982 on bank equity showed a consistently lower impact on excess returns than would be suggested by the magnitude of the news. 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 the average annual excess returns of banks exposed to Mexico (Schoder and Vankudre 1986, Bruner and Simms 1987, and Spiegel 1992).[4] Similarly, James (1990) finds that changes in the value of bank stock equity are smaller than exposure-weighted movements in the secondary market prices of sovereign debt would imply.

This paper is organized as follows: Section I reviews the performance of commercial banks under the Baker Plan. Section II then introduces our theoretical model. The impact of deposit insurance, both explicit and implicit, is examined in Section III. Section IV contains simulations concerning the empirical predictions of the effects discussed in the theory. Section V concludes.

## I. THE BAKER PLAN: 1986–1988

The “Baker Plan,” named for former Treasury Secretary James Baker, provides one of the best recent examples of collective action problems among international creditors. Subsequent to Mexico’s suspension of payment on its external debt, a number of countries experienced difficulties in obtaining financing. The general belief concerning the difficulties faced by these countries was that their problems were ones of “illiquidity” rather than “insolvency.” In other words, if financing could be obtained to get countries through a relatively difficult period, they would then be able to service all of their debts. Subsequent to this period “... countries could grow their way out of debt and could expand their exports enough to reduce their relative debt burdens to levels compatible with a return to normal credit market access” (Cline 1989 p. 177).

The Baker Plan called for commercial banks to extend approximately $7 billion annually, or 2.5 percent of total exposure, to fifteen highly indebted developing countries.[5] Cline (1989) claims that banks achieved capital flows of approximately $13 billion over the Baker Plan period, or about two-thirds of their $20 billion target.[6] It was well understood at the time that the anticipated disbursements from commercial banks under the plan were by no means certain. Brainard (1987) suggested that banks needed to understand how the involved government intended to manage the Baker Plan or “... increased official lending will merely substitute for reduced bank credits.”

In retrospect, the magnitude of actual flows during the Baker Plan period seems even lower than Cline’s estimate. Husain (1989) points out that while the IMF estimates that commercial banks committed $16.4 billion in new money and actually disbursed $15 billion—figures the commercial banks themselves used to support their claims of having come close to the Baker Plan targets—debtor country data show that net new long-term financing to the highly indebted countries amounted to only $4 billion (see Table 1). Moreover, if private nonguaranteed debt is taken into

2. See Bernanke (1991) for a discussion of domestic “credit crunches.”

3. See, for example, Berlin and Mester (1992).

4. Beebe (1985) and Cornell and Shapiro (1986) show larger declines over the long run, but their measures do not approach the magnitudes observed in bond-spread movements.

5. The original countries were Algeria, China, Egypt, Greece, Hungary, India, Indonesia, Malaysia, Pakistan, Poland, Portugal, Thailand, and Turkey; Costa Rica and Jamaica were added later.

6. Ironically, public sector capital flows to the Baker nations actually did worse over the plan, falling by $4 billion annually. This occurred because of large decreases in IMF and bilateral lending.

TABLE 1

COMMERCIAL BANK LENDING TO HIGHLY INDEBTED COUNTRIES UNDER THE BAKER PLAN
(In billions of US dollars)

| | 1986 | 1987 | 1988 | 1986–1988 |
|---|---|---|---|---|
| CONCERTED NEW MONEY | | | | |
| Commitments | 8.3 | 2.4 | 5.6 | 16.4 |
| Disbursements | 3.2 | 5.7 | 6.0 | 15.0 |
| CHANGE IN EXCHANGE RATE | | | | |
| Adjusted claims | 3.5 | 0.6 | 2.0 | 6.1 |
| NETDISBURSEMENTS | –0.4 | 2.3 | 2.1 | 4.0 |

Source: Husain (1989)

account, there were net repayments to commercial banks amounting to $2.4 billion. In no case did commercial banks provide more net financing than they received in interest payments. Husain also adds that "U.S. banks have been most active in reducing their developing country exposure. Between mid-1987 and the end of the third quarter of 1988, these banks reduced their claims on all developing countries by more than $20 billion. More than half of this represented a reduction in claims on highly indebted countries" (p. 14).

In summary, the Baker Plan is an example of collective action problems across commercial banks. It was generally perceived that increasing exposure in the aggregate was desirable from the point of view of the exposed banks, but individually each bank had the incentive to "free-ride" on the efforts of the other creditors by not fulfilling its disbursement commitment. The result was that the level of new money extended to the highly indebted nations was sub-optimal from the aggregate creditor perspective. Because commercial banks faced incentive problems in taking collective action, a resolution of the debt crisis required turning to voluntary methods, such as the "market-based menu approach" associated with the Brady Plan (see Diwan and Spiegel 1994).

## II. A MONOPOLISTICALLY COMPETITIVE MODEL OF BANK LENDING

### *Setup*

In this section, we derive a formal model which exhibits collective action problems similar to those encountered under the Baker Plan. There are three types of players in the model, a debtor nation government, a group of identical monopolistically competitive banks, and atomistic depositors. The extensive form of the model has five stages: In the first stage, the magnitude of first-period lending by individual banks, $l_1$, and the number of banks participating in the initial lending package, $n$, are determined. Total first period lending, $L_1$, then equals $nl_1$. Loans are assumed to be short term, coming due at the end of the first period.[7] For simplicity, all first-period lending is assumed to be consumed. First-period output of the debtor nation, $q_1$, is determined in the second stage. In the third stage, banks choose an amount of new lending $l_2$, so that total new lending $L_2 = nl_2$. In the fourth stage, the debtor nation government chooses its percentage of debt service on outstanding first-period loans, $\pi_1$, where $\pi_1 \in [0,1]$. Finally, second period debtor nation output, $q_2$, is determined in the final stage, which simultaneously determines the percentage of debt service on outstanding second period lending, $\pi_2$, where $\pi_2 \in [0,1]$.

$q_1$ and $q_2$ are assumed to be exogenous independently distributed random variables distributed uniformly on the interval [0,1].[8] Total lending in each period is equal to the number of banks participating in the lending package, $n$, times individual bank lending, $l_t$. As we show below, $n$ will be constant across periods. Let $\bar{r}_t$ represent one plus the contractual nominal rate of interest on the loan in period $t$ ($t$ = 1, 2). For simplicity, $\bar{r}_t$ is taken as exogenous.[9] Consequently, the outstanding obligation on period $t$ loans at the end of period $t$ will be equal to $\bar{r}_t nl_t$.

7. Creditors might respond to future anticipated renegotiation problems by lengthening the maturity of their debt contract (Sharpe 1991). In practice, however, creditors responded to the increase in the perceived riskiness of the highly indebted countries by shortening the maturity of their loans. The lack of long-term lending may stem from equal-sharing, since some of the benefits of extending a long-term loan would spill over to short-term creditors.

8. We assume that $q_1$ and $q_2$ are independent for simplicity. This does not drive the results below, but it does increase the parameter space in which relending to a problem debtor is an optimal response. If the two were positively correlated, it would be more "likely" that relending would be throwing good money after bad. Nevertheless, since the point of the exercise is to introduce an example where collective action problems may arise, this assumption is relatively innocuous.

The assumption of exogeneity of these output variables is also made for simplicity and drives none of the results below. However, allowing for "debt overhang" effects, where indebtedness may affect output levels, may also affect the desirability of relending in a more general model.

