THE EFFECT OF IMPLICIT DEPOSIT INSURANCE ON BANKS PORTFOLIO CHOICES WITH AN APPLICATION TO INTERNATIONAL 'OVEREXPOSURE'

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ABSTRACT

We analyze the impact of ongoing FDIC deposit insurance practices on how banks price risk. We show that FDIC insurance generally subsidizes risky loans, and that the subsidy increases with risk. We also show that the FDIC subsidy increases if contractually uninsured deposits are insured implicitly. Implicit insurance has the perverse effect of biasing the subsidy towards loans that represent systemic risk to the banking system and may entail a tax to loans with no systemic risk.

This analysis can help explain what appeared to be systematic underpricing of LDC loan risks, prior to the debt crisis.

In the wake of the debt crisis that has evolved since the financial collapse of Mexico in August 1982, bank international lending policies have been the subject of intense debate. In retrospect, it seems surprising that banks were willing to allocate such a large part of their portfolios to Less Developed Countries (LDCs henceforth) without requiring higher risk premia for the risk they were incurring; bank behavior appears even more surprising since claims on sovereign borrowers by and large are unenforceable.[1]

Herring and Guttentag (1985) group the possible explanations for international banks' "overexposure" into three categories. The first possible explanation is that the whole international debt crisis could have been just the result of bad luck; if the shocks that precipitated the crisis were very low probability events that happened to occur, there is very little that has to be explained. The second type of explanation is that banks' large exposure to LDCs and the small risk premia charged were the results of market failures, such as suboptimal use of information for the purpose of risk assessment, failure to account sufficiently for small probability events, or "herd instinct" in bank lending policies. The third type of explanation is that banks' portfolio choices were profit maximizing, in which case they may be explained by the existence of distorting incentives in the market. In this paper we focus on the distorting effects of the existing FDIC deposit insurance practices on banks' portfolio choices. We show that banks' "overexposure" towards LDCs and the apparent underpricing of LDC loans could have been the result of profit maximization in a competitive system, where it is known that FDIC insurance will modify the market outcomes in certain states of the world.

FDIC insurance as implemented currently has two components. One is that bank deposits that meet certain requirements are insured explicitly by the

FDIC at a fixed insurance premium that is independent of the nature of the insured risk. The second component is related to long-standing FDIC practices that frequently end up protecting contractually uninsured depositors, particularly if the size of the bank (or banks) that fails is "large" enough to raise concerns about the stability of the financial system. We label this second component implicit FDIC insurance. While it has long been recognized that explicit deposit insurance coupled with fixed insurance premia creates incentives for banks to take on an excessive amount of risk (for example, Kareken and Wallace 1978, Kareken 1986), the effects of implicit FDIC insurance have not been studied rigorously.

To analyze the impact of FDIC explicit and implicit insurance we construct a model in which banks operate in two separate markets: each bank makes loans in its local market, and all banks may make loans to LDCs in competition with other banks and with nonbank lenders. This assumption about the two loan markets generates a banking system in which banks share a common risk, LDC loans but they also carry risks that are specific to each bank, the local loans. From the point of view of the banking system, LDC loans become systemic risk, and local loans are idiosyncratic risk. It is this characteristic of local loans that differentiates banks in this model, and makes meaningful the distinction between explicit and implicit FDIC insurance.

In the paper, we identify LDC loans with systemic bank risk, because it is this aspect of the international debt crisis that motivated our work.[2] However, the results obtained are much more general, because they apply to any situation in which banks operate simultaneously in two loan markets, one of which represents systemic risk. Clearly the same framework could be used to analyze the pricing of other types of risks, such as energy loans. In order to emphasize the generality of the model, in the remaining paper we label the loans that represent systemic risk Z-loans, rather than LDC loans.

In the paper, we trace the separate contributions of explicit and implicit deposit insurance on the interest rates charged by banks and on the departure of prices and quantities from their undistorted competitive values. We show that, (i) if banks make Z-loans, explicit FDIC insurance always subsidizes these loans, but it may or may not subsidize local loans, (ii) under certain conditions the local loans may subsidize the Z-loans, (iii) the FDIC subsidy to a loan <u>increases</u> as the risk of that loan increases, but the subsidy to that loan <u>declines</u> as the risk of other loans increases, (iv) implicit FDIC insurance always increases the subsidy to Z-loans but it need not increase the subsidy to local loans, and (v) implicit FDIC insurance biases the subsidies towards the loans that represent systemic risk, for similar probabilities of default.

The paper is organized as follows. In section I we describe the individual banking firm and the banking system behavior in the presence of explicit FDIC insurance only, and we derive the equilibrium interest rates for local loans and Z-loans. In section II we incorporate implicit FDIC insurance by postulating a decision rule that the FDIC follows to decide whether to indemnify uninsured deposits when a bank fails. Then we show the impact of this implicit insurance on bank portfolio choices and risk pricing. In section III we reexamine our results under alternative hypotheses about banks' borrowing behavior. In the fourth section, we simulate the model with a set of realistic parameter values in order to obtain a rough assessment of the reduction in risk premia that can result from explicit and implicit FDIC insurance. Section V is the conclusion.

I. BEHAVIOR OF BANKS AND OF THE BANKING SYSTEM WITH EXPLICIT FDIC INSURANCE

In this section we develop a model of individual bank behavior and, by aggregation, of the behavior of the banking system. First, we describe our assumptions about the financial environment in which a typical bank operates. Next we describe the maximization problem faced by banks and its solution. Finally, we describe the resulting banking system equilibrium.

I.1 The Banking Environment

We define a bank as a firm that is endowed with some capital and has the exclusive opportunity to make loans in its local market. Banks cannot compete in each other's local markets, and local borrowers do not have direct access to the competitive capital market. As a result, each bank faces a downward sloping demand curve for loans in its local market. We hasten to stress that banks' degree of monopoly power in their local markets plays no role in our qualitative results. The local monopoly assumption is needed only to generate a bank asset whose returns are not highly correlated across banks. In section III we discuss the affect of alternative assumptions.

Each bank also can make Z-loans by competing with other banks in the competitive capital market. Each bank is a price-taker with respect to the Z-loan rate, both because there are many banks making Z-loans, and because Z-borrowers have direct access to the competitive capital market.

We assume that banks offer both deposits insured by the FDIC, for which they pay the risk free rate, and deposits that are not insured contractually, for which they have to pay appropriate rates of return. Also, they may raise additional equity in the capital markets at competitive rates. In order to focus on the pricing of loan risk we do not model borrowing behavior explicitly. Rather, we present results for alternative assumptions about the sources of additional funds, where in each case the liability structure is taken as exogenous. For now we proceed with the simplest assumption, that is, banks' equity is fixed and banks expand at the margin by obtaining insured and uninsured deposits in fixed proportions. However, the assumption of fixed capital is not crucial to our findings, and in section III we also give results under the alternative assumptions that (i) banks finance loans at the margin by holding constant the proportions of insured deposits, uninsured deposits, and capital, (ii) banks finance loans at the margin only through uninsured deposits.

Finally, in order to keep the model tractable we assume that there is a fixed number of banks, N, and that each bank is identical. In particular, all local loan demand schedules are identical, and the liability structure of all banks is the same.

I.2 The Loan Markets

We assume that each local loan has a fixed probability of default π_ℓ, regardless of the amount a bank lends in that market. A bank can increase its lending in the local market by offering a lower interest rate but it cannot affect the probability of default. We assume that, just like the demand schedules, the probabilities of default in different local loan markets are identical, and that the probability of default in each local market is independent of the probability of default in any other local market. This independence assumption differentiates the risk characteristics of Z-loans from local loans, from the point of view of the banking system. Thus local loans are not systemic risk.

The demand for local loans is known with certainty. The jth bank chooses the interest rate it charges for its local loans, $r_{\ell j}$, and it lends L_j dollars to local borrowers in the 1st period. In the 2nd period the bank receives

$L_j(1+r_{\ell j})$--with probability $1-\pi_\ell$--if the loan is good, and the bank receives nothing--with probability π_ℓ--if the loan is bad (see Table 1).

Z-loans also are assumed to have a fixed probability of default π_z, that is unaffected by the quantity of their total borrowing. Furthermore, π_z is independent of π_ℓ. The demand schedule of Z-loans is also known with certainty and it is negatively sloped. Because each bank is assumed to be an atomistic competitor in this market, it takes the loan rate for Z-loans, r_z, as given, and it chooses the quantity of the loan it wants to purchase, Z_j, in the 1st period. In the 2nd period the bank receives $Z_j(1+r_z)$--with probability $1-\pi_z$--if the Z-loans are good, and it receives nothing--with probability π_z--if the loans are bad. Finally, banks are <u>not required</u> to participate in this market (see Table 1).[3]

Table 1

Cash Flow Outcomes for jth Bank

Outcomes: Z-Loans	Local Loans	Cash Flows	Probability
Good	Good	$Z_j(1+r_z) + L_j(1+r_{\ell j})$	$(1-\pi_z)(1-\pi_\ell)$
Good	Bad	$Z_j(1+r_z) + 0$	$(1-\pi_z)\pi_\ell$
Bad	Good	$0 + L_j(1+r_{\ell j})$	$\pi_z(1-\pi_\ell)$
Bad	Bad	0	$\pi_z\pi_\ell$

I.3 Cash Flows and the Cost of Deposits

The cash flow structure summarized in Table 1 determines the cost of deposits faced by the jth bank. Since the cost of each deposit depends on its contingent cash flow, first we need to know what the payoffs are to each type of liability. We assume that default in either the local loans or the Z-loans causes the bank to default, so that it cannot repay fully its uninsured depositors.[4] This turns out to be the most general assumption in this context, because it makes it possible to see the contribution of the risk characteristics of each loan on the cost of uninsured deposits.[5]

When a bank defaults, the cash flow from the performing loans is divided proportionally between the insured and the uninsured depositors. The FDIC makes up the difference to the insured depositors but the uninsured depositors get only their share of the cash flow from the good loans. Finally, the equity owner gets a return only if both loans pay off. We assume that there are no bankruptcy costs and that banks pay a fixed FDIC insurance premium. For simplicity, we set the FDIC insurance premium equal to zero.[6]

Table 2 summarizes the payoffs to each liability of the bank. In the table, the value of all deposits plus equity of the jth bank is V_j, and the fixed amount of equity is $\bar{E}_j$. Then the quantity of insured deposits is $(V_j-\bar{E}_j)d_i$, and that of uninsured deposits is $(V_j-\bar{E}_j)d_u$.

