NEW YORK UNIVERSITY
STERN SCHOOL OF BUSINESS
FINANCE DEPARTMENT

Working Paper Series, 1997

Can Delegating Bank Regulation to Market Forces Really Work?

Nagarajan, S. and C. W. Sealey

FIN-97-8

CAN DELEGATING BANK REGULATION TO MARKET FORCES REALLY WORK?

S. Nagarajan*and C. W. Sealey†

February 12, 1997

Abstract

A major theme in the literature on bank regulation is that greater reliance on market forces can help alleviate the moral hazard problem inherent in government sponsored deposit insurance. Proposals include minimum requirements on (1) uninsured subordinated debt financing (either fixed-term or with option-type features), and (2) private co-insurance on deposits. Such policies amount to delegating the responsibility for bank regulation to various private-sector claimholders. Our results show that, in general, such delegation (even if the claims include option-type features) is at best ineffective in lowering bank risk, at least within the present framework of deposit-taking institutions. We also show, however, that there are alternative mechanisms that will minimize regulatory costs, alleviate the moral hazard problem, and achieve first-best. But, the regulator (deposit insurer) *must* be an integral part of any solution; thus, such solutions are not attributable to market discipline.

*Visiting Associate Professorof Finance, New York University, and Associate Professor of Finance, McGill University.

†The Torrence E. Hemby, Sr., Distinguished Professor in Banking, University of North Carolina at Charlotte

1 Introduction

It is well known that a basic problem in regulating a banking system with government sponsored deposit guarantees is that imperfect information, and the resulting moral hazard problem, makes it difficult for the regulator to control bank risk-taking behavior.[1] It has been argued that the incentive problems for banks arising from deposit insurance can be either eliminated or significantly mitigated by imposing greater market discipline on banks.[2] To this end, two recommendations are often mentioned: (1) require banks to increase their dependence on uninsured private-sector debt financing, such as subordinated debentures (with or without option features); and (2) require banks to obtain private co-insurance on at least a portion of their deposits.

In essence, the policy of relying on market discipline to constrain bank risk amounts to delegating the responsibility for bank regulation to various uninsured private sector claimholders. Since a bank's asset quality is private information, and claimholders do not have inherent knowledge of this quality, delegation will be successful only if sufficient incentives are present to induce private sector claimholders to collect information concerning risk and exert market discipline on banks. Moreover, even if proper incentives exist, claimholders may not possess the means to control the bank's actions. Hence, control— legal and/or contractual— must be considered an integral part of the system. Although there is a considerable volume of work advocating dependence on greater market discipline, to our knowledge there are no specific models in the literature to show how, why, or under what conditions private sector claimholders have (1) proper incentives to produce information

[1] A comprehensive discussion of these problems can be found in Benston, et al. (1987). Models that deal specifically with moral hazard and/or adverse selection are John, John, and Senbet (1991), Chan, Greenbaum, and Thakor (1992), Campbell, Chan, and Marino (1992), Giammarino, Lewis, and Sappington (1993), and Nagarajan and Sealey (1995a, 1995b).

[2] A complicating factor, which we do not deal with in this paper, is that the regulator may have its own self-interested goals that conflict with its regulatory mission.. On this issue, see Kane (1987, 1989) and Boot and Thakor (1993). For discussions of the rationale for greater market discipline, see, for example, Benston, et al. (1987), Wall (1989), Evanoff (1991), and Congressional Budget Office (1992).

and exert discipline on banks, (2) goals that are consistent with prudential regulation, and (3) the ability to induce banks to take less risk.[3,4]

The purpose of this paper is to develop a model of bank regulation, under conditions of moral hazard, and to examine the feasibility of delegating the regulatory function to market forces. The model is designed to investigate the incentives of different claimholders to exert market discipline on banks' risk-taking decisions. The results presented here can be classified into three general categories. First, as a benchmark, we assume that all claimholders, both private and government, have identical regulatory powers and monitoring technology. Under this condition, our results show that the quality of bank assets is not likely to be improved by relying on market discipline imposed on banks by private-sector claimholders, at least using the relative seniority and amounts of subordinated debt and private co-insurance either presently in effect or under consideration.[5] Specifically, we show that the various private sector claimholders of a bank will choose optimal levels of information production and monitoring that are less than that of the regulator, who, in turn, will optimally monitor less than the social planner.[6]

Second, even if private-sector claimholders lack the legal authority of a

[3]There are a number of conjectures in the literature concerning these points. For example, Baer (1990) notes that "Market participants do not necessarily have better information. However, they have better incentives to make use of the information they do have." Also, according to Avery, et al. (1988, p. 598), "... one might expect that the discipline exercised by holders of bank subordinated debt should be compatible to that of the FDIC and consistent with the objectives of government regulation and prudential supervision." Neither, however, presents a model to show that these conjectures are valid.

[4]While there exist substantial empirical research on the disciplinary effects of uninsured debt financing on bank risk-taking, the results have been largely inconclusive. See, for example, Baer and Brewer (1986), Avery, Belton, and Goldberg (1988), Hannan and Hanwick (1988), James (1988, 1990), Gilbert (1990), Gorton and Santomero (1990), and Ellis and Flannery (1992).

[5]For example, Evanoff (1992) advocates a subordinated debt requirement of four percent of bank assets, Benston, et al. (1987) mention an amount equal to three to five percent of deposits, and a recent FDIC proposal suggests approximately three percent of assets. The FDIC Improvement Act of 1991 authorizes regulatory authorities to seek private sector co-insurance on up to ten percent of insured deposits.

[6]For our purposes,the distinction between the regulator (deposit insurer) and the social planner can be described as follows: The regulator may (1) pursue goals in accordance with its legislative mandate (e.g., minimize losses to the deposit insurance fund), or (2) act in a self-interested manner (see Boot and Thakor (1989). The social planner, on the other hand, is concerned exclusively with the socially optimal allocation.

government regulator, the addition of various option features to the subordinated debt of banks has been suggested in the literature as a means of giving private sector claimholders recourse against risk-shifting banks. Thus, private-sector claimholders may be induced to produce information and take actions that are allowable under the contractual provisions of their claims. Our results show, however, that the addition of option features to bank debt does not necessarily improve asset quality. Puttable subordinated debt may result in suboptimal risk choices by the bank when compared to straight debt. Convertible subordinated debt does better, but only marginally, since the amount of insured deposit claims still remains substantial in comparison.