9. It is well known that allowing banks to choose both $l_t$ and $\bar{r}_t$ would result in a multiplicity of equilibria. Holding $\bar{r}_t$ constant is valid if the debtor is credit constrained, which we assume for a problem international debtor.

### *Debtor Decisions*

We assume that output is not storable and consumption takes place at the end of each period. First period consumption, $c_1$, will equal output plus new lending minus service on outstanding debt:

$$c_1 = q_1 - \pi_1\bar{r}_1L_1 + L_2 . \tag{1a}$$

Similarly, second period consumption is equal to second period output minus service on outstanding second period obligations:

$$c_2 = q_2 - \pi_2\bar{r}_2L_2 . \tag{1b}$$

The debtor chooses $\pi_t$ ($t = 1, 2$) to maximize utility. Debtor utility, $u_t$, is an increasing function of current consumption and a decreasing function of an exogenous "default penalty," $P(\pi_t)$:

$$U_t = U[c_t, P(\pi_t)]; \quad (t = 1, 2). \tag{2}$$

where $U_c>0$, $U_{cc}<0$, $U_{ccc} = 0$, $U_P<0$, $U_{PP}<0$, $P_\pi<0$, $P_{\pi\pi}<0$, and $U_{cP} = 0$. $P(\pi_t)$ is decreasing in the percentage of debt service and is intended to represent the discounted costs of default.[10] In the Appendix, we show that maximization of (2) subject to (1a) and (1b) implies that the debtor's first-period decision satisfies the triple:

$$\pi_1 = \pi_1^* (q_1 , L_1 , L_2), \tag{3a}$$

where $\partial\pi_1/\partial q_1>0$, $\partial\pi_1/\partial L_1<0$, $\partial\pi_1/\partial L_2>0$, and the debtor's second-period decision satisfies:

$$\pi_2 = \pi_2^* (q_2 , L_2), \tag{3b}$$

where $\partial\pi_2/\partial q_2>0$, $\partial\pi_2/\partial L_2<0$. Note that the expected percentage of debt service on outstanding first-period loans is increasing in second-period lending. This raises the possibility of profitable rescheduling by exposed creditors, as we show below.

### *Deposit Rates*

Define $r_t$ ($t = 1, 2$) as one plus the risk-free rate of interest. Depositors are risk neutral and atomistic and have the right to remove deposits after each period. They therefore require an expected return equal to $r_t$. Define $q_t^B$ ($t = 1, 2$) as the probability of bankruptcy by the representative creditor in period $t$. Note that since $q_t$ is distributed uniform on the unit interval, $q_t^B$ also represents the minimum realization of $q_t$ which leaves the creditor solvent. Uninsured depositors will therefore require a nominal rate of interest on uninsured deposits equal to $r_t/(1 - q_t^B)$ in period $t$. Define $\tau$, $\tau \in [0,1]$, as the share of bank deposits that are insured by the deposit insurance institution of the commercial bank, taken as exogenous.[11] Finally, define $\gamma_t$ as one plus the average rate of interest paid by the representative commercial bank on deposits. $\gamma_t$ will satisfy:

$$\gamma_t = r_t[(1 - \tau)/(1 - q_t^B) + \tau]; \quad (t = 1, 2). \tag{4}$$

Note that $\gamma_t$ is increasing in $q_t^B$ and decreasing in $\tau$. To the extent that deposits are uninsured, the average rate paid to depositors will be increasing in the the probability of bankruptcy, $q_t^B$. However, to the extent that deposits are insulated from loss through deposit-insurance, the sensitivity of $\gamma_t$ to $q_t^B$ is diminished.

### *Creditors*

There are assumed to be a large number of homogeneous potential creditors who have identical portfolios of non-debtor-nation loans with face values of $a_t$ that pay nominal interest equal to $\rho_t$. Both $a_t$ and $\rho_t$ are assumed to be invariant with respect to the lending decisions towards the debtor nation and deterministic. Given $l_t$ and $\gamma_t$, the creditor finances its lending by issuing $(a_t + l_t)$ in liabilities. The creditor's return in period $t$ satisfies:

$$R_t = \rho_t a_t + \pi_t\bar{r}_t l_t - \gamma_t(a_t + l_t); \quad (t = 1, 2). \tag{5}$$

We assume that banks have limited liability and that regulators close banks in the event that a bank shows negative net worth in either period. We examine the case where regulators merge failing banks under some circumstances below. For simplicity, we assume banks do not retain earnings. Consequently, a bank fails if $R_t$ falls below zero in either period.

### *Second Period Lending Decision*

To insure sub-game perfection, we begin with the second period creditor decision. In the second period, creditors choose their individual amount of new lending, $\hat{l}_2$, taking other creditors' new lending as given. Given the po-

10. The default penalty is needed to generate positive lending in equilibrium, but its specification does not drive our results. Default penalties in sovereign lending have been motivated by loss of future access to capital markets (Eaton and Gersovitz 1981), seizure of assets (Bulow and Rogoff 1989), or loss of reputation (Grossman and Van Huyk 1988). Lindert and Morton (1989) show that the ex-post rate of return on sovereign lending has historically been competitive, implying that the perception of a penalty for default exists.

11. Generalizing the model by allowing depositors to increase $\tau$ by "brokering" deposits across a number of banks would actually strengthen the results below by providing an additional incentive for an increase in the number of banks.

tential for sub-optimal levels of credit extension we derive below, only one lender would emerge per nation in the absence of incentives for banks to avoid taking on the entire lending package. However, lending to debtor nations is usually broken up over a large number of banks. To accommodate this empirical fact, we assume that banks are risk-averse and that the riskiness of their asset portfolio is increasing in bank exposure to the debtor nation. Under this assumption, we specify the value function of creditors in period 2, $\Omega_2$, as increasing in the returns on bank operations and decreasing in bank risk, $\sigma_2$, where $\sigma_t$ is an increasing function of $\hat{l}_t$, $\sigma_t = \sigma(l_t)$ $(t = 1, 2)$. In period 2, $\Omega_2$ satisfies:

$$\Omega_2 = \Omega_2[R,\sigma(l_2)]\ , \tag{6}$$

where $R = R_1 + (1/r_2)R_2$ and $\Omega_R>0$, $\Omega_\sigma<0$, $\Omega_{R\sigma} = 0$, $\sigma_{l_2}>0$.

Consider a representative exposed creditor who extended a loan equal to $l_1$ in the first period. Subsequent to the realization of $q_1$, the creditor's decision problem is to choose the value of $\hat{l}_2$ which maximizes the expected value of $\Omega_2$. The creditor's first-order condition satisfies:[12]

$$\frac{\partial\Omega_2}{\partial R}\left[\frac{\partial\pi_1}{\partial L_2}\bar{r}_1 l_1 + \frac{1}{r_2}\left[\pi_2\bar{r}_2 - \gamma_2 + \frac{\partial\pi_2}{\partial L_2}\bar{r}_2\hat{l}_2 - \frac{\partial\gamma_2}{\partial\hat{l}_2}(a_2+\hat{l}_2)\right]\right] + \frac{\partial\Omega_2}{\partial\sigma}\frac{\partial\sigma}{\partial\hat{l}_2} = 0. \tag{7}$$

The first term in equation (7) reflects the sum of pecuniary benefits in both first- and second-period earnings of an increase in $l_2$ on the margin. The first portion of that term reflects the positive impact on outstanding loans, while the second term reflects the impact on second-period loans. The overall sign of this term is ambiguous because of the second term in equation (7). If banks are sufficiently risk-averse, they will cease lending to the debtor at a point which leaves it profitable for some new entry to occur in the second period. Since this would greatly complicate the model, we rule this out. This requires the parameter restriction that the positive impact on the margin to an exposed creditor exceeds the adverse impact of the increase in risk, i.e.,

$$\frac{\partial\Omega_2}{\partial R}\frac{\partial\pi_1}{\partial L_2}\bar{r}_1 l_1 + \frac{\partial\Omega_2}{\partial\sigma}\frac{\partial\sigma}{\partial\hat{l}_2} > 0.$$

Satisfaction of this restriction leaves the rate of return on second-period lending less than zero and the number of exposed creditors in the second period unchanged at $n$.