Now we turn to the pricing of deposits. Since insured deposits pay off fully in all states, the banks need to offer only the risk-free rate, r_f, to attract such deposits. The bank has to pay r_{uj} to attract uninsured deposits. Uninsured deposits, as well as equity, are options on the cash flows of the bank, and their rate is determined by the cash flows that accrue to uninsured depositors and the prevailing state prices. Given the partial equilibrium nature of the model--capital markets are exogenous--banks take

Table 2

Payoffs to the jth Bank's Liabilities with Explicit FDIC Insurance

Outcomes: LDC Loans	Local Loans	Insured Deposits	Uninsured Deposits	Equity	State Prices
Good	Good	$d_i(V_j-\bar{E}_j)(1+r_f)$	$d_u(V_j-\bar{E}_j)(1+r_{uj})$	$L_j(1+r_{\ell j})+Z_j(1+r_z) - (V_j-\bar{E}_j)[d_i(1+r_f) + d_u(1+r_{uj})]$	$\delta(1-\pi_z)(1-\pi_\ell)$
Good	Bad	$d_i(V_j-\bar{E}_j)(1+r_f)$	$d_u Z_j(1+r_z)$	0	$\delta(1-\pi_z)\pi_\ell$
Bad	Good	$d_i(V_j-\bar{E}_j)(1+r_f)$	$d_u L_j(1+r_{\ell j})$	0	$\delta\pi_z(1-\pi_\ell)$
Bad	Bad	$d_i(V_j-\bar{E}_j)(1+r_f)$	0	0	$\delta\pi_z\pi_\ell$

state prices as given. We assume that state prices are proportional to the probability of each state, where the constant of proportionality is δ, and $\delta = \frac{1}{1+r_f}$. This assumption is not restrictive, and in particular it does not imply that our results are applicable only when the world is risk-neutral, because π_ℓ and π_z can be readily reinterpreted as being risk-adjusted probabilities.[7]

Given state prices, the interest rate banks have to pay for uninsured deposits in competitive capital markets can be established readily, because the net present value of investing in these deposits must be zero. This net present value is given by,

$$\delta(1-\pi_z)(1-\pi_\ell)(V_j-\bar{E}_j)d_u(1+r_{uj}) + \delta\pi_\ell(1-\pi_z)Z_j d_u(1+r_z) \tag{1}$$

$$+ \delta\pi_z(1-\pi_\ell)L_j d_u(1+r_{\ell j}) - (V_j-\bar{E}_j)d_u = 0 .$$

The competitive rate on uninsured deposits then is:

$$1+r_{uj} = \frac{1 + r_f}{(1-\pi_z)(1-\pi_\ell)} - \frac{\pi_\ell}{1-\pi_\ell} \frac{Z_j}{(V_j-\bar{E}_j)} (1+r_z) - \frac{\pi_z}{1-\pi_z} \frac{L_j}{(V_j-\bar{E}_j)} (1+r_{\ell j}) . \tag{2}$$

Banks must pay uninsured depositors a premium above the risk free rate r_f, and this premium is higher the lower the probability of no bank default, $(1-\pi_\ell)(1-\pi_z)$. But this premium is reduced by the present value of the cash flows when there is default. For example, for any given probabilities of default, π_ℓ and π_z, the rate paid for uninsured deposits falls as the bank invests a larger fraction of its funds, $Z_j/(V_j-\bar{E}_j)$, in Z-loans (the second term), but this rate rises because the fraction of funds invested in the local loans, $L_j/(V_j-\bar{E}_j)$, falls (the third term). The reason is that if the local loans default, the payoff to uninsured depositors increases as $Z_j/(V_j-\bar{E}_j)$ increases, but if the Z-loans default the payoff to uninsured depositors falls, because a fraction of the performing local loans is used to pay insured depositors.

I.4 The Bank's Maximization Problem

The jth bank is assumed to maximize the present value of its profits, given its cost of funds.[8] The maximization problem is given by,

$$\max_{r_{\ell j}, Z_j} P_j = \delta(1-\pi_z)(1-\pi_\ell)\{Z_j(1+r_z) + L_j(1+r_{\ell j}) - (V_j-\bar{E}_j)[d_i(1+r_f) + d_u(1+r_{uj})]\} = P_j \tag{3}$$

where the equilibrium values are subject to,

$$\frac{P_j}{\bar{E}_j} \geq \frac{1 + r_f}{(1-\pi_z)(1-\pi_\ell)} , \tag{3a}$$

$$Z_j \geq 0, \; L_j > 0 , \tag{3b}$$

and subject to the cost of uninsured deposits, given by equation (2).

The inequality (3a) arises because $\frac{1 + r_f}{(1-\pi_z)(1-\pi_\ell)}$ is the competitive market return paid for the risk incurred by equity-holders. If bank owners do not receive at least this rate of return, they will close the bank and invest in market securities.

The first-order condition for the local loans is:

$$1 + r_{\ell j} = - \frac{L_j}{L_j'} + \frac{1+r_f}{1-\pi_\ell} \phi_\ell , \tag{4}$$

where $\phi_\ell = \frac{d_i(1-\pi_z)(1-\pi_\ell) + d_u}{1 - \pi_z d_i}$, $L_j \equiv L_j(r_{\ell j})$ and $L_j' \equiv \frac{\partial L_j}{\partial r_{\ell j}} < 0$.

Equation (4) shows that $r_{\ell j}$ consists of three elements: the first element is $\frac{1+r_f}{1-\pi_\ell}$, the interest rate that a local borrower would pay if she had access to the competitive capital market, and it is equal to the risk free rate divided by the probability of no default in that local loan. The second element, ϕ_ℓ, measures the effect of explicit FDIC deposit insurance on $r_{\ell j}$; clearly, the expression approaches unity as insured deposits vanish (d_i goes to zero and d_u goes to unity). The third element, $-L_j/L'_j$, represents the increase in the local loan rate above the competitive rate that comes from the monopoly position of the bank, and it is a function of the elasticity of the demand for local borrowing.

To determine the optimal quantity of Z-lending, banks take the prevailing Z-loan rate, r_z, as given since they are perfect competitors. The jth bank's lending in that market, Z_j, can then be found by equating its marginal cost of lending in this market to its marginal revenue $1+r_z$, in the state in which equity gets positive returns.[9]

The jth bank's total cost of borrowing is given by,

$$TC_j = (V_j-\bar{E}_j)[d_i(1+r_f) + d_u(1+r_{uj})] \ . \tag{5}$$

Substituting equation (2) for $1+r_{uj}$ and differentiating with respect to Z_j we get,

$$\frac{\partial TC_j}{\partial Z_j} = MC_{zj} = (1+r_f)\left[d_i + \frac{d_u}{(1-\pi_z)(1-\pi_\ell)}\right] - \frac{\pi_\ell}{1-\pi_\ell} d_u(1+r_z) \ . \tag{6}$$

Equation (6) shows that the marginal cost of making Z-loans is independent of the quantity of outstanding Z-loans and of the proportion of Z-loans in a bank's portfolio. This is because the total cost of borrowing is a linear function of Z_j and L_j. To see this substitute equation (2) into equation (5). By equating the marginal cost to the marginal revenue, $1+r_z$, we obtain,

$$1+r_z = \frac{1+r_f}{1-\pi_z}\phi_z \ , \qquad \text{where} \qquad \phi_z = \frac{d_i(1-\pi_z)(1-\pi_\ell) + d_u}{1 - \pi_\ell d_i} \ . \tag{7}$$

The interpretation of equation (7) is similar to that of equation (4). The rate charged to Z-loans is composed of the undistorted competitive rate, $\frac{1+r_f}{1-\pi_z}$, and a factor of proportionality, ϕ_z, that captures the effect of explicit FDIC insurance on the loan pricing decision.

Without any additional concavity in the marginal cost function from other sources, the first order condition in equation (7) cannot determine the size of the Z-loan of the jth bank, Z_j. In the next section we use the assumption that all banks are identical to define both the banking system equilibrium and the individual bank equilibrium.

I.5. The Banking System Equilibrium

In the local loan markets, the assumption that there are N identical banks implies that local loans all have the same rate, r_ℓ, given by equation (4), and that the value of total loans to local markets from the banking system is given by $N \cdot L(r_\ell)$.