Third, we show that there are alternative mechanisms involving option-type claims that may solve the moral hazard problem and restore the first-best outcome. The important aspect of these mechanisms, however, is that they depend on the involvement of the regulator and thus do not rely on marker discipline. For example, we show that a new security, which we call *partially convertible deposits (PCD),* could be designed by the regulator and would be superior to subordinated fixed claims held by the private sector, irrespective of any option features that these private sector claims may involve. Partially convertible deposits give the regulator a call option to convert a pre-specified portion of the insured deposits of the bank into equity. By optimally designing this instrument and its conversion features, we show that the moral hazard problem can be completely solved, and the first-best outcome can be restored. Such a solution also increases overall social welfare because it does not involve monitoring the quality of the bank, which represents a dead-weight loss in equilibrium.[7]

The remainder of the paper is organized as follows. The next section proposes a simple model of delegated monitoring where various private sector claimholders produce information and directly monitor the bank. Section 3 examines the incentives of these claimholders to expend resources on information production and monitoring, derives the optimal monitoring levels of each class of claimholder, and compares optimal monitoring levels. Section 4 considers indirect monitoring using subordinated debt embedded with options-type features. Section 5 analyzes alternative mechanisms that the regulator can use to mitigate the moral hazard problem. Section 6 concludes.

[7]PCDs do require monitoring of the cashflows to a bank, but this is a far less demanding task than monitoring the quality of the loan portfolio.

2 The Model

2.1 The Setup for the Bank

In this section, we develop a simple model of bank regulation under moral hazard that involves direct monitoring of the bank by any one of its different classes of claimholders. At $t = 0$, the bank contributes its own equity capital E, takes in deposits worth D, and issues subordinated debt with a face value B, where deposit claims are strictly senior to subordinated debt claims. The bank invests its total funds in a portfolio of risky loans, A, and chooses the quality of this portfolio, $q \in (0, 1)$. The bank's managers are assumed to make decisions in the interests of shareholders.

The regulator may mandate a minimum requirement on regulatory capital, which is computed as the sum of equity and subordinated debt[8], and insures a portion, α_R, of the bank's deposits, where $0 < \alpha_R \leq 1$. The remaining fraction of deposits, α_C, is insured by a private insurance firm (henceforth, referred to as the co-insurer). Let p_R and p_C denote the insurance premiums, per dollar of deposits, charged by the regulator and the co-insurer, respectively. These insurance premiums may or may not be equal, and the regulator may or may not charge a risk-adjusted premium.

The return on the bank's loan portfolio is realized at $t = 1$, and is contingent on one of three possible states, which in turn depends on two variables. First, the end-of-period returns depend on the quality of the bank's portfolio, $q \in [\underline{q}, \overline{q}] \subset (0, 1]$, chosen ex ante by bank management. Second, returns depend on an exogenous parameter, θ, where $0 < \theta < \left(\frac{1}{q} - 1\right)$, which is explained below. In *State 1* the loan portfolio performs well and the bank's return is $R(q)+\tilde{\varepsilon}$ with probability q, where $E(\tilde{\varepsilon}) = 0$. In this state, the bank's return is more than sufficient to payoff both depositors and subordinated debtholders, i.e., $R(q) > D + B$. In *State 2*, the loan portfolio performs well

[8]It is well-known that the regulator can solve most incentive problems faced by banks by mandating a very high capital requirement (Campbell, Chan, and Marino 1992). Such a requirement would result in a fundamental change in the services provided by banks, and as Campbell, Chan and Marino point out, such a change may not be desirable because of the social value of the liquidity services provided by banks. Since our aim is to focus on the delegated monitoring of banks, we do not address the regulator's optimal capital requirement for banks, which has been addressed elsewhere in the literature (e.g., Nagarajan and Sealey 1995a, 1995b).

but does not generate sufficient funds to cover all of the bank's fixed claims. Let R_2 denote the *State 2* return, where $D+B > R_2 > D$, which occurs with probability θq. The bank's return in this state is sufficiently high to pay all the bank's deposit liabilities but only partially pay the bank's subordinated debtholders. In *State 3*, the bank's return is denoted by R_3, which occurs with probability $(1-q)(1-\theta)$. Return in this state is insufficient to provide full payment even to the bank's depositors, i.e., $D > R_3 \geq 0$. In this state, the bank is declared bankrupt, its assets are liquidated, and its return is shared pro rata among the insuring agents (regulator and coinsurer)[9]. Thus, the regulator receives $\alpha_R R_3$, and the co-insurer gets $\alpha_C R_3$. The insurers then pay depositors in full, incurring a loss.

The parameter θ introduced above is critically important in the following analysis since it allows us to investigate the implications of the *relative seniority* of the deposit claim over the subordinated debt claim. As implied above, the higher θ, the greater the probability that subordinated debtholders will receive at least a partial payment. To see this, note that at one extreme, when $\theta \rightarrow \left(\frac{1}{q}-1\right)$, the likelihood of *State 3* occurring is low and thus subordinated debtholders have a high probability that they will receive at least some payoff, whereas, at the other extreme, when $\theta \rightarrow 0$, the likelihood that *State 2* will occur is low indicating a high probability that subordinated debt will either receive full payment (*State 1*) or no payment at all (*State 3*). In other words, as the value of θ falls, the effect is equivalent to lowering the priority of the subordinated debt claim. As will be clear later, the value of θ also determines the extent to which the interests of subordinated debtholders diverge from those of the regulator and/or the coinsurer.[10]

The return function, $R(q)$, is assumed to be such that $R'(q) < 0$, while $qR(q)$ is increasing and concave in q, assuring the existence of a socially

[9]It is the prerogative of the regulator to force the bank into bankruptcy. We assume that the regulator closes the bank in *State 3* where return is insufficient to cover deposit liabilities. The regulator could choose to close the bank in State 2 where the regulator itself does not experience a loss. Whatever the closure decision, it is irrelevant to our results.

[10]Although deposit claims are strictly senior to the subordinated debt claims, the distribution of returns may be such that the holders of subordinated claims have a high probability of being repaid, or, at the other extreme, a high probability of total loss. On the other hand, the return distribution may indicate a more balanced payoff probability somewhere between these extremes. The parameter θ captures this cashflow implication of seniority.

optimal level of quality, q^{FB}, for the bank's portfolio. From the distribution of returns described above, it follows that a higher quality level, i.e., a higher q, increases the likelihood of the good state, *State 1*, while at the same time decreasing the magnitude of returns in *State 1*. Thus, a bank interested in shifting risk will choose a lower quality loan portfolio than it would do otherwise. For expositional ease, the bank is assumed to capture all the surplus from the loan returns,[11] and cashflows are not discounted.

The bank's choice of q is private information, and cannot be observed, even ex post. The presence of the borrower-specific noise, $\tilde{\varepsilon}$, ensures that q cannot be inferred from the ex post realization of returns. This gives rise to a moral hazard problem in that the bank may have an incentive to choose a level of asset quality that may be suboptimal from a social or regulatory point of view. In the process, the bank may take advantage of the holders of its fixed claims as well as the deposit insurer. Nevertheless, the bank's choice of quality may be monitored and controlled, as described below.

