Spring

1984

Economic Review

Number

2

Federal Reserve Bank of San Francisco

The Federal Reserve Bank of San Francisco's Economic Review is published quarterly by the Bank's Research and Public Information Department under the supervision of Michael W. Keran, Senior Vice President. The publication is edited by Gregory J. Tong, with the assistance of Karen Rusk (editorial) and William Rosenthal (graphics).

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Deregulation and Deposit Insurance Reform

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Bank deregulation has increased the need for deposit insurance reform. In particular, it has enhanced the opportunities for insured institutions to exploit risk-taking incentives in the existing deposit insurance system. Many reform proposals focus on ways of pricing the risk that is not now differentially priced. A comparative statics analysis of the insurer's liability, applying options theory, suggests that improved monitoring and control of bank activities to prevent insolvency is more important.

Lots of people are talking about deposit insurance reform because, as deposit insurance is structured and administered, it may be incompatible with a deregulated banking system.[1] Congress, while responsible for the heightened interest, does not seem to be doing anything about it. The *Garn-St Germain Act of 1982* required federal insurers to study the deposit insurance system. The agencies responded with over 500 pages of text and tables that may be only the first of a flood. At least three articles on deposit insurance have appeared since the agency reports were released (Horvitz, 1983; Peterson 1983; and Kane, 1983a), and more are forthcoming (Campbell and Glenn, 1983; Campbell and Horvitz, 1983).

Why add to this torrent of words? Chiefly, to report some new evidence on the cost of deposit guarantees that is relevant to deposit insurance reform (Section II), but also to comment on ways that bank deregulation makes reform more imperative (Section I). One hopes that adding to the evidence may help move Congress and the bank regulators toward useful action (Section III).

Legislation in progress

There is little sign that the 98th Congress will enact deposit insurance reform. The *Financial Institutions Deregulation Act* introduced by Senator Garn for the Treasury does not address this topic.[2] Neither did Senator Garn include deposit insurance reform in his "omnibus" banking bill, the proposed *Financial Services Competitive Equity Act* introduced in November 1983. There are proposals to alleviate symptoms of the ailing insurance system: Congressman St Germain's proposal to regulate deposit brokers and the attempt in the Treasury bill to come to grips with the elusive "non-bank" bank. The *Federal Deposit Insurance Improvements Act* introduced by Senators Garn and Proxmire for the FDIC does propose some reforms, but since they were not incorporated into Senator Garn's omnibus bill, it is not clear how they will fare in Congress. Even if they had been incorporated, the premium risk adjustment

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proposed is limited to the rebate of net FDIC assessment income. This may not be enough to produce effective risk-related premiums. The FDIC bill would also establish payment priorities in liquidation proceedings, but it does not address the critical problem of controlling the liquidating value of failing institutions.[3]

In contrast to the inaction on deposit insurance reform, legislation intended to further the banking deregulation process continues to be introduced. Since deregulation is being driven by market forces that have proved hard to restrain, it is likely that we will have more bank deregulation whether or not there is Congressional action on proposed legislation. We therefore need to know whether the existing deposit insurance system is compatible with a deregulated banking system and, if reform were needed, how it should be structured.

I. Deregulation and the Need for Deposit Insurance Reform

The debate over deposit insurance, which predates bank deregulation[4], has frequently revolved around the objection that the current system of flat-rate insurance premiums encourage risk-taking by insured institutions. Defenders of the system are not convinced that these institutions have taken significant advantage of this built-in incentive to take risk. I was recently asked why anyone should worry about the risk-taking incentives of a deposit insurance system that has remained solvent through the exigencies of the last 50 years. My answer is twofold. First, there may be reason to question its solvency. Kane (1983b) estimated the net worth of insured S&Ls and mutual savings banks at minus 100 to 175 billion dollars in December 1981. Interest rates have fallen since then so the immediate threat to the funds has decreased, but it is prudent to remember that the laws of gravity do not apply to interest rates.