The same assumption allows us to propose an equilibrium for the Z-loans in which all banks hold a fraction 1/N of all the Z-loans.[10] Accordingly, the Z-loan market equilibrium is defined by,

$$Z_j = Z(r_z)/N \, , \tag{8a}$$

or

$$Z_j = 0 \, . \tag{8b}$$

If (8b) is the equilibrium then all the Z-borrowing is done directly in the competitive capital market, and it is not intermediated by banks. The rate on Z-loans in this case is given by, $1+r_z = \frac{1+r_f}{1-\pi_z}$. If Z-loans are made in the competitive capital market, arbitrarily we assume that they are not simultaneously made by banks. Therefore banks will hold Z-loans only if

$1+r_z < \frac{1+r_f}{1-\pi_z}$, in which case (8a) describes the equilibrium, and Z-loans are made by banks exclusively. This happens because banks are willing to make these loans at rates lower than those required by the competitive capital market. If banks make Z-loans, these loans are priced by equation (7), which is rewritten here for convenience:

$$1+r_z = \frac{1+r_f}{1-\pi_z}\phi_z , \qquad \phi_z = \frac{d_i(1-\pi_z)(1-\pi_\ell) + d_u}{1-\pi_\ell d_i} , \tag{7}$$

and where it must be that $\phi_z<1.0$, for the banks to be making Z-loans.

If there is no FDIC insurance ($d_i=0$), then $\phi_z=1.0$, that is, banks price Z-loans exactly as the competitive capital market. The existence of explicit FDIC insurance results in $\phi_z<1.0$, and Z-loans are made by banks exclusively, at rates subsidized by the FDIC.

Now we present some results.

Result 1: FDIC insurance subsidizes both the Z-loans and the local loans. We show this by proving that $\phi_z<1.0$, $\phi_\ell<1.0$.

From (7), $\phi_z < 1.0$ implies that:

$$d_i(1-\pi_z)(1-\pi_\ell) + d_u < 1-\pi_\ell d_i . \tag{9a}$$

Recognizing that $d_i+d_u = 1.0$, equation (9a) reduces to,

$$-\pi_z d_i(1-\pi_\ell) < 0 , \tag{9b}$$

which shows that $\phi_z<1.0$ always. Similar manipulations for ϕ_ℓ result in

$$-\pi_\ell d_i(1-\pi_z) < 0 , \tag{10}$$

which proves the result. We note that $1-\phi_z$ and $1-\phi_\ell$ measure the size of the subsidy as a proportion of the rate that would be charged by the competitive capital market.

The existence of two types of loans also affects the allocation of the FDIC subsidy between the loans. The intuitive reason is that the allocation of the FDIC subsidy depends on how the cost of uninsured deposits is affected at the margin by the default probabilities of the two types of loans. If a bank borrows $1 more in order to increase its Z-loans, then the uninsured deposit rate r_u will go down because depositors will receive more funds if the local loan fails ($Z_j/[V_j-\bar{E}_j]$ is higher in equation 2), but it will go up because depositors will receive fewer funds if the Z-loans fail ($Z_j/[V_j-\bar{E}_j]$ is lower in equation 2). The configuration of π_ℓ and π_z determine the marginal cost of borrowing to finance Z-loans and local loans, and thereby the allocation of the FDIC subsidy between the two types of borrowers.

<u>Result 2</u>: If a type of bank loan becomes more risky, the subsidy from explicit FDIC insurance for that loan increases, while the subsidy for the other type of loan decreases. In addition, if the two default probabilities are equal, the subsidy is equally divided.[11]

To see this, differentiate ϕ_z and ϕ_ℓ with respect to π_z and π_ℓ:

$$\frac{\partial \phi_z}{\partial \pi_z} = -\frac{d_i(1-\pi_\ell)}{1-\pi_\ell d_i} < 0 , \qquad (11a)$$

$$\frac{\partial \phi_z}{\partial \pi_\ell} = \frac{d_i(1-\pi_z)}{1-\pi_\ell d_i} \left[\frac{d_i + \frac{d_u}{1-\pi_z} - \pi_\ell d_i}{1-\pi_\ell d_i}\right] > 0 . \qquad (11b)$$

Similarly $$\frac{\partial \phi_\ell}{\partial \pi_\ell} < 0 , \quad \frac{\partial \phi_\ell}{\partial \pi_z} > 0 . \qquad (11c)$$

And, by inspection $\phi_Z=\phi_\ell$ if $\pi_Z=\pi_\ell$.

The intuitive reason for this result is that, since part of the financing comes from insured deposits, the probability of default of a loan is not reflected in the marginal cost of funds. And as this probability of default increases, the difference between the marginal cost of funds and the "efficient" rate widens, resulting in increased subsidies to the borrowers.

The implication of these results is that Z-loans will be made by banks at rates below those required by the competitive capital market. Furthermore, since the FDIC insurance subsidy increases with the risk of the loan, the divergence between the undistorted market rate and what banks charge increases as the Z-loan risk increases. The counterpart of these statements is that Z-borrowers will borrow more than they would, because of the lower rates, and this excess borrowing will be larger the riskier they are.

The situation with local loans is somewhat different. Even though local loans are subsidized by the FDIC, i.e., $\phi_\ell<1.0$, the rate banks charge may still be above what local borrowers would pay in the competitive capital market, because of the monopoly position of the banks. Therefore FDIC insurance may reduce the distortion created by the bank's monopoly power in this case. For high π_ℓ and low monopoly power, however, the FDIC subsidy will drive r_ℓ below its competitive level. Simulations reported in the last section show that FDIC-induced distortions are substantial, for reasonable default probabilities.

II. IMPLICIT FDIC INSURANCE AND BANK BEHAVIOR

The FDIC deals with a failing bank either by closing it and paying out the insured depositors, or by merging it with a healthy institution. In the second case, the FDIC will either assume some of the bad loans and pay the acquiring bank for them or else it will provide an alternative financial inducement to the healthy institution. The importance of this second approach, often called payment and assumption, or P&A, is that uninsured depositors do not suffer losses, because the acquiring institution assumes all the deposits of the failing bank at face value. In this way the FDIC provides implicit insurance to contractually uninsured deposits.

In recent years the FDIC has frequently used the P&A method, or similar methods that protect uninsured depositors of failing banks. For instance, from 1978 through 1984 only 41 out of 206 banks that failed were closed. And over that period the banks that were closed represented an average of only 0.2 percent of total deposits.

II.1 The Equilibrium with Implicit and Explicit FDIC Insurance

In order to assess the effect of implicit deposit insurance on banks' pricing of risk, we have to define a policy rule that the FDIC follows. We postulate that the FDIC steps in and protects uninsured depositors when more than a given proportion of banks fail. This formulation of the rule is intended to capture a view often expressed by policymakers, that they want to "protect" the financial system in the case of a systemwide shock. The proportion of failing banks, α, which prompts the FDIC to protect uninsured deposits in this model defines what policymakers view as a systemwide shock.

It is straightforward to extend our model to incorporate this implicit FDIC insurance. First, we discuss what happens when Z-loans do not fail. If the Z-loans do not fail, then there is a probability π_ℓ that the jth bank will fail and a probability $1-\pi_\ell$ that it will not. Furthermore, by our assumptions, these probabilities are independent across banks. As a result, the distribution of failures is binomial, and it is <u>independent</u> of the individual bank decisions. The FDIC decision on the policy parameter α

Table 3

Payoffs to the jth Bank's Liabilities with Explicit and Implicit FDIC Insurance[a]

Outcomes: LDC Loans	Local Loans	Insured Deposits	Uninsured Deposits	State Prices
Good	Good	$d_i(V_j-\bar{E}_j)(1+r_f)$	$d_u(V_j-\bar{E}_j)(1+\hat{r}_u)$	$\delta(1-\pi_z)(1-\pi_\ell)$
Good	Bad	$d_i(V_j-\bar{E}_j)(1+r_f)$	$d_u(V_j-\bar{E}_j)(1+\hat{r}_u)$	$\delta(1-\pi_z)\pi_\ell(1-\sigma)$ [FDIC intervention]
Good	Bad	$d_i(V_j-\bar{E}_j)(1+r_f)$	$d_u Z_j(1+\hat{r}_z)$	$\delta(1-\pi_z)\pi_\ell\sigma$ [no FDIC intervention]
Bad	Good	$d_i(V_j-\bar{E}_j)(1+r_f)$	$d_u(V_j-\bar{E}_j)(1+\hat{r}_u)$	$\delta\pi_z(1-\pi_\ell)$
Bad	Bad	$d_i(V_j-\bar{E}_j)(1+r_f)$	$d_u(V_j-\bar{E}_j)(1+\hat{r}_u)$	$\delta\pi_z\pi_\ell$

[a]Cash flows to equity are identical to those of Table 2.

determines the probability that the FDIC will intervene to protect uninsured depositors if the Z-loans are good; we label this the probability of FDIC intervention, $1-\sigma$. Bankers and depositors alike take $1-\sigma$ as exogenous in their calculations. If the Z-loans fail then all the banks fail, given our assumptions. In that case the FDIC will protect uninsured depositors, regardless how close to unity it has set α. The Appendix contains a more complete discussion of the FDIC rule.

Table 3 shows the cash flows that accrue to a typical bank's liabilities in the presence of implicit FDIC insurance. As before, the cash flows that accrue to uninsured deposits determine their cost, $\hat{r}_u$ (we drop the j since all banks are identical):[12]

$$1+\hat{r}_u = \frac{1+r_f}{1-\pi_n} - \frac{\pi_n}{1-\pi_n}\frac{Z}{(V-\bar{E})}(1+\hat{r}_z) \ , \tag{12}$$

where "^" indicates loan rates when implicit FDIC insurance is in force, and π_n is the probability of the uninsured deposits not being paid in full, and it is given by,

$$\pi_n = \sigma\pi_\ell(1-\pi_z) \ . \tag{13}$$

An interesting aspect of equation (12) is that the cost of uninsured deposits no longer depends on the quantity of the local loans, or their rate. The reason is that those variables matter to uninsured depositors only when the Z-loans default. But since FDIC will always make whole uninsured depositors if the Z-loans fail (there is always a system crisis in this case), the behavior of local loans no longer matters to uninsured depositors.