2.2 The Monitoring Technology

In this paper, we consider two types of delegation of information production and monitoring, referred to here as direct and indirect monitoring. For both types, the delegation is implicit, i.e., the regulator sets requirements on banks to maintain a minimum level of private sector claims and then relies on the holders of these claims to produce information and monitor in a manner that is consistent with their own maximizing behavior. Thus, the private sector claimholders incentive to produce information and monitor is determined by the contractual provisions of their claims, as well as the regulatory framework. This situation is in contrast to what might be called explicit delegation, where the regulator would directly contract with, and compensate, a third party to perform the information production and monitoring function.[12] The former is most consistent with proposals for greater reliance on market discipline.

For any type of monitoring to be worthwhile, the monitor must have some contractual ability to undertake actions, on the basis of the information gathered, to control the bank's behavior. Otherwise, even if the monitor can

[11]The results continue to hold as along the bank captures a positive share of the profits (see Chan, Greenbaum, and Thakor 1992).

[12]The case of explicit monitoring, where an agent is explicitly compensated to monitor the bank, is modeled by Campbell, Chan and Marino (1992).

observe the bank's risk perfectly, the bank can (and will) simply ignore the dictates of the monitor if the latter has no recourse. The characteristics that distinguish direct from indirect monitoring are (1) the contractual provisions of the bank's private sector claims, and (2) the means of recourse available to the monitor if the bank is discovered to be shifting risk. Under direct monitoring, the claims issued by the bank are assumed to be straight vanilla claims (either fixed-term uninsured debt or co-insurance), but the claims may include covenants that give the holder certain enforcement powers, such as the power to issue cease and desist orders to banks. Under indirect monitoring, the private sector claims are assumed to lack explicit regulatory powers, but the claims may be fashioned to have option-type features that can be exercised on the basis on information produced, or other signals received, by the claimholders. These provisions then act as the means of recourse for the monitor.

For both direct and indirect monitoring, information is gathered about the riskiness of the bank's portfolio through the use of a monitoring technology that is assumed to be available to all the claimholders of the bank. This technology is not divisible among different claimholders, with the implication that it can be used by only one class of claimholders at a time. This assumption has the effect of allowing only one class of claimholders to act as the delegated monitor at any one time. If the class of claims has a diverse ownership, the issue of delegated monitoring may become one more step removed, as in Diamond (1984), where a class of claimholders may find it necessary to delegate monitoring to still another party[13]. This issue is abstracted from here by assuming that the various classes of claims are held by small groups of agents capable of acting in unison.

The monitoring technology is assumed to be stochastic, but simple, and it works as follows. Let δ denote the probability that the monitor observes the bank's asset quality decision, q. With probability $(1-\delta)$, the monitor observes nothing. The parameter δ is a measure of the noise in the monitoring technology, higher δ corresponding to less noise. In the event the monitor

[13]One interpretation of an entire class of claimholders monitoring the bank is that these claims (e.g. subordinated debt) are privately held, and hence there are no free-rider problems *within* the same class of claimholders. In general, if the claims are widely held, then free-riding within a class of claims becomes a problem, and it may become necessary for the claimholders themselves to delegate the monitoring function. In Diamond (1984), e.g., lenders (depositors) delegate the task of monitoring borrowers to banks.

does observe the bank's choice of quality, given the assumption of full regulatory powers, it can influence the bank's choice of quality by choosing an appropriate level of monitoring. Formally, for a given level of monitoring, μ, the bank's feasible set of quality choices becomes $[\underline{q}, 1] \subset [0, 1]$, where $\underline{q} = f(\mu)$, and $f(.)$ is an increasing function. This implies that monitoring sets a lower bound for the bank's choice of quality, q, with higher monitoring levels leading to higher quality choices by the bank.[14] Such monitoring of bank compliance is costly, however. Let $C(\mu)$ be the cost of monitoring, which is assumed to be increasing and convex, i.e., $C(0) = 0, C(1) \rightarrow \infty, C'(\mu) > 0$,and $C''(\mu) > 0$.

3 The Bank's Quality Decision With No Monitoring

First, we examine the benchmark case when the bank is not monitored at all. In this case, banks choose the ex ante level of quality, q, to maximize their expected payoff, which is given by

$$\pi^E(q) = [R(q) - D - B]q - D(\alpha_R p_R + \alpha_C p_C) - E.$$

The first-order condition yields the second-best solution:[15]

$$\frac{\partial[q^{SB}R(q^{SB})]}{\partial q^{SB}} - (D + B) = 0. \tag{1}$$

By contrast, a social planner will maximize the expected social surplus,

$$\pi^0(q) = [qR(q) + \theta qR_2 + R_3(1 - (1 + \theta)q)] - A.$$

The first-best (socially optimal) solution implies,

[14]One interpretation of the monitoring process is that, with probability δ, an examination or an audit identifies loan portfolios of quality less than a particular level, $\underline{q}$, determined by the monitoring level μ. If the bank attempts to choose quality levels below $\underline{q}$, then the monitor can resort to "cease-and-desist" orders, and force the bank to choose better quality. Also see Campbell, Chan, and Marino (1992).

[15]Throughout the paper, the focus will be on the first-order conditions. It is easy to verify that the second-order conditions are satisfied, given our assumptions about the returns.

$$\frac{\partial[q^{FB}R(q^{FB})]}{\partial q^{FB}} + \theta(R_2 - R_3) - R_3 = 0. \qquad (2)$$

Since $(D + B) > R_3 - \theta(R_2 - R_3)$ by earlier assumptions about the returns, it follows from solutions (1) and (2) that the second-best solution in the case of no monitoring under moral hazard, q^{SB}, is such that $q^{SB} < q^{FB}$. That is, the bank will have an incentive to choose a lower level of loan quality than the socially optimal level. This suboptimal behavior is caused by the bank's incentive to shift risk to the holders of fixed claims against the bank, e.g., the deposit insurer or the holders of subordinated debt.

4 The Bank's Quality Decision With Direct Monitoring

As stated above, the degree of success of the monitor in controlling bank risk depends on (1) the amount of (costly) resources invested in information production and monitoring, and (2) the ability of the monitor to either directly control bank decisions or seek recourse in the event the bank is engaging in risk-shifting behavior. In this section, we deal with the case of direct monitoring where the bank's financial claims are of the straight vanilla type, but the monitor possesses certain regulatory powers. In order to keep the comparisons valid, it is assumed that each class of claimholders, including the regulator, have access to the same monitoring technology, as well as the same regulatory powers.[16] Furthermore, consistent with our discussion earlier concerning the inability of pricing, per se, to solve the moral hazard problem, we abstract from much of the pricing issues here in order to focus on the incentives of different claimholders to monitor the bank. This assumption is easily justifiable since pricing and monitoring are interdependent (substitute) decisions for claimholders; thus, given any pricing regime, the claimholder can choose a monitoring level to optimize.