Second, and more relevant, today's financial environment differs markedly from that of the last 50 years. The banking system has changed in fundamental and permanent ways, and these changes make it easier for insured institutions to act on the risk-taking incentives of deposit insurance. The pronounced interest rate volatility of the 1970s and early 1980s was an important difference in the environment, but perhaps a transitory one. The changes resulting from the deregulation of financial services that began with the *Depository Institutions Deregulation and Monetary Control Act of 1980,* however, show no signs of ending. They are, in large measure, responses to market forces that do not appear to be abating, let alone reverting.[5] Moreover, insurer insolvency *per se* is not the major reason for concern about the deposit insurance system. The more important consideration is that the failure to price deposit insurance correctly leads to allocative inefficiencies. Even if deposit insurance premiums were correct on average so that the funds were solvent, allocative inefficiencies could remain flaws in the present deposit insurance system. The rest of this section contains a discussion of some ways that deregulation has intensified the need for deposit insurance reform.

Asset deregulation

Excessive credit risk has not been the major cause of bank failures over the past 50 years, the Penn Square debacle and the continuing LDC loan scare notwithstanding. Leverage risk, interest rate risk, and fraud have been more important. The secular increase in interest rate levels and volatility has troubled many institutions, but increased interest rate risk may not be a permanent problem and, in any case, is a manageable one since interest rate risk can be hedged. It is arguable, however, that the measurement of interest rate risk is a less serious problem for the insurers than measurement of credit risk or the detection of fraud.[6]

Is the bank risk experience of the past a harbinger of the future? Much of the thrust of asset deregulation, past and proposed, points in the other direction. Savings and loan holding companies, for example, have been authorized to engage in a broad range of activities, including real estate development, credit, life and health insurance.[7] The *Financial Institutions Deregulation Act* proposes to extend similar powers to bank holding companies. Although these new asset and product-line powers may have been intended to increase asset diversification, they also create the

potential for increased risk-taking by insured institutions.

Deposit deregulation

Congress, through the Depository Institutions Deregulation Committee, has eliminated most deposit rate ceilings. The resulting flow of funds into the deregulated accounts has been amazing.[8] More changes, including interest on all demand deposits, are proposed. Whether this will increase liability costs at banks and thrifts in the long run is an open question. Depositors may just receive more direct interest and less implicit interest in the form of free or subsidized services. At the minimum, the response time to market rate changes will be shortened. Existing institutions must learn to manage new trade-offs between deposit rates and deposit services. They will have to do so while competing with entrants free of the physical and mental trappings suited to a more regulated era. Airline executives should be able to advise bankers on this problem.

Brokered deposits

New entrants into the banking field, and many older firms, have discovered brokered deposits as a means to expand their deposit draw beyond their own geographically limited areas. The deposit broker obtains funds from investors throughout the country and channels them to the client depository institutions, assigning title for the deposit in separate units, up to the insurance limit of $100,000, to a number of different investors. With deposit rate deregulation, banks can offer a higher yield on brokered deposits as an enticement. Those institutions that want to engage in increased risk-taking, therefore, need not wait for local deposit growth to provide the funding.[9] Moreover, their deposit draw is no longer limited to those who know the institutions well. This situation, without question, presents a serious problem for insurers.

Another problem with brokered deposits is that the insurer, in effect, has replaced the Federal Reserve as the lender of last resort. A bank in trouble can go to the brokered deposit market instead of the discount window for liquidity. This is quite rational behavior when the insurers offer failing institutions a bargain insurance rate on the brokered deposits while the Federal Reserve wants good collateral for loans at the discount window.

Access to a national deposit market may be a new and heady thing for smaller banks, but it is old hat for large banks. They have tapped the money market for some years both by direct and brokered placement of large, mostly uninsured CDs. Given the revealed behavior of bank regulators, a large bank's lenders have been confident of their deposits' safety. With the notable exception of Penn Square National Bank, large bank failures have been resolved with no losses for uninsured depositors. This has resulted in less than full risk-pricing of deposit liabilities for banks issuing large denomination CDs. The introduction of insured deposit brokerage may well be an important concern for the deposit insurers, but so is the direct or brokered sale of "uninsured" deposits that are thus implicitly insured.

Making insured deposit brokerage more difficult does not solve the problems deposit brokerage presents. Instead, it risks cutting off an economically efficient deposit-gathering mechanism. An analogy may help make the point. When large banks began to use large computers, it was suggested that scale economies in computing would drive small banks out of business. This has not happened because a large computer does not have to be owned directly by a small bank for the bank to use competitively priced computer services; the small bank can purchase them. Similarly, by pooling the deposit offerings of a number of banks, a deposit broker uncouples size and access to national deposit markets. The flaw lies in the mispricing of deposit guarantees, whether explicit or implicit, for large banks as well as small, and not in the deposit marketing mechanism.