We can determine the Z-loan rate and the local loan rate by maximizing the net present value of profits, as done in Section I. The result for the Z-loans is:

$$1+\hat{r}_z = 1+r_f \, , \tag{14}$$

that is $\hat{\phi}_z=1-\pi_z$. When there is implicit deposit insurance, Z-borrowers pay the risk-free rate.

The intuition behind this result is that additional funds that come from uninsured deposits are fully insured at the margin through implicit FDIC insurance, as long as they go to purchase Z-loans (if Z-loans fail the FDIC indemnifies uninsured depositors). Furthermore, when the local loans fail, the cash flows from the Z-loan are divided between the additional insured and uninsured deposits at the proportion in which the bank raised the additional funds. Thus the marginal cost of funds is the risk-free rate.

The comparable result for the local loan is:

$$1+\hat{r}_\ell = -\frac{L}{L'} + \frac{1+r_f}{1-\pi_\ell}\hat{\phi}_\ell \, , \quad \text{where} \quad \hat{\phi}_\ell = \frac{d_i(1-\pi_\ell)(1-\pi_n) + d_u(1-\pi_\ell)}{1-\pi_n} \, . \tag{15}$$

II.2 Characteristics of the Equilibrium with Implicit and Explicit FDIC Insurance

In this section we present some results on banks' pricing decisions when implicit deposit insurance is added to explicit deposit insurance.

Result 3: Implicit FDIC deposit insurance increases the FDIC subsidy to Z-loans and lowers the rate banks charge for them, that is $\hat{\phi}_z<\phi_z$ and $\hat{r}_z<r_z$.

To see this, note that from equations (7) and (14) $\hat{\phi}_z/\phi_z<1$ implies that,

$$(1-\pi_z)(1-\pi_\ell d_i) < d_i(1-\pi_z)(1-\pi_\ell) + d_u \, . \tag{16}$$

Rearranging (16) one obtains $-\pi_z(1-d_i) < 0$ which is always true.

Result 4: For similar risk characteristics, implicit FDIC insurance biases the subsidy towards the Z-loans.

Using equations (14) and (15), $\hat{\phi}_z/\hat{\phi}_\ell<1$ implies that,

$$(1-\pi_n)(1-\pi_z) < d_i(1-\pi_\ell)(1-\pi_n) + d_u(1-\pi_\ell) \ . \tag{17a}$$

Rearranging (17) and recalling once more that $d_i+d_u = 1$,

$$d_i(1-\pi_\ell)(1-\pi_n) - (1-\pi_n)(1-\pi_z) + (1-d_i)(1-\pi_\ell) > 0 \ ,$$

$$(1-\pi_\ell)(1-d_i\pi_n) - (1-\pi_n)(1-\pi_z) > 0 \ . \tag{17b}$$

If $\pi_\ell=\pi_z$, (17b) becomes

$$(1-\pi_\ell)[1-d_i\pi_n-1+\pi_n] = (1-\pi_\ell)\pi_n(1-d_i) > 0$$

which is always positive. Clearly $\pi_\ell=\pi_z$ is a sufficient condition for the result to hold. However, the implicit insurance may bias the subsidy towards Z-loans even though π_ℓ is somewhat larger than π_z. Extensive simulations indicate that the result holds for reasonable parameter values.

Result 5: The introduction of implicit FDIC insurance also increases the FDIC subsidy to local loans.

From equations (4) and (15) we get,

$$\phi_\ell - \hat{\phi}_\ell = \frac{d_i(1-\pi_z)(1-\pi_\ell) + d_u}{1-\pi_z d_i} - \frac{d_i(1-\pi_\ell)(1-\pi_n) + d_u(1-\pi_\ell)}{1-\pi_n} \ . \tag{18}$$

Cross-multiply, collect terms, and expand π_n to get:

$$(1-\pi_z d_i)(1-\pi_n)(\phi_\ell-\hat{\phi}_\ell) = d_u\pi_\ell\left[1-\sigma(1-\pi_z)\right]+\pi_z d_i(1-\pi_\ell)\left[d_u-(1-d_i)(1-\pi_n)\right] \ . \tag{19a}$$

Recognize that $d_u=1-d_i$ and collect terms to get:

$$(1-\pi_z d_i)(1-\pi_n)(\phi_\ell \hat{\phi}_\ell) = d_u \pi_\ell [1-\sigma(1-\pi_z)] + \pi_z d_i d_u (1-\pi_\ell)\pi_n > 0 \ . \qquad (19b)$$

It should be noted that an increase of FDIC subsidy to the local loans is not sufficient to reduce the interest rate for those loans. The reason is that the elasticity of demand for the local loans also is an important factor that determines their interest rate.

III. ALTERNATIVE ASSUMPTIONS ABOUT BANKS' BORROWING BEHAVIOR

In the preceding two sections we assume that banks finance their loans at the margin by issuing insured and uninsured deposits at fixed proportions and that capital is fixed. In principle, one would like to endogenize the financing decision. However, this undertaking is beyond the scope of this paper. Instead, we show how the results in sections I and II are affected when we employ alternative financing assumptions. We examine first the effect of assuming that banks finance their loans at the margin by issuing insured deposits, uninsured deposits, and equity, in fixed proportions. Next we examine the effect of assuming that banks finance their loans at the margin only with uninsured deposits.

We choose these two alternatives because the first one--proportional expansion--seems to be the most natural assumption from the point of view of longer run considerations. The second alternative assumption--expansion through uninsured deposits only--may approximate short-run behavior of large, money center banks.

III.1. Financing with Proportional Expansion of Liabilities

In order to determine the equilibrium interest rates, we proceed exactly in the same way as in sections I and II. To save space we do not repeat the various steps.

If all sources of funds grow at the margin, the cost of insured deposits to the jth bank becomes:

$$1+r_{uj} = \frac{1+r_f}{(1-\pi_z)(1-\pi_\ell)} - \frac{\pi_\ell}{1-\pi_\ell}\frac{Z_j}{(d_i+d_u)V_j}(1+r_z) - \frac{\pi_z}{1-\pi_z}\frac{L_j}{(d_i+d_u)V_j}(1+r_{\ell j}) \ . \quad (20)$$

Maximizing expected profits subject to equation (20) we obtain the equilibrium interest rates when there is only explicit deposit insurance. The two interest rates, r_z and $r_{\ell j}$ can be expressed as in equations (4) and (7), but ϕ_z and ϕ_ℓ, the size of the subsidies, are now different:

$$\phi_z = \frac{d_i(1-\pi_z)(1-\pi_\ell) + d_u + d_e}{1-\pi_\ell(1-\gamma)} \ , \quad \text{and} \quad \phi_\ell = \frac{d_i(1-\pi_z)(1-\pi_\ell) + d_u + d_e}{1-\pi_\ell(1-\gamma)} \ . \quad (21)$$

where d_e is the proportion of equity in total liabilities, and $1-\gamma=d_i/(d_i+d_u)$.

The difference is that now the subsidy depends also on the debt/equity ratio since the marginal cost of lending is a function of the equity return as well, which is $(1+r_f)/(1-\pi_z)(1-\pi_\ell)$ (see equation 3a).

Result 2 in section I is unaffected by this alternative financing assumption. However, Result 1 needs to be modified. It turns out in this case, that if a bank makes only one type of loan, FDIC insurance always subsidizes it. But if it makes both types of loans, then it is possible for ϕ_z or ϕ_ℓ to exceed unity. Extensive simulations show that for typical liability structures, ϕ_z and ϕ_ℓ are less than unity, unless there is a large divergence in the default probabilities of the two loans.[13] This implies that if the probability of default of local loans, π_ℓ, is sufficiently high, then $\phi_z \geq 1.0$, and banks will <u>not make</u> Z-loans. On the other hand, if the probability of default of Z-loans, π_z, is sufficiently high, then $\phi_\ell \geq 1.0$. But in this case banks will continue to make local loans (because local borrowers have no recourse), and the local loans will be subsidizing the Z-loans.

When there is also implicit deposit insurance, the values of the ϕ's become:

$$\hat{\phi}_z = \frac{d_i(1-\pi_z)(1-\pi_n)+d_u(1-\pi_z)+d_e(1-\pi_n)/(1-\pi_\ell)}{1-\pi_n(1-\gamma)}, \qquad (22a)$$

and

$$\hat{\phi}_\ell = \frac{d_i(1-\pi_\ell)(1-\pi_n)+d_u(1-\pi_\ell) + d_e(1-\pi_n)/(1-\pi_z)}{1-\pi_n}. \qquad (22b)$$

The intuition for these modifications is that if a bank expands all its liabilities together, then its marginal cost of funds for Z-loans is higher than the risk-free rate. This is because the funds that come from issuing more equity do <u>not</u> receive a return if the Z-loans fail. Compared to the fixed equity case, uninsured deposits get slightly higher cash flows at the margin when only the local loans fail, because the cash flows from the additional Z-loan are divided only among the two types of deposits, and no cash flow accrues to the additional equity. But this additional cash flow is never enough to lower the marginal cost of funds for Z-loans to the risk-free rate.

Now we turn to the results with implicit deposit insurance. A sufficient condition for Result 3 to hold is that $\phi_z \le d_i+d_u$. However, extensive simulations failed to uncover cases for which $\hat{\phi}_z > r_z$ when $\phi_z \le 1.0$, indicating that, as a practical matter, if banks would make Z-loans with only explicit FDIC insurance, implicit FDIC insurance always lowers the Z-loan rate.[14] A proof of this sufficient condition is in the Appendix.