[16]Note that, unlike in a typical corporation, a bank's subordinated debtholders cannot, among other things, force the bank into bankruptcy. Hence, the assumption that other claimholders of a bank have the same regulatory powers as the FDIC is a bit strong. Nevertheless, the purpose of such an assumption is to show that even with such strong regulatory powers, the other claimholders may not monitor as diligently as the regulator.

As noted above, when a claimholder i chooses a monitoring level, μ_i, with probability δ the monitor is able to observe the bank's choice of quality and control the minimum quality level, $\underline{q}$. Hence, the bank's optimal choice of ex ante quality is given by

$$\begin{aligned} q^*(\mu_i) \in \arg\max_{q\in[\underline{q},1]} \pi^E(q) &= \delta[(R(q)-D-B)q - D(\alpha_R p_R + \alpha_C p_C)] \\ &+(1-\delta)[(R(q^{SB})-D-B)q^{SB} - D(\alpha_R p_R^{SB} + \alpha_C p_C^{SB})] - E. \end{aligned}$$

It follows that $q^*(\mu_i) = \underline{q} = f(\mu_i)$ when the bank is monitored, for μ_i such that $f^{-1}(q^{SB}) < \mu_i < f^{-1}(q^{FB})$.[17] On the other hand, with probability $(1-\delta)$ the bank will not be monitored at all, and hence it will choose the second-best quality, q^{SB}. In the analysis that follows, $q^*(\mu_i)$ represents the *reaction function* of the bank in response to a level of monitoring, μ_i, carried out by claimholder i.

4.1 Socially Optimal Monitoring

Before proceeding to the monitoring incentives of the various claimholders, it is illustrative to first consider the socially optimal monitoring level. The social planner will choose μ_0 to maximize the expected social surplus,

$$\begin{aligned} \pi^0(\mu_0) &= \delta[q^*(\mu_0)R(q^*(\mu_0)) + \theta q^*(\mu_0)R_2 + R_3(1-(1+\theta)q^*(\mu_0))] \\ &+(1-\delta)[q^{SB}R(q^{SB}) + \theta q^{SB}R_2 + R_3(1-(1+\theta)q^{SB})] \\ &-A - C(\mu_0). \end{aligned}$$

The first-order condition gives

$$\begin{aligned} \delta\frac{\partial q^*(\mu_0)}{\partial \mu_0}[R(q^*(\mu_0)) + q^*(\mu_0)R'(q^*(\mu_0)) + \theta R_2 \\ -R_3(1+\theta)] - C'(\mu_0) &= 0. \end{aligned} \tag{3}$$

[17] Note that the cases $f^{-1}(q^{SB}) > \mu_i$ and $f^{-1}(q^{FB}) < \mu_i$ do not arise: The former achieves nothing, whereas the latter is suboptimal for the monitor, given that monitoring is costly.

4.2 The Regulator's Problem

For a given deposit insurance premium p_R^*,[18]the regulator chooses its optimal level of monitoring, μ_R,in order to maximize, subject to a break-even constraint, its expected payoff given by

$$\begin{aligned}\pi^R(\mu_R) &= \delta[\alpha_R D q^*(\mu_R)(1+\theta) + \alpha_R R_3[1-(1+\theta)q^*(\mu_R)] + \alpha_R p_R^* D] \\ &\quad +(1-\delta)[\alpha_R D q^{SB}(1+\theta) + \alpha_R R_3[1-(1+\theta)q^{SB}] + \alpha_R p_R^{SB} D] \\ &\quad -\alpha_R D - C(\mu_R) \\ &= \delta[\alpha_R(D-R_3)q^*(\mu_R)(1+\theta) + \alpha_R D p_R^*] \\ &\quad +(1-\delta)[\alpha_R(D-R_3)q^{SB}(1+\theta) + \alpha_R p_R^{SB} D] + \alpha_R R_3 \\ &\quad -\alpha_R D - C(\mu_R).\end{aligned}$$

Note that the regulator's objective function is different from that of the social planner, since the regulator is a deposit claimholder. The first-order condition implies,

$$\delta\alpha_R[D-R_3]\frac{\partial q^*(\mu_R)}{\partial \mu_R}(1+\theta) - C'(\mu_R) = 0. \tag{4}$$

4.3 The Subordinated Debtholder's Problem

The subordinated debtholders choose their level of monitoring, μ_B, to maximize their expected payoff, given by

$$\pi^B(\mu_B) = \delta[B+\theta(R_2-D)]q^*(\mu_B) + (1-\delta)[B+\theta(R_2-D)]q^{SB} - B - C(\mu_B).$$

The first-order condition is

$$\delta[B+\theta(R_2-D)]\frac{\partial q^*(\mu_B)}{\partial \mu_B} - C'(\mu_B) = 0. \tag{5}$$

[18]The deposit insurance premium in the case of monitoring is taken as fixed, since we wish to focus on the incentives to monitor. As is well known, if the regulator can charge a large enough premium to break-even, then monitoring becomes irrelevant.

4.4 The Private Co-insurer's Problem

The private co-insurer chooses its level of monitoring, μ_C, in order to maximize its expected payoff, which is given by

$$\begin{aligned}\pi^C(\mu_C) &= \delta[\alpha_C D q^*(\mu_C)(1+\theta) + \alpha_C R_3[1-(1+\theta)q^*(\mu_C)] + \alpha_C p_C^* D] \\ &\quad +(1-\delta)[\alpha_C D q^{SB}(1+\theta) + \alpha_C R_3[1-(1+\theta)q^{SB}] + \alpha_C p_C^{SB} D] \\ &\quad -\alpha_C D - C(\mu_C) \\ &= \delta[\alpha_C(D-R_3)q^*(\mu_C)(1+\theta) + \alpha_C D p_C^*] \\ &\quad +(1-\delta)[\alpha_C(D-R_3)q^{SB}(1+\theta) + \alpha_C p_C^{SB} D] + \alpha_C R_3 - \alpha_C D - C(\mu_C).\end{aligned}$$

The first-order condition implies,

$$\delta\alpha_C[D-R_3]\frac{\partial q^*(\mu_C)}{\partial \mu_C}(1+\theta) - C'(\mu_C) = 0. \qquad (6)$$

4.5 A Comparison of Optimal Monitoring Levels

We are now ready to compare the optimal monitoring levels of the regulator with those of the subordinated debtholder, the private coinsurer, and the social planner.