The creditor also considers the impact on its deposit rate, $\gamma_2$, when making its new lending decision. We demonstrate in the Appendix that the second-period deposit rate, $\gamma_2$, is a triple:

$$\gamma_2 = \gamma_2(\hat{l}_2, L_2, \tau), \tag{8}$$

where $\partial\gamma_2/\partial\hat{l}_2>0$, $\partial\gamma_2/\partial L_2>0$, and $\partial\gamma_2/\partial\tau<0$. We also conduct the comparative static exercises for (7) and demonstrate that the individual bank's second-period lending is a quadruple:

$$\hat{l}_2 = \hat{l}_2(\hat{l}_1, L_1, L_2, \tau), \tag{9}$$

where $\hat{l}_t$ $(t = 1, 2)$ represents an individual bank's choice of $l_2$ taking the decisions of other banks as given and $\partial\hat{l}_2/\partial l_1>0$, $\partial\hat{l}_2/\partial L_1>0$, $\partial\hat{l}_2/\partial L_2<0$, and $\partial\hat{l}_2/\partial\tau>0$.

Equation (9) is derived as the optimum lending choice for an individual bank taking the lending choices of other banks as given. However, in equilibrium $L_2 = nl_2$. Substituting for $L_2$ in (9), and recalling that $\partial l_2/\partial L_2<0$, we obtain the quadruple:

$$\hat{l}_2 = \hat{l}_2(\hat{l}_1, L_1, n, \tau). \tag{10}$$

where $\partial\hat{l}_2/\partial n<0$.

Second-period lending is increasing in the magnitude of first-period lending because first-period debt service is increasing in second-period lending. Consequently, banks have an incentive to engage in "conciliatory relending" by rolling over a portion of the outstanding debt to decrease the magnitude of first-period default. The greater is a bank's exposure, the greater are the benefits from a unit increase in $\pi_1$ and the greater is the magnitude of relending per bank. An individual bank's second-period lending is decreasing in the total magnitude of outstanding first-period lending, however, because the degree to which a bank benefits from its own relending efforts is decreased by the amount of outstanding claims on the debtor. In equation (10), second period relending is decreasing in $n$, the total number of creditors, because the positive first-period effects of relending diminish as the magnitude of new lending increases, while the negative effects on expected second-period returns are enhanced. Finally, the magnitude of second period lending per bank is increasing in the share of insured deposits. Deposit insurance makes it less costly to engage in conciliatory relending. Consequently, holding all else equal, a bank would be more willing to engage in conciliatory relending the larger is the share of insured deposits.

12. Equation (7) is simplified by noting that on the margin $\partial\pi_t/\partial\hat{l}_2 = \partial\pi_t/\partial L_2$ $(t = 1, 2)$.

### *Comparison with a Globally Optimal Solution*

Finally, we compare the creditor's solution with one which would be globally optimal across creditors. The solution that would maximize global creditor profits would satisfy:

$$(11)\quad \frac{\partial\Omega_2}{\partial R}\left[\frac{\partial\pi_1}{\partial L_2}\bar{r}_1 L_1 + \frac{1}{r_2}\left[\pi_2\bar{r}_2 - \gamma_2 + \frac{\partial\pi_2}{\partial L_2} - \frac{\partial\gamma_2}{\partial\hat{l}_2}(na_2+L_2)\right]\right] + \frac{\partial\Omega_2}{\partial\sigma}\frac{\partial\sigma}{\partial\hat{l}_2} = 0\,.$$

Rearranging terms, we obtain:

$$(12)\quad \frac{\partial\Omega_2}{\partial R}\left[n\left[\left[\frac{\partial\pi_1}{\partial L_2}\bar{r}_1 L_1 + \frac{\partial\pi_2}{\partial L_2}\bar{r}_2 l_2/r_2\right] - \left[\frac{\partial\gamma_2}{\partial\hat{l}_2}(a_2+l_2)\right]/r_2\right] + \left[\pi_2\bar{r}_2 - \gamma_2\right]/r_2\right] + \frac{\partial\Omega_2}{\partial\sigma}\frac{\partial\sigma}{\partial\hat{l}_2} = 0.$$

The first bracketed term can be signed as positive by (7), since the other terms in (7) are negative.

Comparing equations (12) and (7), we can see the source of the sub-optimality of lending by the individual bank from the global point of view of creditors. The individual bank's first-order condition accounts for the positive impact of new lending on the rate of return on his outstanding loans. However, he does not consider the positive spillovers to other outstanding creditors. To see this clearly, note that the positive impact on an individual bank's profits from new lending in equation (12) is multiplied by $n$, the number of banks in the lending package, while this number is only multiplied by one in the individual bank's decision in equation (7). Consequently, the individual bank's level of new lending is sub-optimal and the disparity between the individual solution and the globally optimal solution among creditors as a group is increasing in $n$.

However, we should point out that the socially optimal outcome would be the one that would emerge without fixed-premium deposit insurance, rather than one which induced the globally optimal level of second-period lending. The optimal allocation will include some degree of sub-optimal second-period lending because of bank risk-aversion. This outcome could alternatively be achieved by charging banks a variable premium equal to the expected liability of the deposit insurance institution. Nevertheless, while such a policy may be optimal ex ante, it may not be time-consistent ex post since regulators will wish to enhance second-period credit extension.

## III. EQUILIBRIUM UNDER DEPOSIT INSURANCE

### *Equilibrium under Explicit Deposit Insurance*

Given the expected second-period responses derived above, we now compute the first-period values of $\hat{l}_1$ and $n$. We proceed under the assumption that a collective action problem exists among creditors, i.e., that the percentage of first-period debt service is decreasing in $n$. The conditions for this innocuous assumption are derived in the Appendix. Under this assumption, we demonstrate in the Appendix that the first-period deposit rate, $\gamma_1$, is a quadruple:

$$(13)\quad \gamma_1 = \gamma_1(\hat{l}_1, l_1, n, \tau),$$

where $\partial\gamma_1/\partial\hat{l}_1>0$, $\partial\gamma_1/\partial l_1>0$, $\partial\gamma_1/\partial n>0$, and $\partial\gamma_1/\partial\tau<0$.

The bank's cost of funds is increasing in $l_1$ (and $\hat{l}_1$) and $n$ because increases in both raise the stock of outstanding debt and lower the expected percentage of debt service. In addition, increases in $n$ exacerbate the public good problem associated with new lending. However, deposit insurance, by insulating a portion $\tau$ from bankruptcy risk, reduces the sensitivity of depositor interest rates to the probability of creditor bankruptcy. Hence $\partial^2\gamma_1/\partial n\partial\tau<0$, as we show in the appendix.