As for Result 4, the sufficient condition for the result to hold is the same as in Section I. If all the liabilities expand together, then $\hat{\phi}_z < \hat{\phi}_\ell$

if $\pi_z \geq \pi_\ell$, and it also holds if π_ℓ is somewhat larger than π_z. To see this, calculate $\hat{\phi}_z/\hat{\phi}_\ell$:

$$\frac{\hat{\phi}_z}{\hat{\phi}_\ell} = \frac{d_i(1-\pi_z)(1-\pi_n) + d_u(1-\pi_z) + d_e(1-\pi_n)/(1-\pi_\ell)}{d_i(1-\pi_\ell)(1-\pi_n) + d_u(1-\pi_\ell) + d_e(1-\pi_n)/(1-\pi_z)} \cdot \frac{1-\pi_n}{1-\pi_n(1-\gamma)} . \qquad (23)$$

It is clear that if $\pi_\ell=\pi_z$, $\hat{\phi}_z/\hat{\phi}_\ell<1.0$. And as π_z increases the subsidy to the Z-loan rises ($\hat{\phi}_z$ falls) and the subsidy to the local loan declines ($\hat{\phi}_\ell$ rises). But if $\pi_\ell>\pi_z$ sufficiently, the local loan gets subsidized more heavily.

Finally, if all liabilities expand together, then Result 5 does not always hold. However, simulations show that it must be that $\pi_z \gg \pi_\ell$ for this result to not be true. For instance, if the proportion of equity, d_e, is 0.03, then it is necessary for $\pi_z \geq 0.22$ and $\pi_\ell \leq 0.01$ for the result not to hold. And if $d_e=0.12$, then $\pi_z \geq 0.05$, $\pi_\ell \leq 0.01$ reverses the results. These values were calculated assuming the probability of FDIC intervention, $1-\sigma$, is 0.6. Higher probabilities of FDIC intervention require bigger differences in the probabilities of default in order for the result not to hold.

To conclude: all the results that we develop for the fixed equity case still apply when banks fund loans at the margin from all sources of funds in fixed proportions, providing that the probabilities of defaults of the two loans do not differ substantially.

III.2. Financing by Expanding Uninsured Deposits Only

When there is only explicit insurance, the pricing solutions are complicated and harder to interpret.[15] As pointed out before, a property of the solution for the two earlier financing assumptions is that interest rates (apart from the degree of monopoly power, -L/L') are independent of both the size of the loans and of the banks' portfolio composition. This independence ceases to exist for this financing assumption, and r_z and $r_{\ell j}$ are now no longer set independently of each other. This turns out to be a major source of analytical complication.

To understand why this independence property disappears, consider a bank making additional Z-loans and financing the loans with uninsured deposits only. The additional Z-loans increase the proportion of uninsured deposits in total deposits. If the Z-loans default, then uninsured depositors will be better off at the margin since the additional dollar lent to the bank increases their share of the proceeds from the local loans. From this point of view, the marginal cost of making Z-loans declines the larger the proportion of local loans in banks' portfolio. But if the local loans default, uninsured depositors will be worse off since they will receive only a fraction $\frac{d_u}{d_i+d_u} = \rho$ of the cash flows that come from the additional Z-loan.

Because of the complexity of the solution, we resorted to extensive simulations. The chief difference between this case and the other two is that the FDIC subsidy appears to be smaller for equal probabilities of default, and banks do not make Z-loans when the probability of default of the local loan is even modestly higher than that of the Z-loans. Like the first two cases, the FDIC subsidy to a loan increases as its probability of default increases. A sufficient condition, however, is that the probabilities of default in Z and local markets are not both unreasonably high. More precisely, Result 2 holds if,

$$\frac{ZL\rho^3}{V^2 d_i}\left(\frac{\pi_\ell}{1-\pi_\ell \rho K_\ell}\right)\left(\frac{\pi_z}{1-\pi_z \rho K_z}\right) < 1 \ , \qquad (24)$$

where $$K_\ell = \frac{L-E}{V-E} \ , \quad \text{and} \quad K_z = \frac{Z-E}{V-E} \ .$$

For realistic parameter values the first term in equation (24) is small. As a result the inequality fails to hold only if both π_ℓ and π_z are very high (on the order of 0.9). Therefore, normally we expect Result 2 to hold.

When there is implicit deposit insurance, the ϕ's become

$$\hat{\phi}_z = \frac{1-\pi_z}{1-\pi_n(1-r_z)}, \quad \text{and} \tag{25}$$

Clearly, the marginal cost of funds for additional Z-loans is again higher than the risk-free rate. Using simulations we find that $\hat{\phi}_z<1$ even when $\phi_z>1$, that is, the existence of implicit FDIC insurance results in a subsidy to Z-loans, even if banks would not make Z-loans in the absence of implicit insurance.[16]

IV. SELECTED MODEL SIMULATIONS.

In this section we present some simulations obtained with a set of realistic parameter values. We present the simulations for two reasons. The first is that these simulations illustrate the relations between important parameters of the model and the rates charged to the two types of loans. The second is that these simulations help quantify the likely size of the FDIC subsidy and the relative importance of explicit and implicit deposit insurance. We present four simulations in Figures 1 through 4. In all the simulations we assume that banks obtain funds at the margin from all three types of liabilities, at fixed proportions. Also, for simplicity, we assume that the semi-elasticity of the demand for local loans, -L/L', is constant, and it is always equivalent to 300 basis points.

Figure 1 shows the effect of explicit and implicit FDIC insurance on both loan rates, when the probability of FDIC intervention to protect uninsured depositors, 1-σ, increases from 0 to 1. Figure 1 suggests four comments. First, the overall subsidy to the Z-loans can be very large, around 300 basis points in this case. Second, both explicit and implicit insurance have a sizeable impact on interest rates. With a risk free rate of 7 percent and equal default probability for both loans of 3 percent, the competitive market rate in both markets should be 10.3 percent. Explicit deposit insurance reduces that rate to 8.4 percent for Z-loans and to 11.4 percent (down from 13.4 percent) for local loans. Notice that the local loan rate still is higher than the competitive market rate because of the monopoly power. The addition of implicit insurance cuts the Z-loan rate to a level only 35-40 basis points above the risk free rate. This simulation suggests that FDIC policies could have resulted in LDC borrowers paying only 30 to 50 basis points above LIBOR--risk premia that were fairly common for LDCs before August 1982--when the riskiness of these loans could have required a premium as large as 300 basis points above LIBOR. In the local market, when the probability of an FDIC intervention is very high, the insurance subsidy almost completely offsets the effect of monopoly power on the pricing of loans. Third, the interest rate for Z-loans is affected only minimally by the probability of FDIC intervention, 1-σ, once there is implicit insurance. This means that, in practice, it does not make much difference at what level the FDIC sets its intervention point, once it is known that the FDIC will protect uninsured depositors. Fourth, the probability of intervention does affect the local loan rate. When the probability of intervention is very high, the local loan rate comes very close to the competitive market rate, despite the monopoly power of banks.

The second and third simulations show how changes in the risk configurations affect the level and allocation of the FDIC subsidy with and without explicit deposit insurance. In Figures 2 and 3 we report the subsidized rates and the competitive rates, and the risk free rate for comparison. Figure 2 shows that as Z-loans become riskier, they become more heavily subsidized. The subsidy is measured by the vertical distance between r_z^e and $\hat{r}_z$. Part of this subsidy, however, is paid by local borrowers as the spread over the competitive rate grows in that market. The increase in subsidies as loans become riskier is remarkable. For example, at π_z=0.01 the subsidy to the Z-loan is only 85 basis points, but at π_z=0.13 the subsidy grows to 1350 basis points. Figure 3 shows that when local loans become riskier the subsidy to those loans grows (the distance between r_z^e and $\hat{r}_z$ narrows). In addition, the figure shows that, for low levels of π_ℓ, r_ℓ^e is below $\hat{r}_\ell$ because the subsidy is not sufficiently high to offset the degree of monopoly power.

Finally, Figure 4 shows that higher bank capital requirements reduce the FDIC subsidies only modestly, and they would not have prevented banks from becoming "overexposed" towards Z-loans. Even if banks had been required to maintain d_e at .15 instead of .01, the subsidy to Z-loans would have only declined from 325 basis points to 200 basis points. This simulation assumes that the higher equity ratio, ϕ_ℓ, is <u>not</u> <u>eneough</u> to alter the bankruptcy states of the typical bank. Obviously, to the extent that the capital requirements eliminate bankruptcies in some states, this conclusion would change.

V. CONCLUSION

An important feature of the US banking system is the existence of FDIC insurance for certain types of bank deposits. We call this explicit FDIC insurance. To offer this insurance, the FDIC charges banks a risk premium per dollar of insured deposits, not to exceed 12 basis points. In addition, as a result of its policies, the FDIC offers, at least de facto, partial insurance to uninsured deposits. We call this implicit FDIC insurance.

In the paper we study the impact of both explicit and implicit FDIC insurance on bank loan pricing decisions. This work was motivated by the commonly held view that in the middle and late seventies LDCs were paying "too small" risk premia for bank loans, relative to the riskiness of these loans. The main objective of the paper is to show that the existing FDIC insurance, by itself, may have accounted for banks' portfolio choices in international capital markets.

To achieve our objective we build a simple partial equilibrium model of the banking system. There are N banks. They all are endowed with some monopoly power in local lending, but the demand schedules and the probabilities of default of these local loans are the same for all banks. This makes all the banks identical, except that the probabilities of default are independent across local loans. Banks, in competition with each other, may also lend to Z-borrowers, who have access to competitive capital markets. Thus each bank generally carries a common risk, the Z-loans, and an idiosyncratic risk, the local loans.