Deposit deregulation and the liability mix

There is a positive aspect to deposit deregulation from the regulator's viewpoint in that it may help regulators enforce capital adequacy standards. The removal of deposit rate ceilings undermines the argument that deposits are a cheaper source of funds than other bank liabilities. Even before deposit rates were deregulated, Black, Miller, and Posner (1978) made a convincing case that capital requirements are not a costly form of bank regulation. The basic

idea is that competition among banks for deposits will drive the total return on deposits into equilibrium with the cost of other sources of funds. If the substitute liabilities were subordinated to deposits, they may pay a higher return than deposits just as in other corporations subordinated debt pays a higher return than senior debt, and equity a higher return that subordinated debt. In none of these cases is the higher required return an economic cost to the issuer as long as it is consistent with the risk borne by that class of investor. Considerations such as taxes, corporate control, and financial flexibility may influence the choice between debt and equity. If the bank is free to use both debt and equity liabilities in place of deposits, these considerations do not influence the choice between deposits and other liabilities.[10]

When deposit rate ceilings were binding, the industry was forced into non-rate competition. It is conceivable that this non-rate competition was less than perfect, and that it allowed at least some banks to raise funds at the margin at lower cost than by issuing deposits. The elimination of deposit rate ceilings has made full rate competition possible again. If marginal deposits are bargains when full rate competition is possible, it is because some bank markets are not fully competitive or because deposit insurance premiums are insufficient to cover the insurer's deposit guarantee liability. Regulatory policies regarding capital adequacy standards should not allow depository institutions to take advantage of these sources of deposit "cheapness."

Geographic deregulation

There has been no systematic deregulation of the geographic restrictions on banking, yet we have gone a long way toward removing those restrictions. Market forces, acting through loan production offices, money market mutual funds, deposit brokers, nonbank banks, electronic banking networks, and other channels, continue to push the banking system in this direction.

Bank regulators have aided the process of geographic deregulation. Before 1978, a foreign bank could obtain charters in more than one state. A number did and were "grandfathered" when this loophole in geographic regulation was closed in the *International Banking Act of 1978*. More recently, geographic deregulation has been fostered by interstate acquisitions of troubled institutions. The explicit authorization of interstate acquisitions in the *Garn-St Germain Act of 1982* confirmed a process of extraordinary acquisition in use by the federal agencies. Notable examples include the 1981 acquisition of two out-of-state institutions by the California-based Citizens Savings (since metamorphosed into First Nationwide Savings) and the Citicorp acquisition of Fidelity Savings and Loan of San Francisco immediately before the 1982 Act was approved. Since the 1982 Act, there have been additional out-of-state acquisitions, including two more proposed thrift acquisitions (in Chicago and Miami) by Citicorp.

Interstate franchises and insurance funds

Together, market forces and regulatory policies are breaking down the barriers to interstate banking. As these barriers fall, the value of a multi-state franchise falls too. This has an important implication for the deposit insurance funds. The major bidders for troubled institutions have often been out-of-state firms. Over the past two years or so, they have resulted in more than a dozen interstate acquisitions. The out-of-state bidders made offers that included the value of a multi-state franchise as well as the value of the troubled firm's asset portfolio. If the insurers had been unable to offer a significant relaxation of geographic barriers to these bidders, does anyone doubt that the insurance funds would be smaller today?

When we achieve full geographical deregulation, *de facto* or *de jure,* the deposit insurance agencies will not have valuable multi-state franchises to sell. They will then have to bear the full brunt of the shortfall in asset value in failed institutions.

II. Targets for Deposit Insurance Reform

The preceding arguments suggest that bank deregulation has increased the need for deposit insurance reform. If so, how should that reform be structured? A central theme of the arguments about the effects of deregulation is that deregulation has increased the opportunity for insured institutions to respond to the risk-taking incentives in the current deposit insurance contract. The proposed reforms have correspondingly focused on bank risk and the pricing of risk, as in risk-related premiums. This view of the reform process, especially the use of risk-related premiums, has its critics, who think reform should focus more on the process by which the insurers monitor and control the net worth of insured institutions.