Proposition 1 *The optimal monitoring levels of various claimholders do not coincide, either with that of the social planner, the regulator, or with each other. The optimal monitoring levels,* $\{\mu_R^*, \mu_B^*, \mu_C^*\}$*,are such that the following relationships hold:*

1. $\mu_R^* \gtreqless \mu_B^*$, *iff* $[B+\theta(R_2-D)] \lesseqgtr \alpha_R(D-R_3)(1+\theta)$, *and*
2. $\mu_R^* \gtreqless \mu_C^*$, *iff* $\alpha_C \lesseqgtr \alpha_R$.

Proof. The proof follows from a comparison of the first-order conditions, (3), (4), (5), and (6).

This result can be understood as follows. Since the regulator, subordinated debtholder, and private co-insurer all have debt-like, fixed claims

against the bank's assets, their optimal monitoring strategies differ from that of the social planner who maximizes the total social surplus. If these fixed claims are equal in size and have the same priority, then the optimal level of monitoring by these various claimholders will also be the same. If not, then their optimal monitoring levels depend on the relative seniority and sizes of their claims.

In the case of the regulator and private co-insurer, the seniority of their claims is the same; hence, as long as the relative sizes of their claims are equal, their optimal monitoring levels will also be equal. If the sizes vary, then the incentives to monitor become proportional to the size of the claims. In particular, the co-insurers will invest *less* resources in monitoring than the regulator if their claims are smaller. For the relatively small amounts of private co-insurance proposed, e.g., FDICIA authorizes private co-insurance up to ten percent of insured deposits, this result suggests that co-insurance obtained from private sector insurers will lead to lower asset quality at banks when compared to a regulator who monitors to maintain fairly priced deposit insurance.

Since subordinated debt is the most often mentioned private sector claim for the purpose of imposing market discipline on banks, a more interesting comparison is the monitoring incentives of the regulator versus subordinated debtholders. Proposition 1 shows that the subordinated debtholders' optimal monitoring level, μ_B^*, is more likely to be comparable to that of the regulator, μ_R^*, if (1) the liquidation value of the assets in the bankruptcy state, R_3, is large (but insufficient to payoff the depositors), (2) the return in the second state, R_2, is large (but insufficient to payoff the subordinated debtholders), and (3) the regulator insures only a small fraction of the deposits, α_R. However, in this case, risk-shifting by the bank is of less concern to the regulator in the first place.

On the other hand, in the more important cases where the regulator insures a large fraction of deposits (say, $\alpha_R \simeq 1$), and/or the returns in the second and third states are relatively small (e.g. $R_3 \simeq 0$ and $R_2 \simeq D$), the subordinated debtholders may have *less* incentive to monitor the bank than the regulator — even if their claims are of equal size. This is because the subordinated debt claim on the bank's assets is *junior* to the claims of the regulator. The divergence in the incentives to monitor between the regulator and the subordinated debtholders depends critically on the proxy parameter for seniority, θ: the smaller θ, the less subordinated debtholders' incentive

to monitor. In order to induce them to invest at least the same resources in monitoring the bank as would the regulator, the size of the subordinated debt may have to strictly *exceed* the size of the deposits insured by the regulator. Again, the greater the seniority of the regulator's claims, the greater the amount of subordinated debt that must be issued to offset the effect of this seniority. In any case, the relatively small subordinated debt levels (three to five percent of assets) advocated in the literature cannot offer the type of discipline for banks that supporters envision.

5 The Bank's Quality Decision in the Absence of Direct Monitoring

The last section considers direct monitoring as a means of alleviating the moral hazard problem inherent in bank regulation.[19] It is questionable, however, that regulators and lawmakers would be willing to delegate sufficient regulatory powers to private sector claimholders to allow them to function effectively as direct monitors. As noted earlier, without some means of recourse in response to bank decision-making, there is little incentive for delegated monitoring in the absence of direct payments to the monitor by the regulator. In this section, we examine the redesign of the bank's private sector claims by incorporating option-type features. Under this scenario, private-sector claimholders have recourse only by exercising the contractual options associated with their claims.[20]

5.1 Indirect Monitoring and Puttable Subordinated Debt

When subordinated debt contains option-type features, the holders of these claims may have an incentive to produce information, and undertake uni-

[19]Direct monitoring may be feasible if the bank's private sector claims are privately held by a small group of investors, as in the case of privately placed subordinated debt or a single insurer or single consortium of insurers. Direct monitoring is less feasible, however, when the bank's claims are diffused and widely held, as in the case of publicly placed debt.

[20]What we refer to a indirect monitoring closely corresponds to a number of policy proposals to use subordinated debt as a source of market discipline on banks. See, for example, Wall (1989) and Evanoff (1991).

lateral actions (exercise their option) on the basis of this information. An example consistent of this type of indirect monitoring is the proposal by Wall (1989) that advocates a variant of subordinated debt that includes an imbedded option, specifically, a put feature. The holders of this puttable subordinated debt could exercise their option to put the debt back to the bank if they believe the bank is shifting risk.

Henceforth, we assume that the regulator insures all deposits, and thus $\alpha_R = 1$. The setup for indirect monitoring is as follows: The subordinated debtholders can, as before, produce costly information concerning the asset quality choices made by the bank, but they lack the authority to force the bank to make any particular quality choice. The indirect monitoring case is perhaps more consistent with the spirit of market discipline, and it implies that the subordinated debtholders can use their information to act unilaterally — while remaining, of course, within the legal and contractual framework of their claims. These unilateral actions can take the form of, say, exercising the option to put the debt back to the bank for payment at par.

Subordinated debt with a put option can be modeled as follows. As before, the bank chooses its quality level q at $t = 0$. Simultaneously, the subordinated debtholders choose a monitoring level, μ_B, that determines the probability that monitoring will reveal the bank's risk. For simplicity, assume that this probability itself is μ_B. Prior to the realization of returns, the bank's risk is revealed completely with probability μ_B. If the bank's quality choice turns out to be the first-best level, i.e., q^{FB}, then the subordinated debtholders do nothing. If, instead, the monitoring reveals an inferior quality choice , i.e., $q < q^{FB}$, then the debtholders "put" the debt back to the bank before the cashflows are realized, and the bank is bound by the stipulations of the puttable debt contract to buy the debt back at face value.[21] On the other hand, with probability $(1-\mu_B)$, monitoring reveals nothing, and hence the subordinated debtholders have no basis to put back the debt. Thus, the subordinated debtholders put back the debt if and only if their monitoring reveals that the bank has chosen less than the first-best level of quality.

In the event the debt is put back to the bank, the capital requirement by the regulator implies that the bank has to raise the amount B in alternative financing from capital markets, again before the final cashflows are realized.

[21] If the subordinated debtholders demand compensation for the monitoring costs they incur, then the bank may have to offer a premium. This will not change our results.