In the first period, participating creditors choose the value of $\hat{l}_1$ which maximize expected returns subject to limiting their risk exposure, taking the actions of other creditors as given. Similar to our assumption above, we specify the value function of creditors in period 1, $\Omega_1$, as increasing in the returns on bank operations and decreasing in bank risk on both periods, $\sigma_1$ and $\sigma_2$, where $\sigma_t$ ($t$ = 1, 2) is an increasing function of $\hat{l}_t$:

$$(14)\quad \Omega_1 = \Omega_1[R, \sigma(\hat{l}_1), \sigma(\hat{l}_2)]\,.$$

The participating creditor's first-order condition satisfies:

$$(15) \qquad \frac{\partial\Omega_1}{\partial R}\left[\frac{\partial\pi_1}{\partial L_1}\bar{r}_1\hat{l}_1 + \pi_1\bar{r}_1 - \gamma_1 - \frac{\partial\gamma_1}{\partial\hat{l}_1}(a_1+\hat{l}_1) + \frac{1}{r_2}\left[\pi_2\bar{r}_2 - \gamma_2 + \frac{\partial\pi_2}{\partial L_2}\bar{r}_2\hat{l}_2 - \frac{\partial\gamma_2}{\partial\hat{l}_2}(a_2+\hat{l}_2)\right]\frac{\partial\hat{l}_2}{\partial\hat{l}_1}\right] + \frac{\partial\Omega_1}{\partial\sigma}\frac{\partial\sigma}{\partial\hat{l}_1} + \frac{\partial\Omega_2}{\partial\sigma}\frac{\partial\sigma}{\partial\hat{l}_2}\frac{\partial\hat{l}_2}{\partial\hat{l}_1} = 0\,.$$

In addition to the maximization decisions of the individual banks, monopolistic competition among banks with free entry will lead to zero expected "value function" profits for participating banks in each period. Let $\Omega^n$ equal the expected value function for the representative bank if it chooses not to enter. Competition across banks insures that banks will continue to enter until:

$$(16) \qquad \Omega^n \geq \Omega_1.$$

We therefore define a competitive equilibrium satisfying the assumptions above by the solutions $\hat{l}_1^*$ and $n^*$ which represent the maximum level of $n\hat{l}_1$ which satisfies equations (15) and (16) with equality. See Figure 1. Despite the fact that both curves are downward-sloping, the initial equilibrium is the standard one in monopolistic competition models, with one equation representing the individual lenders' profit maximization decision, the "MM curve," and one equation representing a zero-profit condition, the "ZZ curve." Note that both curves are functions of the share of insured deposits $\tau$.

To demonstrate the impact of deposit insurance, we conduct a comparative static exercise on the parameter $\tau$. One can consider the introduction of deposit insurance as a discrete increase in $\tau$ from a zero level, which our analysis approximates. The comparative statics of the model satisfy:

$$(17) \qquad \begin{bmatrix} \partial\Omega_1/\partial\hat{l}_1^2 & \partial^2\Omega_1/\partial\hat{l}_1\partial n \\ \partial\Omega_1/\partial\hat{l}_1 & \partial\Omega_1/\partial n \end{bmatrix}\begin{bmatrix} \partial\hat{l}_1/\partial\tau \\ \partial n/\partial\tau \end{bmatrix} = \begin{bmatrix} -\partial^2\Omega_1/\partial\hat{l}_1\partial\tau \\ -\partial\,\Omega_1/\partial\tau \end{bmatrix}.$$

We sign the terms in the Appendix. As we suggested above, the deposit insurance subsidy affects the equilibrium through two channels: First, the subsidy increases total lending; second, banks have less incentive to organize the lending package in a form conducive to collective action. See Figure 2. An increase in $\tau$ shifts out both curves. The

FIGURE 1

INITIAL EQUILIBRIUM

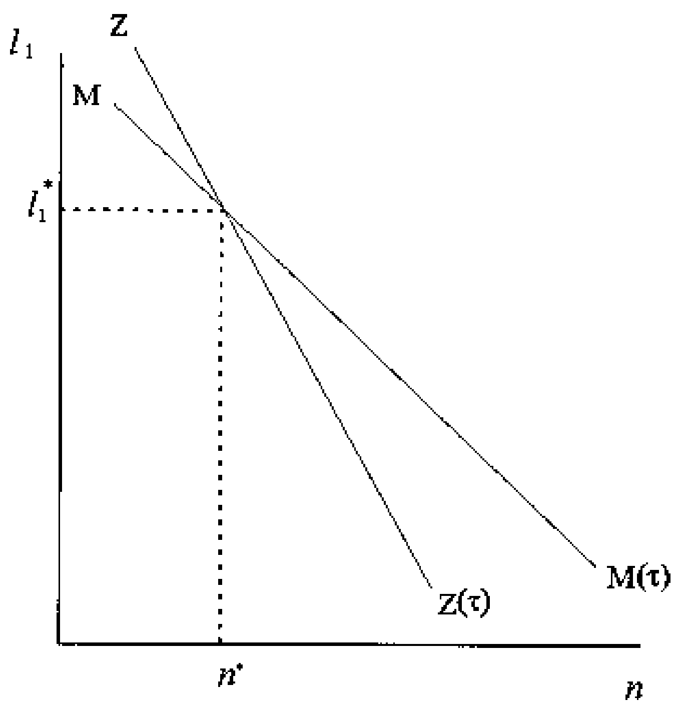
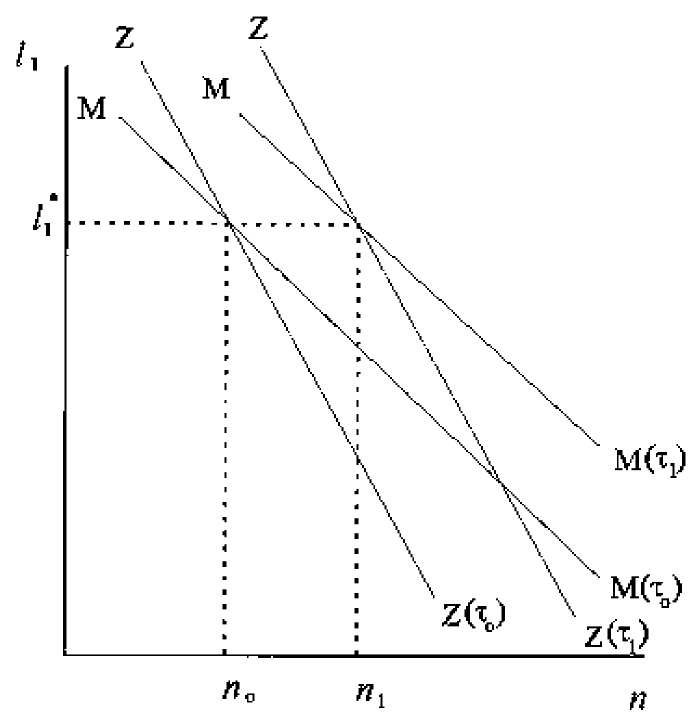



FIGURE 2

COMPARATIVE STATIC RESULTS



zero-profit condition (ZZ) curve shifts out because, holding all else equal, an increase in the share of deposit insurance increases the returns from lending. Given any value of $l_1$, this implies an increase in $n$ to return to zero profits. The MM curve shifts out because holding $n$ constant, the reduction in deposit rates leads each bank to make a larger initial loan, resulting in an increase in $l_1$. However, our comparative static exercise indicates that in equilibrium $\partial n/\partial\tau > 0$ and that $\partial l_1/\partial\tau = 0$. In other words, all of the increase in lending stems from entry rather than increases in individual bank lending. Note that this result magnifies the degree to which second-period lending falls below the global optimum.