A framework for comparing these alternative views on deposit insurance reform can be built around the concept of the deposit insurer's liability. An insurer of a bank's deposits has a liability if that bank could become insolvent, and if, at that time, the value of the bank's assets do not sufficiently cover the deposit guarantee. Bank asset risk and the insurer's insolvency policies are therefore major determinants of this liability.

Consider the effects of bank asset risk. Since bank monitoring is costly, the insurer (or a surrogate) examines a bank at discrete intervals. If the bank's assets are risky (from the insurer's viewpoint), there will be a positive probability that the value of those assets will fall below the deposit guarantee before the next examination. The more volatile the value of a bank's assets, the more likely that this event will occur and the larger the potential shortfall could be. Recognizing this, analysts suggest that deposit insurance reform should include risk-related insurance premiums. However, the critics are not convinced. They argue that risk-related premiums would be hard to implement because measuring risk on non-traded assets is difficult.[11] Nonetheless, the failure to maintain consistency between bank asset risk and the insurance premium is a flaw in the deposit insurance system that is likely to be aggravated by bank deregulation.

Horvitz (1983) has made a thoughtful case against risk-related premiums. A main part of his argument is the distinction between the risk of bank failure and the risk of insurer loss: "The key point... is that if insured institutions are operating with positive net worth, and the insurance agency is able to monitor their condition, then the risk of loss to the agency is low, *regardless of the riskiness of individual institutions.*"[12] This argument emphasizes the important protection given lenders by their right to force insolvency proceedings. Unfortunately, bank and thrift regulators have not always exercised this right in a way that is consistent with a low risk of loss. They often did not deal promptly with failing institutions whose market net worth reached zero. There are a number of reasons for this. One is the divided responsibility among insurers and regulators.[13] A second is the the use of book value net worth standards. The failure to mark fixed-rate, long-term assets to market in a period of rising interest rates allowed numerous institutions to remain in business after their economic net worth had fallen below zero. Once many institutions were in this position, concern over the effects of having a large number fail at the same time strengthened the regulators' reluctance to enforce more realistic insolvency controls. A similar problem has developed with respect to the reliance on book value net worth in banks with a significant fraction of their assets in loans to less-developed countries.

The prospect that a bank will not be declared insolvent as soon as its *market* net worth has been found to reach zero or less is an important determinant of the insurer's current deposit guarantee liability. A net worth standard that permits negative market net worth tends to make the date of insolvency later than it would be under a zero market net worth standard. It thereby reduces the *present value* of a given *future* shortfall in asset value relative to the deposit guarantee. This effect, however, is more than offset by the increased size of the potential shortfall. The net effect of the failure to use market value net worth standards in declaring insolvency therefore is an increase in the present value of the insurer's liability.

The Deposit Insurer's Liability

Recent research on the valuation of the deposit insurer's liability can shed some light on the relative importance of asset risk control and insolvency

control in deposit insurance reform. Merton (1977, 1978) pioneered the use of options theory to model deposit insurance. A recent extension of this model (Pyle, 1983) provides the basis for a comparative statics analysis of the insurer's liability. The model is described in the appended box.

The insurer's guarantee is modelled as a perpetuity. This assumption is not essential to obtain a closed-form solution (see Pyle, 1983), but it does allow one to obtain more useful comparative statics results than can be obtained from a single-period model. As noted earlier, if the insolvency ratio is reduced, the probability of reaching insolvency before the next audit is reduced. But, in essence, this just puts off the date of the insurer's potential loss while increasing its size. In the short run, the reduced likelihood of early insolvency has a significant effect on the value of the liability. By analyzing a perpetual guarantee, one can obtain the long-run effect (and hence, the full effect) of a given insolvency policy on the insurer's liability.

Given some simplifying assumptions, standard options theory can be used to find an equation for the present value of the insurer's liability.[15] This value depends on several variables: the interest spread (over the riskless market interest rate) on deposits, the ratio of the market value of the bank's assets to the face value of the insured deposits, the frequency of examination, the examination costs, the riskiness of the insured bank's assets and the insolvency ratio. The insolvency ratio, as the term is used here, is the ratio of the market value of assets to the face value of deposits below which a bank will be declared insolvent. This variable and the riskiness of the insured bank's assets are of specific interest in our evaluation of deposit insurance reform proposals.