This can be achieved, if possible, through an equity offering or alternatively, by issuing low-quality junior debt. For simplicity, assume that the bank issues junior debt in this case, and incurs an additional cost of ρ per dollar.[22] Like subordinated debt, the junior bonds would be repaid only in *State 1*. As before, we assume that the regulator uses a fixed pricing policy for deposit insurance. The issue is whether the put option on the subordinated debt results in better ex ante quality choices by the bank . To this end, note that the bank chooses the ex ante level of quality, q, to maximize its expected payoff, which is given by

$$\begin{aligned}\pi^E(q|\mu_B) &= \mu_B[(R(q)-D-B)q-Dp]1_{\{q=q^{FB}\}} \\ &\quad +\mu_B[(R(q)-D-B(1+\rho))q-Dp]1_{\{q<q^{FB}\}} \\ &\quad +(1-\mu_B)[(R(q)-D-B)q-Dp]-E\end{aligned}$$

The first-order condition is given by,

$$\frac{\partial[qR(q)]}{\partial q}-(D+B)-\mu_B B\rho 1_{\{q<q^{FB}\}} = 0. \tag{7}$$

The holders of the puttable subordinated debt, on the other hand, choose their monitoring level μ_B, so as to maximize their expected payoff, which is

$$\begin{aligned}\pi^B(\mu_B|q) &= \mu_B B1_{\{q<q^{FB}\}}+\mu_B[B+\theta(R_2-D)]q1_{\{q=q^{FB}\}} \\ &\quad +(1-\mu_B)[B+\theta(R_2-D)]q-B'-C(\mu_B)\end{aligned}$$

Their first-order condition is,

$$B1_{\{q<q^{FB}\}}-[B+\theta(R_2-D)]q1_{\{q<q^{FB}\}}-C'(\mu_B)=0. \tag{8}$$

The Nash equilibrium to this game is a pair, $\{q^*,\mu_B^*\}$, that solves equations (7) and (8). If $\rho>0$, the bank will never choose the first-best level of quality in equilibrium. To see this, note from (8) that if, to the contrary, $q^*=q^{FB}$, then $\mu_B^*=0$, i.e., the holders of puttable subordinated debt will have no incentive to monitor the bank. In this case, the bank can choose an inferior quality portfolio, and get away with it. Thus, in equilibrium, the

[22]This is in contrast to the subordinated debt, which was costless in our discount-free world. Note that if $\rho=\infty$, the bank is *credit-rationed*, and may not be able to raise any money at all.

bank must choose less than first-best quality ($q^* < q^{FB}$), and the debtholders must invest positive resources to monitor the bank ($\mu_B^* > 0$). In fact, the bank's choice of quality may be even worse: Comparing (1) and (7), it follows that $q^* < q^{SB}$, so long as $\rho > 0$. This leads to the following result.

Proposition 2 *Puttable subordinated debt does not improve the bank's choice of quality. In fact, if replacement financing is costly, the bank's optimal quality choice when the debt is puttable is strictly inferior to that when it is a straight subordinated debt.*

Puttable debt does not lead to better risk-taking by the bank because it does not offer sufficient penalties for bad behavior. When the subordinated debtholders choose to put back their debt, the bank can switch over to "junk" financing, which is seemingly more expensive, but in fact is not. The reason is that this additional cost is payable only in good states when the debt itself can be paid, and in any event is priced to reflect the bank's true risk in the first place. Consequently, the bank uses it to shift risk to the deposit insurer and the subordinated debtholders. Thus, contrary to its purpose, puttable debt leads to *more* risk-shifting, not less.[23]

5.2 Convertible Subordinated Debt: A Case of No Monitoring

In this section, we analyze another variant of the subordinated debt contract (i.e., convertibility) that is designed to change the bank's risk-taking behavior without resorting to costly monitoring methods. Green (1984) has shown, in the context of corporate finance, that warrants and convertible debt can alleviate the shifting of risk from stockholders to bondholders. This notion has since been applied to banking regulation by John, John, and Senbet (1993), who argue that taxing a bank's profits in the good states may

[23]To get around this problem, the regulator may require that the bank attempt to raise new equity instead of issuing junk bonds. However, due to the well-known debt-overhang problem (Myers 1977), investors will not subscribe to such an equity issue, as the first cashflows are sure to be paid out to the fixed claimholder, i.e., the deposit insurer. Puttable subordinated debt does no better if the bank faces credit rationing and is unable to raise additional funds. In this case, the bank could be closed and assets sold, but such a strategy is unlikely to generate sufficient funds to pay the subordinated debt holders after depositors and the deposit insurer have been paid.

induce the bank to take better risks ex ante, a result that is isomorphic to a convertible-type claim. In the case of subordinated debt, an interesting question is whether making the subordinated debt convertible to equity can similarly solve the risk-shifting problem.

To examine this issue, let the subordinated debtholders have the option to convert their debt B into a γ fraction of equity. The subordinated debtholders do not engage in any costly monitoring of the bank's ex ante choice of quality. Since any conversion occurs at the option of the subordinated debtholders, this possibility arises only in *State 1*, and the subordinated debtholders will choose to convert their debt in this state if and only if $\gamma[R(q) - D] > B$. This changes the bank's payoffs in *State 1* to $Min\{(1-\gamma)[R(q)-D], R(q)-D-B\}$. The ex ante expected payoffs to the subordinated debtholders become

$$\pi^B = q \max\{\gamma[R(q) - D], B\} + \theta q[R_2 - D] - B.$$

The bank's stockholders maximize their expected payoff, which is

$$\begin{aligned} \pi^E &= q \min\{(1-\gamma)[R(q) - D], R(q) - D - B\} - Dp_R - E \\ &= q(1-\gamma)[R(q) - D]1_{\{C\}}(q) + q[1 - 1_{\{C\}}(q)][R(q) - D - B] \\ &\quad -Dp_R - E, \end{aligned}$$

$$\text{where } 1_{\{C\}}(q) = \begin{array}{l} 1 \text{ if } \gamma[R(q) - D] > B \\ 0 \text{ else.} \end{array}$$

The solution is given by the first-order condition,

$$\frac{\partial[qR(q)]}{\partial q} - (D + B) + 1_{\{C\}}(q)\{B - \gamma[\frac{\partial[qR(q)]}{\partial q} - D]\} = 0.$$

We are now ready for the following result.

Proposition 3 *The optimal convertible subordinated debt involves a conversion factor γ^* such that*

$$\gamma^* \geq \frac{B}{R(q^*) - D}, \text{ where } q^* \text{ is s.t. } \frac{\partial[q^* R(q^*)]}{\partial q^*} - D = 0.$$

Furthermore, $q^{FB} > q^* > q^{SB}$.