### *Liability of the Deposit Insurance Institution*

Define the expected liability of the deposit insurance institution from exposure to the debtor nation in period $t$ as $\psi_t$. $\psi_t$ satisfies:

(18) $$\psi_t = \tau q_t^B n \hat{l}_t \quad (t = 1, 2).$$

Differentiating $\psi_1$ with respect to $\tau$ yields:

(19) $$\partial\psi_1/\partial\tau = q_1^B n\hat{l}_1 + \tau q_1^B \hat{l}_1 (\partial n/\partial\tau) + \tau n\hat{l}_1 (\partial q_1^B/\partial n)(\partial n/\partial\tau) > 0,$$

where:

$$(\partial q_1^B/\partial n)(\partial n/\partial\tau) = -[(\partial\pi_1/\partial n)(\partial n/\partial\tau)\bar{r}_1\hat{l}_1]/(\partial\pi_1/\partial q_1)\bar{r}_1\hat{l}_1 > 0.$$

Equation (19) shows that an increase in $\tau$ unambiguously increases the expected liability of the deposit insurance institution. The first term captures the direct effect: Given the exposure of banks and the expected probability of bankruptcy, an increase in $\tau$ will increase the expected liability of the deposit insurance institution. However, the other two terms are also positive. The second term shows that fixed-premium deposit insurance gives banks an incentive to increase their lending, all of which comes from an increase in $n$. The third term reflects the impact of deposit insurance on the probability of bankruptcy, $q_1^B$.[13] This term is enhanced in our model by the public good problem associated with relending.

### *"Implicit Deposit Insurance"*

Finally, we examine the implications of extending deposit insurance to insure "implicitly" some uninsured bank deposits. In their discussion of implicit deposit insurance, Penati and Protopapadakis (1988) claim that regulators distinguish between two types of loans: "local loans," whose failure only harms exposed banks, and "system-threatening" loans, whose failure would threaten the stability of the banking system and the solvency of the deposit insurance institution. They respond to a local loan default by closing failing banks, while they respond to systemic loan defaults by merging failing banks with other banks. The salient distinction is that uninsured deposits are carried at par subsequent to a merger, while uninsured deposits in closed banks lose their value.

Assessing the impact of implicit deposit insurance on banking organization requires specification of the criterion used by the bank regulators in identifying "system-threatening loans." Penati and Protopapadakis (1988) took this designation as exogenous. Here, we endogenize the criterion and show that the equilibrium can be affected by the criterion used by regulators to identify system-threatening loans.

Define $p_s$ as the probability that uninsured deposits will be carried at par subsequent to a bank failure, where $0 \le p_s \le 1$. For simplicity, we assume that the risk associated with uncertainty concerning the policy rule is diversifiable, so that it does not affect the value of $\sigma$. Suppose that $p_s$ is an increasing function of total exposure to the debtor, $p_s = p_s(nl_1)$. Define $E(\tau)$ as the expected total share of bank deposits subject to deposit insurance, either explicit or implicit. $E(\tau)$ satisfies:

(20) $$E(\tau) = \tau + p_s(nl_1)(1-\tau).$$

Equation (20) identifies the link between the equilibrium lending decision and the probability of implicit insurance. Implicit deposit insurance gives banks an incentive to tailor the lending package in a way that enhances the probability that the deposit insurance institution will merge rather than close a failing bank.[14]

To examine the impact of an increase in the importance of implicit deposit insurance under this criterion, we assume that $p_s$ is linear in the magnitude of first-period lending: $p_s = \delta(nl_1)$.[15] We then can examine the implications of an increase in $\delta$ as an example of an increase in the sensi-

13. Note that the impact of changes in $\gamma_1$ on the probability of bankruptcy does not affect $\psi_1$ because they already reflect a liability of the deposit insurance institution.

14. Penati and Protopapadakis (1988) suggested alternatively that the probability that loans are implicitly insured may be increasing in the number of banks involved in the lending package, so that $p_s = p_s(n)$. The qualitative results under this alternative criterion would be identical.

15. Since $0 \le p_s \le 1$, this linear specification must be considered as a local approximation to a non-linear function.

tivity of the probability of a bail-out by the deposit insurance institution to $nl_1$. The comparative statics of the model satisfy:

$$(21)\quad \begin{bmatrix} \partial\Omega_1/\partial\hat{l}_1^2 & \partial^2\Omega_1/\partial\hat{l}_1\partial n \\ \partial\Omega_1/\partial\hat{l}_1 & \partial\Omega_1/\partial n \end{bmatrix} \begin{bmatrix} \partial\hat{l}_1/\partial\delta \\ \partial n/\partial\delta \end{bmatrix} = \begin{bmatrix} -\partial^2\Omega_1/\partial\hat{l}_1\partial\delta \\ -\partial\,\Omega_1/\partial\delta \end{bmatrix},$$

where the first matrix has the same signs as above.

We show in the Appendix that the comparative static solutions are $\partial n/\partial\delta>0$ and $\partial\hat{l}_1/\partial\delta = 0$. $n$ is increasing in $\delta$ for two reasons. First, an increase in $\delta$, holding the number of banks in the system constant, represents an increase in the expected share of deposits covered by the deposit insurance institution. Consequently, this directly reduces bank costs and induces additional lending through increases in $n$. In addition, increasing national exposure through an increase in $n$ increases the probability that regulators merge rather than close failing banks, reducing deposit rates. In other words, implicit deposit insurance rewards banks for organizing themselves in a system-threatening manner by increasing the probability of a deposit insurance institution bail-out.

## IV. SIMULATIONS

To examine the potential importance of both explicit and implicit deposit insurance, we use numerical simulations. This requires the assumption of specific functional forms. To make the simulations realistic, we choose parameter values which would be profitable for the banks ex-ante. However, to allow for an analytic solution, we linearize the relationships between the level of lending and the expected percentage of debt service:

$$\pi_1 = 1 - (0.002\cdot nl_1)$$

and the impact of first-period loans on the second-period returns:

$$E(\pi_2 l_2 - \gamma_2) = -\,0.05[1 - (0.001\cdot nl_1).$$

The magnitudes of these specifications were chosen to insure an interior solution for the probability of default between 0 and 1. Moreover, we assume that the creditor has a mean-variance value function and that the variance of profits is linear in exposure to the debtor, with $\phi$ representing creditor sensitivity to exposure:

$$\sigma(l_1) = \phi l_1.$$

We assume that the expected probability of bankruptcy is equal to one minus the expected level of debt service. This simplifies $\gamma_t$:

$$\gamma_t = r_f + [(1-\tau)(1-\pi_t)]; \quad (t = 1, 2).$$

The share of explicit deposit insurance is assumed to be roughly equal to $\tau = 0.65$.[16] The specifications of the other exogenous parameters are: $r_2 = 1.10$; $\overline{r_1} = \overline{r_2} = 1.20$. Under the "implicit deposit insurance" regime, we assume that the expected percentage of insured deposits is equal to:[17]

$$\tau = 0.65 + (0.01\cdot nl_1).$$

Given these specifications, simulations were run for a variety of possible values of $\phi$ under four alternative regimes: (1) no deposit insurance, (2) explicit deposit insurance, (3) explicit and implicit deposit insurance, and (4) 100 percent deposit insurance. The results are reported in Table 2 for various values of $\phi$. The introduction of deposit insurance results in an increase in the number of banks in the system, a decrease in the expected percentage of debt service, and an increase in the expected burden on the deposit insurance institution as a percentage of outstanding loans.