The role of asset risk in determining the size of the insurer's liability is straightforward. The measure of asset risk in the model is the standard deviation of asset return per unit time. For given values of the other determinants of the liability, the larger this standard deviation is, the more likely that the value of the assets will be below any given value (less than the mean) when the next examination takes place. Since the insurer's liability depends on these lower tail outcomes, the size of that liability will increase with increases in asset risk. The magnitude of the standard deviation of asset return, or, as it is also called, the asset return volatility, depends on the types of assets held by the bank. To put this in perspective, the average asset return volatility for common stocks is on the order of 0.2 to 0.3 (20 percent to 30 percent per year), while the return volatility for long-term U.S. Treasury bonds has been estimated to be 0.05 to 0.06 (5 percent to 6 percent per year). Asset return standard deviations of .07 and .10 have been used in the numerical examples in this paper.

The bank's asset portfolio is the underlying asset on which the insurance contract is written. The asset value at which an options contract may be exercised is called the exercise price. Clearly, the exercise price is an important determinant of the current value of the option. The comparable variable in the deposit insurance model is the insolvency ratio—the asset value (at market) to deposit ratio below which a bank will be declared insolvent. The smaller is this "exercise price", the larger is the insurer's liability. For example, suppose the bank regulator uses a book value insolvency rule. A bank will be closed, merged, or reorganized if its asset book value to deposit ratio falls below some number, say 1.03. If book value overstates market value by 15 percent, the book value insolvency rule translates into a true insolvency ratio of 0.875. The insurer will claim assets worth only \$0.875 for each dollar of deposits that must be paid off. There will be some probability that the value of the bank's assets will be insufficient to cover deposit claims at the next audit for any reasonable value of the insolvency ratio. The present value of this potential shortfall is the amount of the insurer's liability. If the true insolvency ratio implied by the regulator's rule is 0.875 instead of 1.0, the magnitude of that present value will be larger.

Before reporting our results on the relative importance of asset risk and the insolvency ratio as determinants of the insurer's liability, a few additional comments on the model are in order.

The insurer's guarantee is modelled as a perpetuity. This assumption is not essential to obtain a closed-form solution (see Pyle, 1983), but it does allow one to obtain more useful comparative statics results than can be obtained from a single-period model. As noted earlier, if the insolvency

ratio is reduced, the probability of reaching insolvency before the next audit is reduced. But, in essence, this just puts off the date of the insurer's potential loss while increasing its size. In the short run, the reduced likelihood of early insolvency has a significant effect on the value of the liability. By analyzing a perpetual guarantee, one can obtain the long-run effect (and hence, the full effect) of a given insolvency policy on the insurer's liability.

The usefulness of the model is limited by the assumptions on which it is based. Two limiting assumptions are worthy of special note. First, the perpetuity assumption conflicts with the assumption that asset risk is constant. In fact, asset risk is a choice variable for the insured bank (subject to regulatory constraints) and the bank may change its risk policy during the period of the guarantee. The longer the period for which the guarantee holds, the harder it is to accept the assumption that asset risk is constant. This limitation of the model will certainly affect the measured value of the insurer's liability. Its effect on the relative importance of asset risk and the insolvency ratio in determining the size of the liability is not obvious.

Second, the analysis also requires that the policy regarding the true insolvency ratio be known. Since this is a choice variable for the regulators, it should be known in principle. In fact, the true insolvency ratio that will be used for a given institution is probably not known in advance. For example, if a book value insolvency ratio is used, the market value insolvency ratio is a random variable. There is no clear way to deal with this problem in the context of the model. Again it is not clear what effect, if any, this has on the comparative statics analysis of the insurer's liability.

Given these considerations, the results from the model should be approached with some caution.[16] It seems clear that violation of some of the simplifying assumptions would have a significant effect on the measured value of the insurer's liability. However, the comparison between asset risk (σ) and the insolvency ratio (ϕ) was carried out in terms of the ratio of the "price" elasticities of these two parameters. This measure is independent of the specific insurer liability values generated by the model, but not of any biases that the simplifying assumptions may have induced in the partial derivatives of the insurer's liability valuation function.

Asset Risk, the Insolvency Ratio, and Deposit Insurance Liability

Equation (2) in the boxed insert is the model of the insurer's liability that was used to analyze the effect of asset risk and the insolvency ratio on that liability. The partial derivatives of the liability $[p_1(\times)]$ with respect to σ and ϕ were derived and used to obtain the two elasticity measures, e_σ and e_ϕ. These elasticities were evaluated for various values of the parameters.