The Z-loans are intended to capture what turned out to be some very important features of LDC debt: (i) LDC debt is owned by banks that make up a large fraction of total bank deposits, (ii) if major LDCs default, the banks that own the debt would be in jeopardy, (iii) LDC debt performance seems highly correlated across individual countries.

We show that explicit FDIC insurance generally subsidizes both Z-loans and local loans. The addition of implicit FDIC insurance increases this subsidy, and it tilts it towards the Z-loans. Also we show that the riskier the loan the more heavily it is subsidized. Simulation results show that the rate banks charge to Z-loans could be easily 200-400 basis points below the competitive market rate, for realistic parameter values.

The analysis also leads us to conclude that one of the side effects of the current FDIC insurance scheme is to subsidize larger risks more heavily, and to subsidize bank systemic risk more heavily than non-systemic risk.

Footnotes

[1]Before 1982, sovereign borrowers appeared to be facing an infinitely elastic supply of loans, even though the supply schedule should have been backward bending in a profit maximizing banking system (see Eaton and Gersowitz 1981, Sachs and Cohen 1982).

[2]Though the incentives created by the implicit and explicit deposit insurances have much to do with banks' apparent myopia in LDC lending, we do not claim that this is the only valid explanation of bank behavior. One could argue that, before August 1982, banks perceived the returns on various LDC loans to be uncorrelated. In this view, the systemic nature of the LDC debt is coincidental; ex-post it is very difficult to reject such a hypothesis.

[3]The essential features of LDC loans we are trying to capture by specifying Z-loans in this way is that such loans are a sizeable proportion of total banks' liabilities, that they are held by many banks, and that if they default they can put a significant proportion of banks into default.

[4]The conditions implied by our assumptions about bankruptcy are,

$$L_j(1+r_{\ell j}) < (V_j-\bar{E}_j)(1+r_{uj}) > Z_j(1+r_z) \ .$$

[5]This assumption also simplifies the cash flows to equity and makes the maximization problem more tractable. The appendix contains a more complete discussion of the economic interpretation of this assumption.

[6]The inclusion of a risk-independent FDIC insurance premium that is different from zero, or some form of constant bankruptcy costs, would complicate the algebra without yielding any additional economic intuition. As long as these costs are exogenous, they will have no bearing on the bank's maximization problem. Furthermore, because of our assumption about the monopoly power of banks in local loans, the existence of bankruptcy costs will

not drive banks to arrange their asset portfolios so as to avoid default. This is in contrast to the model developed in Kareken and Wallace (1978).

[7]For an extensive discussion of the theory and the application to option pricing see Harrison and Kreps (1979), Huang (1985).

[8]In this paper we abstract from any agency problems that may arise.

[9]This procedure is formally equivalent to maximizing profits. We use the marginal cost approach because it has more intuitive appeal.

[10]This definition of equilibrium is not satisfactory for studying game-theoretic aspects of banks' behavior. However, since the purpose of this paper is to analyze the effect of FDIC insurance on the pricing of loans by banks in general, it is not necessary to complicate the model further by adding assumptions that determine the size of individual banks.

[11]Our monopoly power assumption is important for the cross-subsidy aspect of this and later similar results. Clearly, if local markets are contestable, the amount of subsidization that can accrue to Z-loans from the local loans (or vice versa) would be limited by the conditions under which competitors could come in and make <u>only</u> local loans. We rule out the possibility of competitors making only Z-loans, because a financial intermediary must make local loans in order to be a bank and to be able to obtain FDIC insurance.

[12]The net present value calculation that gives $\hat{r}_u$ is:

$$[\delta(1-\pi_\ell)(1-\pi_z) + \delta\pi_z(1-\pi_\ell) + \delta\pi_\ell\pi_z + \delta(1-\sigma)\pi_\ell(1-\pi_z)](V-\bar{E})d_u(1+\hat{r}_u)$$

$$+ Zd_u(1+\hat{r}_z)\sigma\pi_\ell(1-\pi_z) - (V-\bar{E})d_u = 0 .$$

[13]With the proportion of equity in the 3 to 10 percent range and the proportion of insured deposits in the 60-80 percent range, it requires a value of π_ℓ=0.12 or more, and a value of π_z=0.01 or less, for ϕ_z>1.0. Symmetric conditions are necessary to get ϕ_ℓ>1.0.

[14]In our simulations, over a range of d_e(0.01-0.22), π_ℓ(0.01-0.22), π_z(0.01-0.22) and all possible values for d_i and d_u, we did not encounter a case where $\hat{\phi}_z > \phi_z$ unless $\phi_z \geq 1.0$.

[15]Under the assumption that banks expand at the margin by attracting only uninsured deposits, the equilibrium interest rates become:

$$1+r_z = \frac{1+r_f}{1-\pi_z} \frac{(A_\ell - B_z)}{(1-\pi_\ell)(A_\ell A_z - B_\ell B_z)} + \frac{1-\rho\pi_z}{1-\pi_z} \frac{L(r_\ell)}{L'(r_\ell)} \frac{B_z}{A_\ell A_z - B_\ell B_z} ,$$

$$1+r_\ell = \frac{1+r_f}{1-\pi_\ell} \frac{(A_z - B_\ell)}{(1-\pi_z)(A_\ell A_z - B_\ell B_z)} - \frac{1-\rho\pi_z}{1-\pi_z} \frac{L(r_\ell)}{L'(r_\ell)} \frac{A_z}{A_\ell A_z - B_\ell B_z} ,$$

where
$$A_\ell \equiv \frac{1-\pi_z(1-\Gamma_\ell)}{1-\pi_z} , \qquad A_z = \frac{1-\pi_\ell(1-\Gamma_z)}{1-\pi_\ell} ,$$

$$B_\ell \equiv \frac{\pi_\ell \rho Z}{(1-\pi_\ell)(V-E)} , \qquad B_z = \frac{\pi_z \rho L}{(1-\pi_z)(V-E)} ,$$

and where
$$\Gamma_\ell \equiv 1 - \frac{\rho(Z-E)}{V-E} , \qquad \Gamma_z \equiv 1 - \frac{\rho(L-E)}{V-E} , \qquad \rho \equiv \frac{d_i}{d_i + d_u} .$$

[16]Over the range of d_e(0.01-0.20), all possible values for d_i and d_u, σ(0.0-1.0), Z/V(0.2-0.5), it is always true that $\hat{r}_z < r_z$. This is true even when $\phi_z > 1.0$.

APPENDIX

(1) The Generality of the Specification of Bankruptcy States

Recall that each loan market is characterized by a good state of the world which is denoted ZG or LG for the Z-loans and for each of the local loans, respectively, and a bad state of the world, denoted ZB and LB, respectively.

There are four possible ways to characterize the various default states for the individual bank. A bank defaults (i) when the bad state occurs simultaneously in both local and Z-loans, (ii) when the bad state occurs only for the local loan, (iii) when the bad state occurs only for the Z-loan, and (iv) when the bad state occurs for neither loan. The four possibilities are summarized in Table A1.

TABLE A1. DEFAULT STATES OF AN INDIVIDUAL BANK

States of the World					
Z-loans	Local loans	Case 1	Case 2	Case 3	Case 4
Good (ZG)	Good (LG)	ND	ND	ND	ND
Good (ZG)	Bad (LB)	ND	D	ND	D
Bad (ZB)	Good (LG)	ND	ND	D	D
Bad (ZB)	Bad (LB)	D	D	D	D

ND = NO DEFAULT
D = DEFAULT

An examination of the possible cases shows why case 4 is the most general case. Cases 2 and 3 imply that the riskiness of one of the two loans (Z-loan for case 2, L-loan for case 3) is irrelevant to the holders of uninsured deposits. Therefore, though the riskiness of both loans would affect the pricing of equity risk, these cases are not appropriate vehicles with which to examine the effects of FDIC insurance. In case 1 the riskiness of both loans matters to depositors, but only if they fail together, so that the emphasis in this case is on equity pricing. Furthermore, it would be difficult to separate the effect of the riskiness of the two loans, because their effect on uninsured deposit is symmetric. Case 4, the case we adopt, allows for separate effect of the riskiness of each loan on the cash flows to deposits. Thus, for studying the effects of FDIC policies it is the most general case.

(2) <u>The Independence of the FDIC Rule</u>

The risk specification in our model is that each local loan has a probability of default, π_ℓ, and this probability is independent across local loans. Z-loans have a common probability of default, π_Z, and it is independent of all the π_ℓs.

If the Z-loans fail all N banks fail, and the FDIC intervenes always, even as $\alpha=k/N \rightarrow 1$. If the Z-loans are good, some local loans will fail, and therefore some banks will fail. The probability that k over N banks will fail when the Z-loans <u>do not fail</u> is binomial, and it is given by:

$$\text{(A-2.1)} \qquad \pi_\ell^k(1-\pi_\ell)^{N-k}\binom{N}{k}$$

Let the FDIC decide the proportion of banks failing, $\alpha=k/N$, that constitutes a system crisis. Then the FDIC will step in and protect uninsured deposits if k or more banks fail. The probability of such an event (FDIC intervention) when the Z-loans are good is given by:

$$\text{(A-2.2)} \qquad 1-\sigma = \sum_{j=0}^{N-k} (1-\pi_\ell)^{N-k-j} \; \pi_\ell^{k+i}\binom{N}{k+j}$$

Equation (A-2.2) shows that the probability of FDIC intervention is independent of banks' portfolio choices, so that it can be treated as a parameter for the bank optimization problem.

(3) Proof That $\phi_z \leq d_i + d_u$ Is a Sufficient Condition for $\hat{\phi}_z < \hat{\phi}^*_z$ in Section III

The strategy is to show that $\hat{MC}_z < MC_z$, and to recognize that since each bank takes r_z as given, if $\hat{MC}_z < MC_z$ it follows that $\hat{\phi}_z < \phi_z$.