Our results imply that the introduction of explicit deposit insurance brings an expected loss to the deposit insurance institution of 2.1 percent of outstanding loans. Moving to 100 percent deposit insurance almost doubles the expected burden to 4 percent of outstanding loans. Note that these expected liabilities were obtained under parameter values for which lending to the debtor nation is profitable ex ante for creditors.[18]

## V. CONCLUSION

In this paper, we examined the implications of fixed-premium deposit insurance in a foreign lending model where rescheduling exhibits positive spillovers across creditors. Our results show that deposit insurance raises the number of banks participating in the lending package through three channels: First, deposit insurance acts as a subsidy on lending; second, deposit insurance weakens the degree to which the market induces banks to organize in a manner that will minimize the public good problem associated with relending to a problem debtor; finally, implicit deposit insurance removes much of the remaining liability side of the bank balance sheet from a private regulating role. Moreover, if

16. This share corresponds to that which existed on average from 1980 to 1985 according to Penati and Protopapadakis (1988).

17. These parameters have been chosen to insure that $0<\tau<1$.

18. The surprising result that the number of banks in the system actually declines with increases in $\phi$ stems from the zero-profit condition. Since increases in $\phi$ make lending less profitable, and individual bank lending remains constant, exit must occur for profits to return to zero.

TABLE 2

SIMULATION RESULTS

| | $\phi$ | $n$ | $l_1$ | $E(\pi_1)$ | $E(\psi_1/nl_1)$ |
|---|---|---|---|---|---|
| (1) NO DEPOSIT INSURANCE | | | | | |
| | 0.00 | 11.01 | 1.01 | 0.98 | — |
| | 0.00 | 10.78 | 1.01 | 0.98 | — |
| | 0.01 | 8.98 | 1.01 | 0.98 | — |
| | 0.02 | 6.74 | 1.00 | 0.99 | — |
| (2) EXPLICIT DEPOSIT INSURANCE ($\tau$ = 0.65) | | | | | |
| | 0.00 | 15.56 | 1.01 | 0.97 | 0.02 |
| | 0.00 | 15.24 | 1.01 | 0.97 | 0.02 |
| | 0.01 | 12.70 | 1.01 | 0.97 | 0.02 |
| | 0.02 | 9.52 | 1.00 | 0.98 | 0.01 |
| (3) EXPLICIT PLUS IMPLICIT DEPOSIT INSURANCE | | | | | |
| | 0.00 | 17.52 | 1.01 | 0.97 | 0.03 |
| | 0.00 | 17.12 | 1.01 | 0.97 | 0.03 |
| | 0.01 | 13.94 | 1.01 | 0.97 | 0.02 |
| | 0.02 | 10.19 | 1.01 | 0.98 | 0.02 |
| (4) 100 PERCENT DEPOSIT INSURANCE | | | | | |
| | 0.00 | 20.00 | 1.01 | 0.96 | 0.04 |
| | 0.00 | 19.59 | 1.01 | 0.97 | 0.04 |
| | 0.01 | 16.33 | 1.01 | 0.97 | 0.03 |
| | 0.02 | 12.25 | 1.01 | 0.98 | 0.03 |

the deposit insurance institution's appraisal of the degree of systemic risk in a lending package is endogenous, banks will be rewarded for organizing themselves in a manner that enhances the probability of a bail-out.

Both private creditors and government officials of lending and borrowing countries have argued that the level of loan provision to the highly indebted countries during the debt crisis was sub-optimal from the point of view of the industry as a whole. Previous discussions explain underlending through "herd behavior" followed by banks (Herring and Guttentag 1985). This paper shows that sub-optimally large levels of banking "diffusion," rationally introduced to avoid firm risk and take advantage of fixed-premium deposit insurance, may exacerbate the degree to which credit extensions are sub-optimal, providing an alternative explanation to herd behavior.

## APPENDIX

### *I. Derivation of (3a) and (3b)*

The first-order condition from equation (2) satisfies:

$$-U'\overline{r}_1L_1 + (\partial U/\partial P)(\partial P/\partial \pi_t) = 0; \quad (t = 1, 2)$$

where $U'$ represents $\partial U/\partial c_t$. Totally differentiating with respect to $\pi_1$ and $q_1$, $L_1$, and $L_2$ yields:

$$d\pi_1/dq_1 = U''\overline{r}_1L_1/(d^2U/d\pi_1^2) > 0$$

$$d\pi_1/dL_1 = \overline{r}_1(U' - U''\pi_1\overline{r}_1L_1)/(d^2U/d\pi_1^2) < 0$$

$$d\pi_1/dL_2 = U''\overline{r}_1L_1/(d^2U/d\pi_1^2) > 0$$

$$d\pi_1/dn = d\pi_1/dL.$$

Taking the first-order condition from (2) and totally differentiating with respect to $\pi_2$ and $q_2$ and $L_2$ yields:

$$d\pi_2/dq_2 = U''\overline{r}_2L_2/(d^2U/d\pi_2^2) > 0$$

$$d\pi_2/dL_2 = \overline{r}_2(U' - U''\overline{r}_2L_2)/(d^2U/d\pi_2^2) < 0.$$

### *II. Second-Period Deposit Rates*

By equation (5) and the fact that $q_2$ is distributed uniform on the unit interval, $q_2^B$ satisfies:

$$\pi_2(q_2^B,L_2)\overline{r}_2\hat{l}_2 - \gamma_2(a_2 + \hat{l}_2) + \rho_2a_2 = 0.$$

Totally differentiating with respect to $q_2^B$ and $\gamma_2$, $L_2$, and $\hat{l}_2$ yields:

$$dq_2^B/d\gamma_2 = (a_2 + \hat{l}_2)/(\partial\pi_2/\partial q_2)\overline{r}_2\hat{l}_2 > 0$$

$$dq_2^B/dL_2 = -(\partial\pi_2/\partial L_2)\overline{r}_2\hat{l}_2/(\partial\pi_2/\partial q_2)\overline{r}_2\hat{l}_2 > 0$$

$$dq_2^B/d\hat{l}_2 = -[(\partial\pi_2/\partial L_2)\overline{r}_2\hat{l}_2 + \pi_2\overline{r}_2 - \gamma_2]/(\partial\pi_2/\partial q_2)\overline{r}_2\hat{l}_2.$$

By equation (7), $dq_2^B/d\hat{l}_2$ is of ambiguous sign because of firm risk-aversion. Intuitively, the ambiguity stems from the possibility that firms are sufficiently risk-averse that additional second-term loans are privately (as opposed to globally among creditors as a whole) profitable. Since we are interested in the case where bank lending falls below its optimum, we rule out this possibility. We proceed under the assumption that the numerator of that expression is negative, i.e., that profits on second-period loans, neglecting their impact on first period debt service, are negative. This leaves the entire expression positive, implying that additional bank lending raises the possibility of future bankruptcy.