Audit frequency is a random variable with a mean (λ) of one (an audit is expected to occur once per year). Audit costs of 1, 10 and 100 basis points per dollar of deposits[17] and two asset volatilities, 7 percent per year and 10 percent per year, were considered.[18]

The point elasticities for the insolvency ratio (measured at $\phi = 1$) and for asset risk (measured at $\sigma = 0.07$ and $\sigma = 0.10$) are given in columns 4 and 5 of Table 1. These elasticities measure the percentage change in the present value of the insurer's liability for a given percentage change in each of the two parameters of interest. The elasticity with respect to the insolvency ratio is negative (a smaller insolvency ratio increases the liability) and the elasticity with respect to asset risk is positive. As noted earlier, for any set of parameters, the ratio of the two elasticities is independent of the measured level of the liability so the elasticity ratio given in the last column of Table 1 may be the most useful comparison of the relative importance of the insolvency ratio and asset risk. This elasticity ratio ranges between 7.4 and 19.8. Since these are point elasticities, the comparison only holds for small deviations from the base case. As a check on this, arc (average) elasticities were calculated for finite changes of approximately 20 percent in the two parameters. For audit costs of 10 basis points, the ratio of these arc elasticities was greater than 5.0; for audit costs of 100 basis points, the ratio of arc elasticities ranged between 1.6 and 3.4; and for a 1 basis point audit cost, the ratio exceeded 13.0 for all cases considered.

The conclusion drawn from this analysis is that a given proportional deviation in the insolvency

condition from 1.0 has a significantly larger effect on the size of the insurer's liability than an equal deviation in asset risk from its base value. In other words, the failure to maintain a target insolvency ratio is significantly more important to the insurer than the failure to maintain an asset risk target when those failures are measured as equal percentage deviations from the targets. This result is not particularly surprising given our earlier observations on the mechanism by which changes in these two parameters affect the size of the insurer's liability.

III. Conclusions

Bank deregulation implies an increased need for deposit insurance reform because it has enhanced the opportunities for insured institutions to exploit the risk-taking incentives in the existing deposit insurance system and likely reduced the ability of the deposit insurers to limit their losses by selling valuable franchises. Many current deposit insurance reform proposals focus on risk-related insurance premiums or other ways of pricing the risk that is not differentially priced under the existing deposit insurance structure. Control of asset risk is clearly important. However, our analysis of the relative importance of asset risk and the insolvency ratio implies that improved insolvency control is an even more important focal point for deposit insurance reform legislation.

Table 1
Elasticity of Insurer's Liability
$\lambda = 1$

K(bp)	σ^2	x	$e\phi$	$e\sigma$	$\frac{\lvert e\phi \rvert}{e\sigma}$
1	.01	1.0	−13.6	0.97	14.1
1	.01	1.1	−13.6	0.97	14.1
1	.005	1.0	−19.4	0.98	19.8
1	.005	1.1	−19.4	0.98	19.8
10	.01	1.0	−13.4	0.97	13.7
10	.01	1.1	−13.4	1.00	13.2
10	.005	1.0	−18.9	0.99	19.2
10	.005	1.1	−18.9	1.06	17.8
100	.01	1.0	−10.7	1.04	10.4
100	.01	1.1	−10.7	1.42	7.6
100	.005	1.0	−13.7	1.07	12.7
100	.005	1.1	−13.7	1.84	7.4

A Model of Deposit Insurance

The model that is used in the analysis of deposit insurance reform targets is an adaptation of Merton's (1978) application of options theory to deposit insurance. Interested readers can refer to Pyle (1983) and Merton (1978) for a more detailed derivation of the model.

In the model, it is assumed that the insurer guarantees deposits and, if the insured bank is declared insolvent, that the insurer claims the bank's assets and pays off the insured depositors at face value. The insured bank holds risky assets that are financed with a combination of insured deposits and equity. Some investors (including the insurer and the insured banks) can borrow and lend in a "frictionless" capital market. Marketable assets are assumed to be priced according to the capital asset pricing model. Typical options pricing assumptions on asset value dynamics are employed.

Some assumptions that distinguish the deposit insurance model from other options pricing models of liabilities follow:

1. Some investors are assumed to face a transactions cost for lending in the exchange market. For such investors, insured deposits can yield less (up to the level of the transactions cost) than the riskless interest rate.