First write the difference of the marginal costs:

$$(A\text{-}3.1) \quad \Delta MC_z = \hat{MC}_z - MC_z = (1+r_f)\left[d_i + \frac{d_u + d_e}{(1-\pi_\ell)(1-\pi_z)}\right] - \frac{\pi_\ell}{1-\pi_\ell}\gamma(1+r_z)$$

$$- (1+r_f)\left[d_i + \frac{d_u}{1-\pi_n} + \frac{d_e}{(1-\pi_\ell)(1-\pi_z)}\right] + \frac{\pi_n}{1-\pi_n}\gamma(1+r_z) \; .$$

This simplifies to:

$$(A\text{-}3.2) \qquad \Delta MC_z = (1+r_f)d_u\left[\frac{1-\pi_n - (1-\pi_\ell)(1-\pi_z)}{(1-\pi_n)(1-\pi_\ell)(1-\pi_z)}\right] + (1+r_z)\gamma\left[\frac{\pi_n - \pi_\ell}{(1-\pi_n)(1-\pi_\ell)}\right] .$$

Let $1+r_z = \frac{1+r_f}{1-\pi_z}\phi_z$, as in the text, and let $\theta = \phi_z\gamma/d_u$. Then (A-3.2) becomes:

$$(A\text{-}3.3) \quad \Delta MC_z = \frac{(1+r_f)d_u}{(1-\pi_\ell)(1-\pi_n)(1-\pi_z)}\left[1-\pi_n - (1-\pi_\ell)(1-\pi_z) - \theta\pi_\ell + \theta\pi_n\right] ,$$

Let $\qquad (1+r_f)d_u/(1-\pi_\ell)(1-\pi_n)(1-\pi_z) = W$, and expand to get,

$$(A\text{-}3.4) \qquad \Delta MC_z = W\{\pi_\ell[(1-\pi_z)(1-\theta)(1-\sigma) + \theta\pi_z] + \pi_z\} .$$

A sufficient, but not necessary condition for $\Delta MC_z > 0$ is that $\theta \leq 1.0$. But $\theta \leq 1.0$ implies that $\phi_z \leq d_i + d_u$, from the definition of θ.

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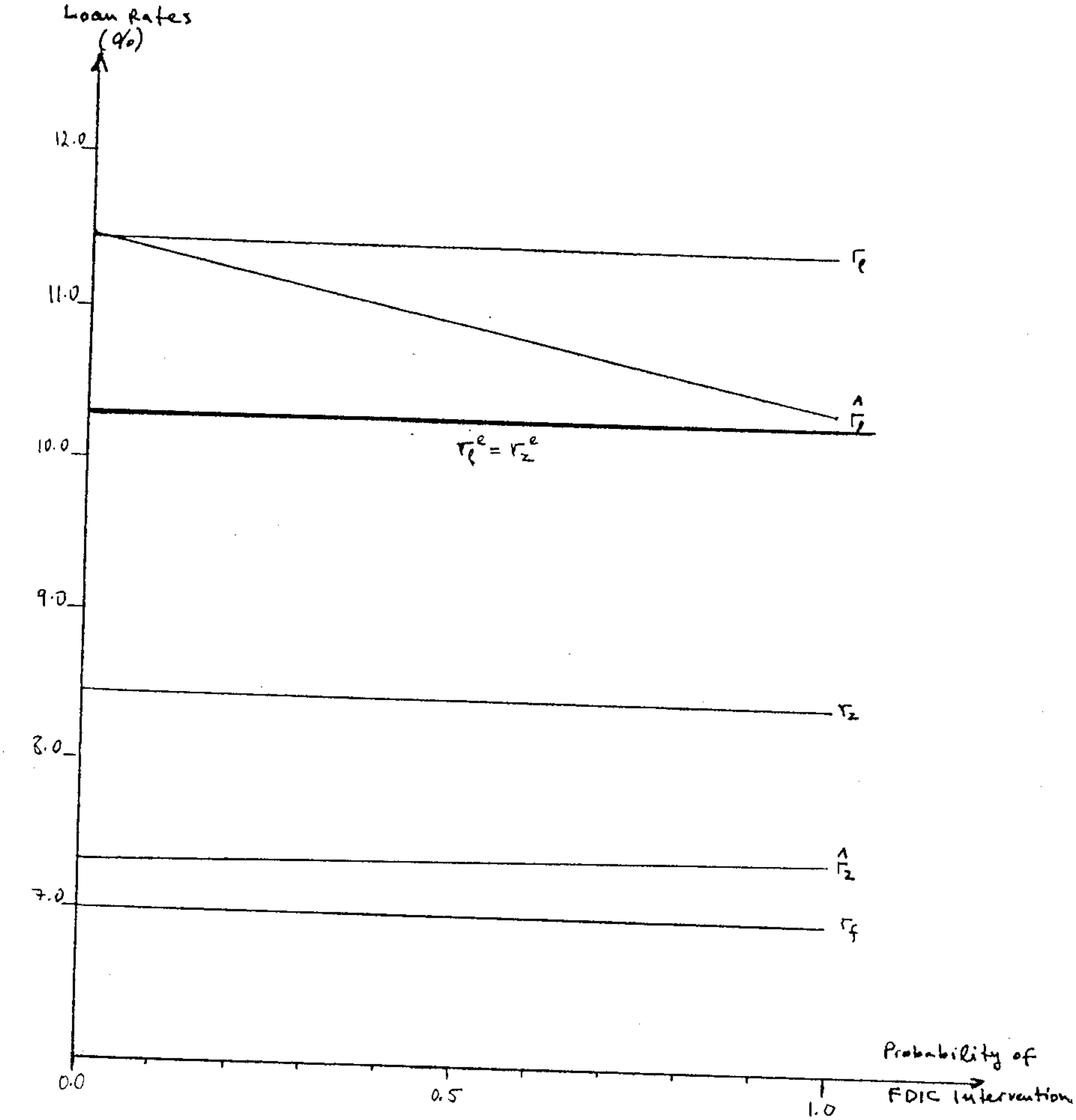

Figure 1: The Relation Between the Probability of FDIC Intervention and Loan Rates.

We assume the following parameter values: r_f=0.07, π_z=π_ℓ=0.03, d_i=0.61, d_u=0.33, d_e=0.06, -L/L'=0.03. The rates that would prevail in the competitive capital markets are labeled r_ℓ^e and r_z^e. The simulation assumes that all deposits expand in constant proportions at the margin.

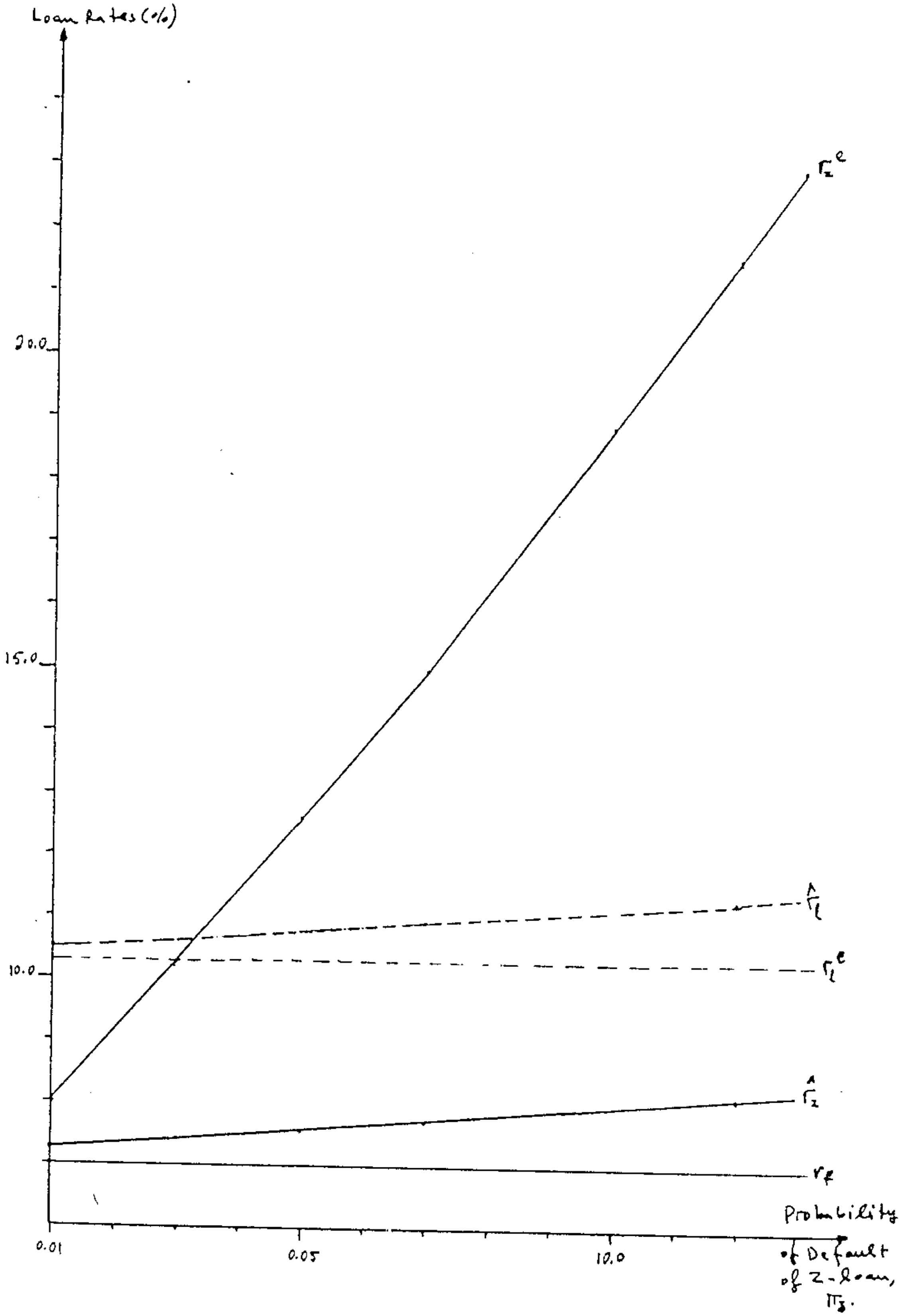

Figure 2: The Effect of the Probability of Default of the Z-loan on Loan Rates.