Totally differentiating (4) with respect to $\gamma_2$ and $\hat{l}_2$, $L_2$, and $\tau$ and simplifying, we then obtain:

$$d\gamma_2/d\hat{l}_2 = (\partial q_2^B/\partial\hat{l}_2)/\{[(1-q_2^B)^2/r_2(1-\tau)] - (\partial q_2^B/\partial\gamma_2)\} > 0$$

$$d\gamma_2/dL_2 = (\partial q_2^B/\partial L_2)/\{[(1-q_2^B)^2/r_2(1-\tau)] - (\partial q_2^B/\partial\gamma_2)\} > 0$$

$$d\gamma_2/d\tau = -q_2^B/\{[(1-q_2^B)/r_2] - [(1-\tau)/(1-q_2^B)](\partial q_2^B/\partial\gamma_2)\} < 0,$$

since the denominators of all three are positive when returns to depositors are increasing in $\gamma_2$.

## *III. Comparative Statics Concerning Second-Period Lending Decisions*

Totally differentiating the first-order condition from (6) yields:

$$d\hat{l}_2/d\hat{l}_1 = -(\partial^2\Omega_2/\partial\hat{l}_2\partial\hat{l}_1)/(\partial^2\Omega/\partial\hat{l}_2^2).$$

By the second-order condition, the denominator is negative so that:

$$Sign[d\hat{l}_2/d\hat{l}_1] = Sign[\partial^2\Omega/\partial\hat{l}_2\partial\hat{l}_1].$$

By (7):

$$Sign\left[d\hat{l}_2/d\hat{l}_1\right] = Sign\left[\frac{\partial\Omega_2}{\partial R}\left[\frac{\partial\pi_1}{\partial L_2}\bar{r}_1 + \frac{\partial^2\pi_1}{\partial L_2\partial\hat{l}_1}\bar{r}_1\hat{l}_1\right]\right] > 0\ ,$$

where $\partial^2\pi_1/\partial L_2\partial\hat{l}_1 > 0$ from our solution for $\partial\pi_1/\partial L_2$ above.

As above, $Sign[dl_2/dL_1] = Sign[\partial^2\Omega/\partial\hat{l}_2\partial L_1]$. By (7):

$$Sign\left[d\hat{l}_2/dL_1\right] = Sign\left[\frac{\partial\Omega_2}{\partial R}\,\frac{\partial^2\pi_1}{\partial L_2\partial L_1}\bar{r}_1\hat{l}_1\right] < 0\ ,$$

where $\partial^2\pi_1/\partial L_2\partial L_1 < 0$ from our solution for $\partial\pi_2/\partial L_2$ above.

Similarly, $Sign[d\hat{l}_2/dL_2] = Sign[\partial^2\Omega/\partial\hat{l}_2\partial L_2]$. By (7):

$$Sign\left[\frac{\partial^2\Omega}{\partial\hat{l}_2\partial L_2}\right] = Sign\left[\frac{\partial\Omega_2}{\partial R}\left[\frac{\partial^2\pi_1}{\partial L_2^2}\bar{r}_1\hat{l}_1 + \frac{1}{r_2}\left[\frac{\partial\pi_2}{\partial L_2}\bar{r}_2 - \gamma_2 + \frac{\partial^2\pi_2}{\partial L_2^2}\bar{r}_2\hat{l}_2 - \frac{\partial^2\gamma_2}{\partial\hat{l}_2\partial L_2}(a_2+\hat{l}_2)\right]\right]\right] < 0.$$

Similarly, $Sign[d\hat{l}_2/d\tau] = Sign[\partial^2\Omega/\partial\hat{l}_2\partial\tau]$. By (7):

$$Sign\left[\frac{\partial^2\Omega}{\partial\hat{l}_2\partial\tau}\right] = Sign\left[-\frac{\partial\Omega_2}{\partial R}\left[\frac{\partial\gamma_2}{\partial\tau} + \frac{\partial^2\gamma_2}{\partial\hat{l}_2\partial\tau}(a_2+\hat{l}_2)\right]/r_2\right] > 0,$$

where $\partial^2\gamma_2/\partial\hat{l}_2\partial\tau < 0$ from our solutions for $d\gamma_2/d\hat{l}_2$ above.

Finally, $Sign[d\hat{l}_2/dn] = Sign[\partial^2\Omega/\partial\hat{l}_2\partial n]$. By (7):

$$Sign\left[\frac{\partial^2\Omega}{\partial\hat{l}_2\partial n}\right] = Sign\left[\frac{\partial\Omega_2}{\partial R}\left[\frac{\partial^2\pi_1}{\partial L_2\partial n}\bar{r}_1 l_1 + \frac{1}{r_2}\left[\frac{\partial\pi_2}{\partial n}\bar{r}_2 - \frac{\partial\gamma_2}{\partial n} - \frac{\partial^2\gamma_2}{\partial\hat{l}_2\partial n}(a_2+\hat{l}_2)\right]\right]\right] < 0\ .$$

## *IV. First-Period Deposit Rates*

By equation (5) and the fact that $q_2$ is distributed uniform on the unit interval, $q_1^B$ satisfies:

$$\pi_1(q_1^B, L_1, L_2)\bar{r}_1\hat{l}_1 - \gamma_1(a_1 + \hat{l}_1) + \rho_1 a_1 = 0.$$

Totally differentiating (5) with respect to $q_1^B$ and $\hat{l}_1$ yields:

$$dq_1^B/d\hat{l}_1 = -[(\partial\pi_1/\partial\hat{l}_1)\bar{r}_1\hat{l}_1 + \pi_1\bar{r}_1 - \gamma_1]/(\partial\pi_1/\partial q_1)\bar{r}_1\hat{l}_1 > 0$$

in the range in which positive lending takes place since the individual bank returns on first-period lending must be positive in the presence of bank risk-aversion. Totally differentiating (4) with respect to $\gamma_1$ and $\hat{l}_1$ then yields:

$$d\gamma_1/d\hat{l}_1 = (\partial q_1^B/\partial\hat{l}_1)/\{[(1-q_1^B)^2/r_1(1-\tau)] - (\partial q_1^B/\partial\gamma_1)\} > 0.$$

As above, the denominator of these terms is positive in the relevant range where returns to depositors are increasing in $\gamma_1$.

Totally differentiating (5) with respect to $q_1^B$ and $l_1$ yields:

$$dq_1^B/dl_1 = -n(\partial\pi_1/\partial L_1)/(\partial\pi_1/\partial q_1) > 0,$$

since $\partial\pi_1/\partial L_1 < 0$ as shown above. Totally differentiating (4) with respect to $\gamma_1$ and $\hat{l}_1$ then yields:

$$d\gamma_1/dl_1 = (\partial q_1^B/\partial L_1)/\{[(1-q_1^B)^2/r_1(1-\tau)] - (\partial q_1^B/\partial\gamma_1)\} > 0.$$

Taking $l_1$ as given, totally differentiating the debtor's first-order condition from (2) (shown above) with respect to $\pi_1$ and $n$ yields:

$$d\pi_1/dn = (d\pi_1/dL_1)(dL_1/dn) + (d\pi_1/dL_2)(dL_2/dn).$$

Substituting, recalling that $L_2 = nl_2$ ,

$$d\pi_1/dn = \bar{r}_1 l_1\,(U' - U''\pi_1\bar{r}_1 L_1)/(d^2U/d\pi_1^2) + U''\bar{r}_1 L_1/(d^2U/d\pi_1^2)[l_2 + n(dl_2/dn)],$$

where $dl_2/dn < 0$ as shown above. Simplifying:

$$d\pi_1/dn = \{l_1U' - U''L_1[\pi_1\overline{r}_1 - l_2 - n(dl_2/dn)]\}\overline{r}_1/(d^2U/d\pi_1^2).$$