2. The insurer uses a random-time audit procedure for bank surveillance (Poisson-distributed audit times).

3. The insurer guarantees the bank's deposits in perpetuity, subject to the declaration of insolvency and the subsequent payoff of depositors.

4. There is an auditing cost that is paid by the insured bank at the time of audit.

Simplifying assumptions include a constant deposit growth rate (which, for convenience, is assumed to be equal to the total return on deposits) and a constant audit cost per dollar of deposits.

The derivation of the model proceeds by writing down the return on the insurer's liability over the next instant in three mutually exclusive circumstances: no audit takes place, an audit takes place and the bank is solvent, and an audit takes place and the bank is insolvent. Using standard options pricing methods, the instantaneous return function is transformed into a pair of differential equations that the in-

surer's liability must satisfy (one for the solvent and one for the insolvent bank). These differential equations are subject to four boundary conditions. The most important for our purposes are the continuity conditions linking the two segments of the liability function at the insolvency point. Letting p_1 be the value of the insurer's liability for a solvent bank and p_2, the comparable value for an insolvent bank and ϕ, the insolvency ratio being used by the regulator, the continuity requirements are:

$$p_1(\phi) = p_2(\phi)$$

and

$$p'_1(\phi) = p'_2(\phi)$$

where the primes denote first derivatives with respect to the asset value-to-deposit ratio.

To obtain the correct value of the insurer's liability, the argument of the liability value function must be the market value of the bank's assets divided by the promised payment to depositors. If the regulator's insolvency policy leads to the closing of a bank as soon as its market net worth is observed to have reached zero, the value of ϕ is 1. If banks are allowed to continue operating after zero net worth is observed, ϕ is less than 1.

The solution of the resulting differential equation system provides a closed-form equation for the insurer's liability per dollar of deposits (see Pyle, 1983).

$$p_1(x) = \frac{(1-k)\phi + \left[\frac{\lambda+\lambda K}{\lambda+\mu}\right] k}{\delta+k} x^{-\delta}\phi^{\delta}, \; x \geq \phi \quad (1)$$

where

$\mu \equiv$ the deposit rate spread (the riskless interest rate minus total deposit return)

$\sigma^2 \equiv$ the instantaneous variance of asset return per unit time

$\delta \equiv 2\mu/\sigma^2$

$\upsilon \equiv 8\lambda/\sigma^2$

$k \equiv \frac{1}{2} \quad 1 - \delta + [(1+\delta)^2 + \gamma]^{\frac{1}{2}} \quad > 1$

$\lambda \equiv$ expected number of audits per unit time

$K \equiv$ the auditing cost per dollar of deposits

$x \equiv$ the market asset value-to-deposit ratio

$\phi \equiv$ the insolvency ratio

A few comments may help in the interpretation of Equation (1). The deposit rate spread must be non-negative in this model to prevent arbitrage by investors who have costless access to the exchange market (for example, other banks). Since γ is strictly positive, k must be greater than 1. Furthermore, for reasonable parameter values, the value of k is determined, to all extents by the value of γ which is a weighted ratio of the critical parameters of the two stochastic processes that the insurer faces.

In Merton (1978), it is shown that the competitive deposit rate spread (μ) is equal to the expected audit cost per unit time (λK). In effect, the depositors pay the expected costs of auditing by receiving less than the riskless rate. They are willing to do so as long as their personal cost to access the exchange market is greater than this spread. This property of competitive equilibrium carries over to the model used here. Therefore, by assuming a competitive deposit market, Equation (1) simplifies to

$$p_1(x) = \frac{(1-k)\phi + k}{\delta+k} x^{-\delta}\phi^{\delta}, \; x \geq \phi \quad (2)$$

where δ and k are now equilibrium values ($\mu = \lambda K$).

Equation (2) can be used to obtain the comparative statics properties of the insurer's liability. The elasticities of $p_1(x)$ with respect to ϕ and to σ are of particular interest.