We assume the following parameter values: r_f=0.07, π_ℓ=0.03, σ=0.20, d_i=0.61, d_u=0.33, d_e=0.06, -L/L'=0.03. The rates that would prevail in the competitive capital markets are labeled r_ℓ^e and r_z^e. The simulation assumes that all deposits expand in constant proportions at the margin.

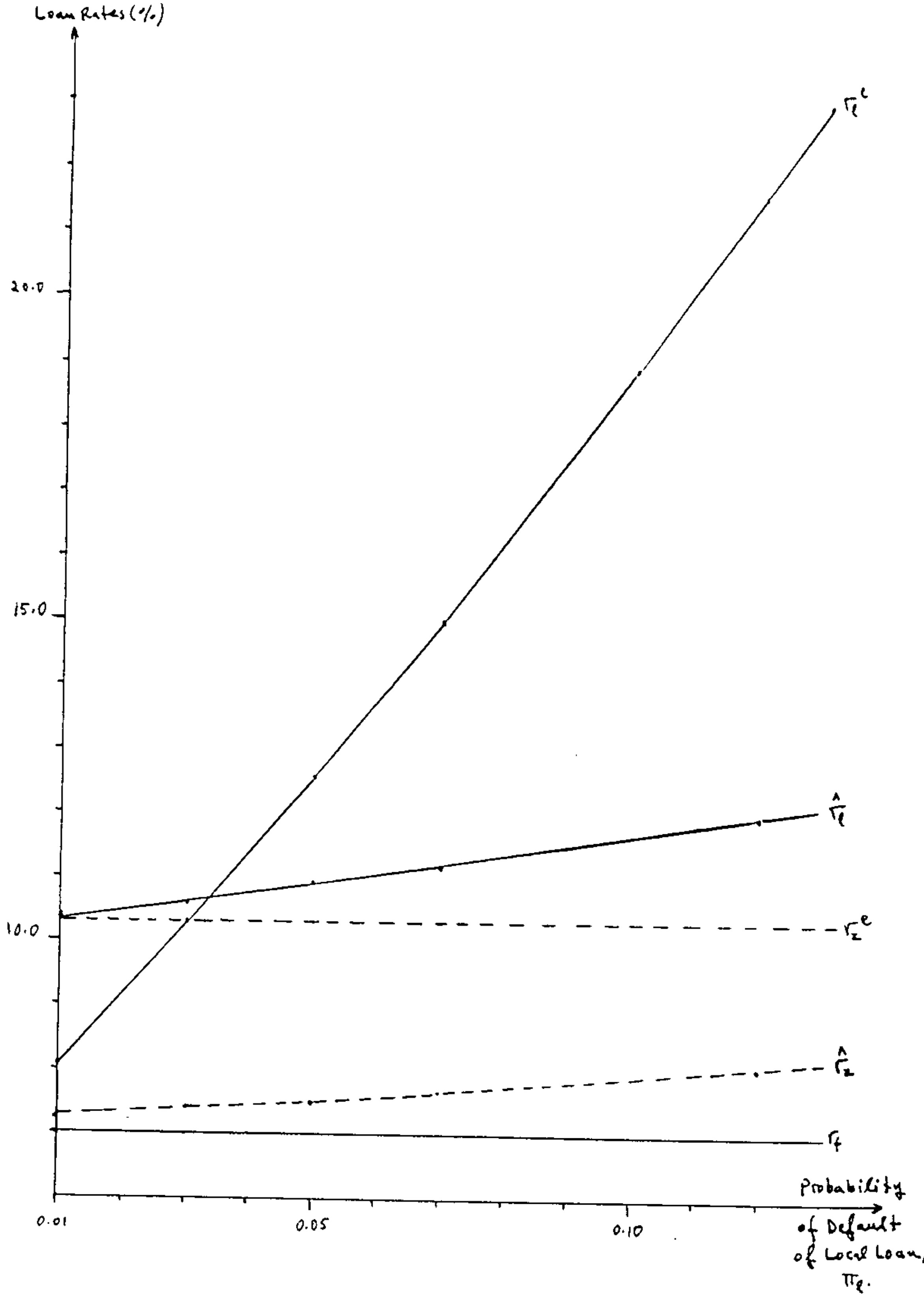

Figure 3: The Effect of the Probability of Default of the Local Loan on Loan Rates.

We assume the following parameter values: r_f=0.07, π_z=0.03, σ=0.20, d_i=0.61, d_u=0.33, d_e=0.06, -L/L'=0.03. The rates that would prevail in the competitive capital markets are labeled r_ℓ^e and r_z^e. The simulation assumes that all deposits expand in constant proportions at the margin.

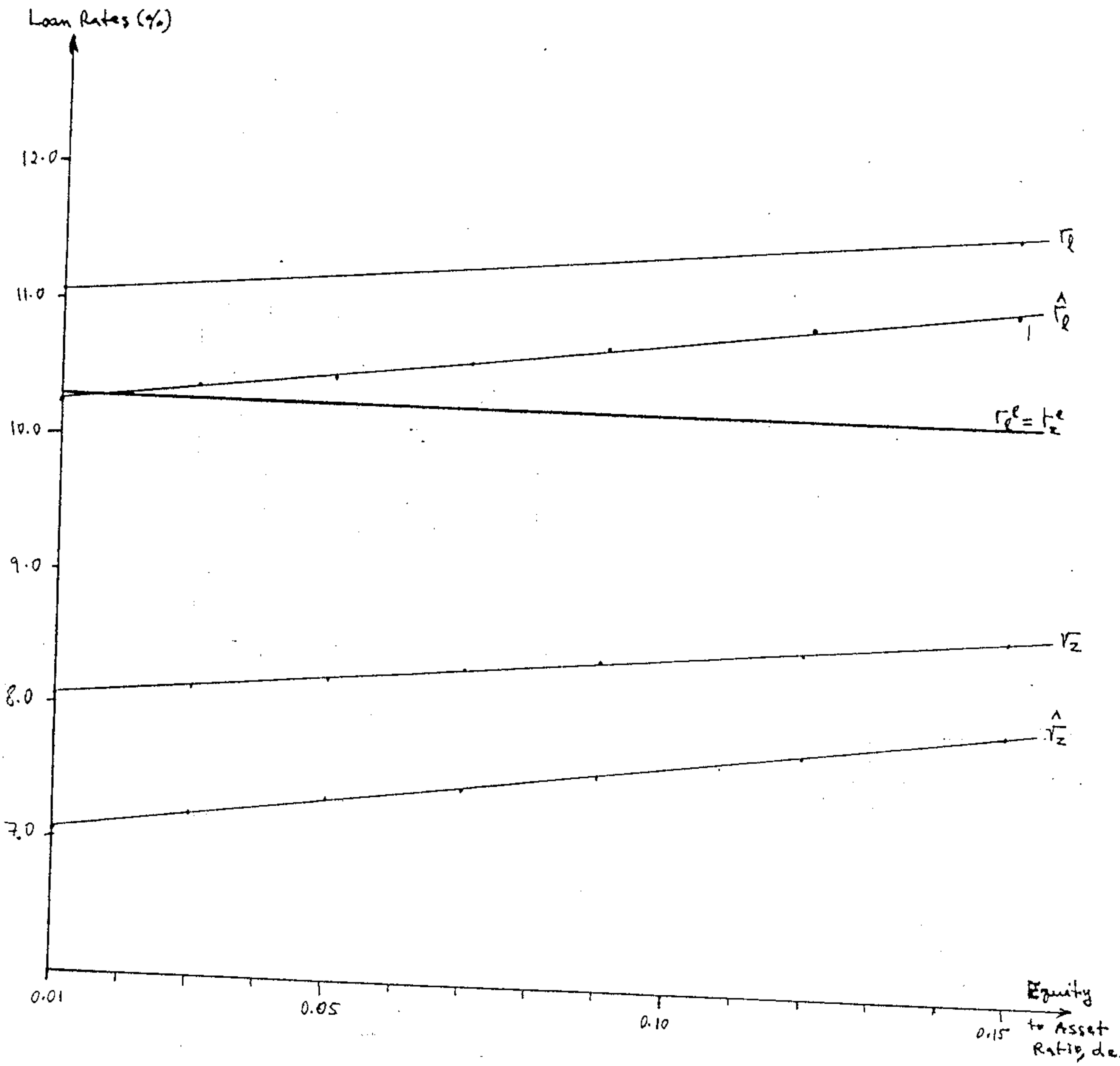

Figure 4: The Effect of Equity to Total Liability Ratio on Loan Rates.

We assume the following parameter values: r_f=0.07, π_z=π_ℓ=0.03, σ=0.20, d_i=0.7(1-d_e), d_u=0.7(1-d_e), -L/L'=0.03. The rates that would prevail in the competitive capital markets are labeled r^e_ℓ and r^e_z. The simulation assumes that all deposits expand in constant proportions at the margin.