This term is of ambiguous sign because it is unclear whether an increase in $n$ results in an increase or decrease in second-period lending, which has a positive impact on first-period debt service. The ambiguity corresponds to the fact that an increase in $n$ results in decreased lending per bank, but more banks in the lending package. We proceed under the assumption that a collective action problem exists, i.e., that an increase in $n$ results in a decrease in first-period debt service. This requires that the above expression be negative. Under this condition, totally differentiating (5) with respect to $q_1^B$ and $n$ yields:

$$dq_1^B/dn = -\,n(\partial\pi_1/\partial n)/(\partial\pi_1/\partial q_1) > 0.$$

Totally differentiating (4) with respect to $\gamma_1$ and $n$ then yields:

$$d\gamma_1/dn = (\partial q_1^B/\partial n)/\{[(1-q_1^B)^2/r_1(1-\tau)] - (\partial q_1^B/\partial\gamma_1)\} > 0.$$

Moreover, note that:

$$\partial^2\gamma_1/\partial n\partial\tau = \frac{-\,(\partial q_1^B/\partial n)[(1-q_1^B)^2/r_1(1-\tau)^2]}{\{[(1-q_1^B)^2/r_1(1-\tau)] - (\partial q_1^B/\partial\gamma_1)\}^2} < 0.$$

Finally, totally differentiating (4) with respect to $\gamma_1$ and $\tau$ yields:

$$d\gamma_1/d\tau = -\,q_1^B/\{[(1-q_1^B)/r_1] - [(1-\tau)/(1-q_1^B)](\partial q_1^B/\partial\gamma_1)\} < 0.$$

## *V. First-Period Equilibrium*

In signing (17), by the first-order condition, $\partial\Omega_1/\partial\hat{l}_1 = 0$. By the second-order condition, $\partial^2\Omega_1/\partial\hat{l}_1^2 < 0$. By (15), $\partial^2\Omega_1/\partial\hat{l}_1\partial n$ satisfies:

$$\frac{\partial^2\Omega_1}{\partial\hat{l}_1\partial n} = \frac{\partial\Omega_1}{\partial R}\Bigg[\frac{\partial^2\pi_1}{\partial L_1^2}\bar{r}_1\hat{l}_1^2 + \frac{\partial\pi_1}{\partial L_1}\hat{l}_1\pi_1\bar{r}_1 - \frac{\partial\gamma_1}{\partial L_1}\hat{l}_1 - \frac{\partial^2\gamma_1}{\partial\hat{l}_1\partial n}(a_1+\hat{l}_1) + \Bigg[\frac{\partial\pi_2}{\partial L_2}\bar{r}_2 - \frac{\partial\gamma_2}{\partial L_2} + \frac{\partial^2\pi_2}{\partial L_2^2}\bar{r}_2\hat{l}_2 - \frac{\partial^2\gamma_2}{\partial\hat{l}_2\partial L_2}(a_2+\hat{l}_2)\Bigg]\frac{\partial L_2}{\partial n}\,\frac{\partial\hat{l}_2}{\partial\hat{l}_1}/r_2 + \Bigg[\pi_2\bar{r}_2 - \gamma_2 + \frac{\partial\pi_2}{\partial L_2}\bar{r}_2\hat{l}_2 - \frac{\partial\gamma_2}{\partial\hat{l}_2}(a_2+\hat{l}_2)\Bigg] \bullet \frac{\partial^2\hat{l}_2}{\partial\hat{l}_1\partial n}/r_2\Bigg],$$

which is of ambiguous sign. A sufficient but not necessary condition for the expression to be negative is that $\partial L_2\partial n > 0$. In other words, despite the fact that each bank lends less in the final period, the increase in the number of banks implies that the total level of new lending increases. We proceed by accepting this condition, under which the entire expression can be signed as negative.

By (5) and (14) $\partial\Omega_1/\partial n$ satisfies:

$$\partial\Omega_1/\partial n = (\partial\Omega_1/\partial R)\{[(\partial\pi_1/\partial n)\overline{r}_1\hat{l}_1 - (\partial\gamma_1/\partial n)(a_1+\hat{l}_1)] + (1/r_2)[(\partial\pi_2/\partial n)\overline{r}_2 l_2 - (\partial\gamma_2/\partial n)(a_2+\hat{l}_2)]\} < 0.$$

It follows that the determinant of the system is positive. $\partial^2\Omega_1/\partial l_1\partial\tau$ satisfies:

$$\partial\Omega_1/\partial l_1\partial\tau = \partial\Omega/\partial R\,[\partial^2R_1/\partial l_1\partial\tau + (1/r_f)\partial^2R_2/\partial l_1\partial\tau] > 0,$$

where:

$$\partial^2R_t/\partial l_1\partial\tau = -\,\partial\gamma_t/\partial\tau - (\partial^2\gamma_t/\partial l_1\partial\tau)(a_t+l_t) > 0;$$
$$(t = 1, 2)$$

since:

$$\partial^2\gamma_t/\partial l_1\partial\tau = -\,[1/(1-q_t^B)](\partial q_t^B/\partial l_t) < 0.$$

$\partial\Omega_1/\partial\tau$ satisfies:

$$\partial\Omega_1/\partial\tau = \partial\Omega/\partial R[-\,(\partial\gamma_1/\partial\tau)(a_1+l_1) - (1/r_2)(\partial\gamma_2/\partial\tau)(a_2+l_2) > 0.$$

By Cramer's rule:

$$\partial n/\partial\tau = -\,(\partial^2\Omega_1/\partial\hat{l}_1^2)(\partial\Omega_1/\partial\tau)/D > 0$$

$$\partial l_1/\partial\tau = -\,(\partial^2\Omega_1/\partial\hat{l}_1\partial\tau)(\partial\Omega_1/\partial n) + (\partial^2\Omega_1/\partial\hat{l}_1\partial n)(\partial\Omega_1/\partial\tau)]/D = 0,$$

where $D$ represents the determinant of the system.

Similarly, for the implicit deposit insurance comparative static exercise in (21):

$$\partial^2\Omega_1/\partial\hat{l}_1\partial\delta = \partial\Omega/\partial R[\partial^2R_1/\partial\hat{l}_1\partial\delta + (1/r_2)\partial^2R_2/\partial\hat{l}_1\partial\delta] > 0$$

where:

$$\partial^2R_t/\partial\hat{l}_1\partial\delta = -\,\partial\gamma_t/\partial\delta - (\partial^2\gamma_t/\partial l_1\partial\delta)(a_t+l_t) > 0;$$
$$(t = 1, 2)$$

since:

$$\partial\gamma_t/\partial\delta = -[r_t n l_1 (1-\tau)/(1-q_t^B) < 0; \quad (t = 1, 2)$$

and:

$$\partial^2\gamma_1/\partial l_1\partial\delta = -[\overline{r}_1 n l_1(1-\tau)/(1-q_1^B)](\partial q_1^B/\partial l_1) < 0$$

$$\partial\Omega_1/\partial\delta = \partial\Omega/\partial R[-(\partial\gamma_1/\partial\delta)(a_1+\hat{l}_1) - (1/r_2)(\partial\gamma_2/\partial\delta)(a_2+\hat{l}_2)] > 0.$$

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