Using equation (2), The elasticity of the insurer's liability with respect to ϕ is

$$e_{\phi} = \frac{(1-k)\phi}{(1-k)\phi + k} + \delta \quad (3)$$

while the elasticity with respect to σ is

$$e_{\phi} = \frac{(1-\phi)\left\{\delta - \frac{\delta(1+\delta)+\frac{1}{2}\gamma}{[(1+\delta)^2+\gamma]^{\frac{1}{2}}}\right\}}{(1-k)\phi + k} + \delta + \frac{\left\{\frac{\delta(1+\delta)+\frac{1}{2}\gamma}{[(1+\delta]^2+\gamma)^{\frac{1}{2}}}\right\}}{\delta+k} + 2\delta\left(\ln\left(\frac{x}{\phi}\right)\right) \quad (4)$$

FOOTNOTES

1. I use the term "banking system" in a broad sense to include thrift institutions as well as commercial banks.

2. See Natter (1983b) for a legal analysis of the Treasury proposal.

3. In a recent development, the Task Group on Regulation of Financial Services has proposed some deposit insurance reforms including higher insurance premiums for banks that engage in risky activities.

4. See Mayer (1965).

5. Some of these changes, ironically, were set off by the **Interest Rate Adjustment Act of 1966.**

6. It is not coincidental that the FHLBB (1983) study of deposit insurance dwells on interest rate risk. This was the problem at S&Ls in the 1970s and early 1980s. Furthermore, a number of analysts believe they can measure interest rate risk. See Beebe (1977, 1983) for evidence on bank risk-taking behavior.

7. See Natter (1983a) p. 7-9.

8. See Zimmerman (1983).

9. The extent to which the increase in deposit brokerage is due to deposit deregulation in 1980 and 1982 or to the increase in insurance ceilings (to $100,000 per account) in 1980 or to some combination of the two is an open question.

10. This statement may not be correct if the bank is near insolvency. Then the competing interests of existing liability holders and the potential buyers of new liabilities may prove difficult to resolve.

11. The cover letter for the NCUA report states that "...risk rating is theoretically and practically inconsistent with the government's role as an 'insurer of last resort.'" The FDIC summary statement on the subject is "The 'ideal system' with premiums tied closely to risk is simply not feasible." (FDIC (1983) p. II.1). Also, see Horvitz (1983) for a discussion of the difficulties in implementing risk-related premiums. A counter to the arguments against risk-related premiums is that lenders regularly set risk premiums on corporate debt. Risk assessment in private markets is competitive. Can the risk assessment for setting deposit insurance premiums be done on a basis equivalent to competitive risk assessment? If not, the corporate destanology losses much of its power. Competitive bank risk assessment may be desirable and practicable, either through private deposit insurance or through more reliance on non-deposit liabilities or, as suggested by the Bush Task Group, by private risk appraisal. Such considerations, while both interesting and important, are beyond the scope of this paper.

12. Horvitz (1983) p. 257 (his emphasis). Unless monitoring is continuous, however, the risk of loss to the agency will depend on the riskiness of the institution.

13. See Kane (1983a) p. 277 for a discussion of the insurers' need for enhanced rights to take timely action.

14. See Beebe and Blank (1983) for a discussion of some of the problems in measuring market net worth in financial institutions.

15. See Jarrow and Rudd (1983) for a thorough treatment of modern option theory.

16. In defense of the model, it can be pointed out that the results obtained for the version of the model reported here are robust to some changes in the simplifying assumptions. See Pyle (1983).

17. Little information is available on the cost of examinations. The evidence that is available suggests that direct supervisory costs are less than 5 basis points per dollar of deposits. However, there are indirect costs for the institution being examined and, perhaps, for the supervisors as well.

18. The bank asset volatilities considered in the analysis lie between the estimated volatility of long-term governments (5 percent-6 percent per year) and the average volatility of common stocks (20 percent-30 percent)

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Page 8 The second sentence of the first paragraph should read:
It is conceivable that this non-rate competition was less than perfect, and that it allowed at least some banks to raise funds at the margin at lower cost by issuing deposits.

Page 13 Column 1

$\gamma \equiv 8\lambda/\sigma^2$

$k \equiv \frac{1}{2}\left\{1 - \delta + [(1 + \delta)^2 + \gamma]^{\frac{1}{2}}\right\} > 1$

Page 13 Column 2 The second line of Equation (4) should read:

$$+ \delta + \frac{\left\{\dfrac{\delta\,(1 + \delta) + \frac{1}{2}\gamma}{[(1 + \delta)^2 + \gamma]^{\frac{1}{2}}}\right\}}{\delta + k} + 2\delta\,[\ln\,(\tfrac{x}{\phi})]$$