That is, while an optimally designed convertible debt contract induces a better quality choice than a straight subordinated debt, it never achieves first-best. The reason is that risk-shifting to the deposit insurer remains a big problem. Unless the size of the convertible subordinated debt is large relative to deposit claims, the regulator cannot view the convertible subordinate debt as an adequate substitute for monitoring by the deposit insurer itself. In fact, as long as the size of the subordinated debt, convertible or not, remains small, there may not be any appreciable improvement in quality of banks' portfolios.

6 An Alternative Mechamism: Solving the Moral Hazard Problem

In the previous sections, we show that proposals for market discipline that rely on uninsured debt financing are not likely to solve the bank's moral hazard problem. In this section, we present an example of an alternative instrument, which we call *partially convertible deposits* (PCD), that will completely solve the moral hazard problem, provided the instrument is optimally designed.[24] This instrument has two distinguishing features. First, the claim must be issued by the deposit insurer and thus cannot be viewed as an example of market discipline. Second, this claim can be designed in such a way that information production is not necessary to solve the moral hazard problem.

For the example, we modify the earlier model of subordinated debt financing as follows: To keep the comparisons valid, the regulator sets the same capital requirement, E, as before, and charges a premium per dollar of deposits, p. Note that this implies that the bank must take in more deposits than before to compensate for the absence of subordinated debt, and thus the bank's returns are now sufficient to cover the full value of deposits only in *State 1*. The new regulatory requirement is that, instead of being required to sell subordinated debt, the bank is now required to (1) fully repay only a portion of the deposits D^*, and (2) sell the regulator (call) options to convert the remaining portion of deposit claims, $(D - D^*)$, to λ shares of equity. These options are to be exercised at the discretion of the regulator, while

[24]The solution discussed in this section is in the spirit of John, John and Senbet (1991), and Green (1984).

depositors, being fully insured, always receive the full value of their deposits.

Given the above features, the regulator optimally exercises the conversion option if and only if $\lambda[R(q) - D^*] > D - D^*$. Define

$$\begin{aligned} 1_{\{C\}}(q) &= 1 \text{ if } \lambda[R(q) - D^*] > D - D^* \\ &\quad 0 \text{ otherwise.} \end{aligned}$$

The ex ante expected payoffs to the regulator become

$$\begin{aligned} \pi^R &= q \max\{\lambda[R(q) - D^*], D - D^*\} + qD^* + \theta q R_2 \\ &\quad + R_3[1 - (1+\theta)q] + pD - D \end{aligned}$$

The bank's stockholders maximize their expected payoff, which is

$$\begin{aligned} \pi^E &= q \min\{(1-\lambda)[R(q) - D^*], R(q) - D\} - pD - E \\ &= q(1-\lambda)[R(q) - D^*]1_{\{C\}}(q) + q[1 - 1_{\{C\}}(q)][R(q) - D] \\ &\quad -pD - E. \end{aligned}$$

The solution is given by the first-order condition,

$$\frac{\partial[qR(q)]}{\partial q} - D + 1_{\{C\}}(q)\{D - D^* - \lambda[\frac{\partial[qR(q)]}{\partial q} - D^*]\} = 0.$$

We now derive the following result.

Proposition 4 *The optimal partially convertible deposits involves a conversion factor λ^* such that*

$$\lambda^* \geq \frac{D - D^*}{R(q^*) - D^*}, \text{ where } q^* \text{ is s.t. } \frac{\partial[q^* R(q^*)]}{\partial q^*} - D^* = 0, \text{ and}$$
$$D^* = R_3 + \theta(R_2 - R_3).$$

Furthermore, it achieves the first-best level of quality, i.e., $q^* = q^{FB}$.

To understand why partially convertible deposits are successful at alleviating the moral hazard problem, it is instructive to recall why uninsured private sector claims do not work. In the case of direct monitoring, private

sector claimholders are unwilling to invest the resources in information production and monitoring that is sufficient to provide adequate monitoring. The reason is that their claims are too small and their seniority too low to make such an expenditure worthwhile. The chief beneficiary of private sector monitoring is the regulator, who is attempting to delegate the monitoring function without any direct payment to the monitor. In other words, the regulator is a free rider, and the usual free rider outcome of under investment results.

In the case of puttable subordinated debt, the problem is somewhat different. If the bank is monitored and detected to be risk shifting, the only penalty is that the bank must go to the bond market and pay a price for the debt that merely reflects the risk that the bank was taking in the first place. And there is a positive probability that the bank will be able to shift risk and not be detected. Moreover, the benefits from shifting risk to the deposit insurer are high, since the insurer has such a large stake in the bank. For convertible subordinated debt, the problem is alleviated to some extent, but not completely. The conversion feature of the debt is not likely to provide a sufficient penalty to the bank to offset the benefits of shifting risk to the deposit insurer.

Now, consider the partially convertible deposits. The conversion option applies to a substantial portion of the bank's sources of funds, and conversion penalizes the bank's shareholders by depriving them of a large portion of their gains from risk shifting. Thus, risk shifting is no longer value enhancing to share holders and the bank chooses better ex ante quality. It is important to note that this solution is not an example of market discipline at work. The solution involves the regulator, which is necessary because the regulator is the only principal with a sufficient stake in the bank to be able to induce the bank to make first-best decisions.

7 Conclusions

A number of policy proposals have been put forth in recent years with the purpose of enhancing market discipline on bank decision-making. The underlying presumption is that traditional government regulators are either unable or unwilling to provide effective regulatory control over bank risk. In this paper, we develop a model of market discipline where the regulator delegates

the responsibility for bank regulation to various private sector claimholders, such as subordinated debtholders and co-insurers. The model is designed to investigate three main issues. First, if private sector claimholders act as direct delegated monitors with powers equivalent to those of the regulator, what are the relative incentives across different categories of claimholders to produce information and monitor the bank's risk? Where incentives do vary, the extent to which they differ from that of the regulator, as well as from the social optimum, is investigated. Second, in the case where private sector claimholders lack any legal regulatory powers other than the contractual provisions of their claims, can option-type features provide sufficient incentives to make delegated monitoring workable? Third, can alternative types of bank claims be designed in such a way that information production is not necessary to solve the moral hazard problem? In this case, the contractual provisions of the bank's claims must be exercisable on the basis of observable variables, such a cash flows.

The main result of the model is as follows: If the banking system remains in its present form with substantial deposit financing and relatively high leverage, then the successful delegation of the regulatory function to private sector claimholders via market discipline is unlikely . This result holds for both the direct and indirect monitoring cases. Specifically, even when the various claimholders have identical regulatory powers and access to the same monitoring technology, they are likely to choose different optimal levels of monitoring. The regulator's monitoring level is less than the social optimum, at least when the regulator acts as a claimholder in the bank, and the holders of subordinated debentures and private co-insurers are likely to monitor less than the regulator. Nevertheless, in the case of private co-insurers, direct delegated monitoring can be achieved if the size of the claims held by these claimholders and the regulator are roughly equal. For the holders of subordinated debentures, however, the same level of monitoring could require the amount of subordinated debt financing to be greater than the amount of deposits insured by the regulator. In the former case, it may not be desirable to have such a large fraction of deposits insured by the private sector, where a systemic problem could lead to financial catastrophe. In the latter case, such a large requirement on subordinated debt financing would fundamentally alter the product mix of the banking industry and perhaps hamper the efficiency, liquidity, and cost of the payments mechanism.

Our results do show, however, that there are alternative mechanisms that

can be designed to solve the moral hazard problem. A feature of these mechanisms is that they do not represent examples of market discipline since they require the regulator to be closely involved. The reason is that it only the regulator that has a sufficiently large stake in the bank to have the incentive to solve the moral hazard problem. One example of such a mechanism is partially convertible deposits where the conversion feature applies to insured deposits. This type of security can be optimally designed to penalize the bank by depriving shareholders of much of the benefits from risk shifting. An additional feature is that this claim can be designed in such a way that information production is not necessary to solve the moral hazard problem.

At least one caveat is in order when interpreting the above results. Specifically, we compare the incentives of various private sector claimholders with a regulator who acts to break even on the provision of deposit insurance services. As noted earlier, in reality the regulator may lack incentives to monitor and/or sanction banks that make poor quality decisions, or may have an altogether different objective function based on self interest. Thus, the overall reduction in bank asset quality from the delegation of bank regulation to private sector claimholders may be less than our model predicts. What our results do show, however, is that it is perhaps better to formulate policies that induce the regulator to act responsibly rather than attempting to pass the buck for bank regulation to claimholders that have much less at stake.

References

[1] Avery, R.B., Belton, T.M. and Goldberg, M.A., "Market Discipline in Regulating Bank Risk: New Evidence from the Capital Markets," *Journal of Money, Credit and Banking*, **20**, (1988), 597–610.

[2] Baer, H., "What We Know About the Deposit Insurance Problem," Chicago Fed Letter, (July, 1990).

[3] Baer, H., and Brewer, E., "Uninsured Deposits as a Source of Market Discipline: Some New Evidence," *Economic Perspectives*, Federal Reserve Bank of Chicago, (September/October, 1986) 23-31.

[4] Benston, G.J., Eisenbeis, R., Horvitz, P., Kane, E., and Kaufman, G., *Perspectives on Safe and Sound Banking: Past, Present, and Future*, Cambridge: MIT Press, 1986.

[5] Boot, A, and Thakor, A. "Self-Interested Bank Regulation," *American Economic Review*, 1993.

[6] Buser, S., Chen, A., and Kane, E., "Federal Deposit Insurance, Regulatory Policy, and Optimal Bank Capital," *Journal of Finance*, **35**, (1981), 51–60.

[7] Campbell, T., Chan, Y.-S., and Marino, A., "An Incentive Based Theory of Bank Regulation," *Journal of Financial Intermediation*, (1992), 255–276.

[8] Chan, Y., Greenbaum, S.I. and Thakor, A.V., "Is Fairly Priced Deposit Insurance Possible?" *Journal of Finance*, **47**, (1992), 227-245.

[9] Congressional Budget Office, "Reforming Federal Deposit Insurance," Congress of the United States, September, 1992.

[10] Diamond, D., "Financial Intermediation and Delegated Monitoring," *Review of Economic Studies*, **51**, (1984), 393-414.

[11] Ellis, D.M., and Flannery, M.J., "Risk Premia in Large CD Rates: Time Series Evidence on Market Discipline," *Journal of Monetary Economics*, **27**, (1992), 481-502.

[12] Evanoff, D.D., "Subordinated Debt: The Overlooked Solution for Banking," *Chicago Fed Letter*, May, 1991.

[13] Flannery, M., and Sorescu, S., "Pricing Bank Default Risk in Subordinated Debenture Yields," *Proceedings: Conference on Bank Structure and Competition*, Federal Reserve Bank of Chicago, May, 1995, 459-482.

[14] Giammarino, R., Lewis, T. and Sappington, D., "An Incentive Approach to Bank Regulation," *Journal of Finance*, **48**, (1993), 1523–1542.

[15] Gilbert, R.A., "Market Discipline of Bank Risk: Theory and Evidence," Federal Reserve Bank Of St. Louis, *Review*, (January/February, 1990), 3-18.

[16] Gorton, G. and Santomero, A., "Market Discipline and Bank Subordinated Debt," *Journal of Money, Credit and Banking,* **22**, (1990), 119-128.

[17] Green, R., "Investment Incentives, Debt and Warrants," *Journal of Financial Economics*, 13, (1984), 115-136.

[18] Hannan, T. H., and Hanweck, G.A., "Bank Insolvency Risk and the Market for Large Certificates of Deposit," *Journal of Money, Credit and Banking,* **20**, (1988), 203-211.

[19] James, C.M., "The Use of Loan Sales and Standby Letters of Credit by Commercial Banks," *Journal of Monetary Economics*, **22**, (1988), 325-346.

[20] James, C.M., "Heterogeneous Creditors and the Market Value of Bank LDC Loan Portfolios," *Journal of Monetary Economics*, **25**, (1990), 611-627.

[21] John, K., John, T.A. and Senbet, L., "Risk-Shifting Incentives of Depository Institutions: A New Perspective on Federal Deposit Insurance Reform," *Journal of Banking and Finance*, **15**, (1991), 895–915.

[22] Kane, E.J., "No Room for Weak Links in the Chain of Deposit-Insurance Reform," *Journal of Financial Services Research*, **1**, (1987), 77–111 .

[23] Kane, E.J., "Changing Incentives Facing Financial-Services Regulators," *Journal of Financial Services Research*, **3**, (1989), 265–274.

[24] Myers, S. "Determinants of Corporate Borrowing," *Journal of Financial Economics,* (1977).

[25] Nagarajan, S. and Sealey, C. W., "State-Contingent Bank Regulation," Working paper, McGill University, 1995a.

[26] Nagarajan, S. and Sealey, C.W., "Forbearance, Deposit Insurance Pricing, and Incentive Compatible Bank Regulation," *Journal of Banking and Finance*, **19**, (1995b), 1109-1130.

[27] Rajan, R., and Winton,A., "Covenants and Collateral as Incentives to Monitor," *Journal of Finance*, **50**, (1995), 1113-1146.

[28] Wall, L. D., "A Plan for Reducing Future Deposit Insurance Losses: Puttable Subordinated Debt," *Economic Review*, (July/August,1989), 2-17.