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A Positive Analysis of Bank Closure*,†

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This paper investigates the incentives of a regulator to close depository institutions, recognizing that an institution's risk taking will be influenced by the regulator's policy regarding bank closure and that there are opportunity costs in closing banks arising from their intermediation function. The regulator focuses not on the current portfolio of the bank, but on the bank's future portfolio. Even if the regulator seeks to maximize welfare, the first best is not obtainable because the regulator is unable to credibly commit to certain policies regarding closure. *Journal of Economic Literature* Classification Numbers: G2, L5, G1.

1. INTRODUCTION

The 1991 FDIC Improvement Act (FDICIA) introduced "prompt corrective action" provisions to ameliorate the moral-hazard problem associated with forbearance. To the extent that (nearly) insolvent banks have

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the greatest incentive to invest in excessively risky assets, placing into conservatorship banks with little chance of recovery would lessen the losses suffered by the insurance fund. While FDICIA calls for increasingly strict sanctions against banks as their capital levels deteriorate, the legislation still permits some regulator discretion as to when to close banks.[1] Recent experience, where numerous S&Ls were permitted to remain in operation with negative capital, suggests regulators use discretion when permitted.

This paper investigates the incentives of a regulator to close depository institutions, recognizing that an institution's risk taking will be influenced by the regulator's policy regarding bank closure and that there are opportunity costs in closing banks. We are interested in the interaction between the bank's current portfolio (of long-lived assets), its future asset choices, and the regulator's closure decision.

As the title indicates, this is a positive analysis of regulatory policy regarding closure. We ignore socially optimal regulatory policy, which in our model does not involve closure. We take as our starting point that closure is a major instrument of bank regulation and often the only one, and we examine the efficacy of bank closure as an instrument of policy. We abstract from issues of asymmetric information and monitoring. While important, explicitly allowing for these issues would only complicate the model without significantly changing our conclusions. Instead, we assume that the regulator cannot force particular asset choices on the bank and that the bank and regulator cannot sign contingent contracts on the asset choice. The advantage of working with a model as simple as ours is that the fundamental insights on *credibility* and *opportunity costs of closure* are sharpened. For the same reason, we have chosen to study the interaction of a single existing bank and the regulator over two periods.

[1] For example, as stated in Section 131, subsection (h)(3), "In general, the appropriate Federal banking agency shall, not later than 90 days after an insured depository institution becomes critically undercapitalized—(i) appoint a receiver (or, with the concurrence of the Corporation, a conservator) for the institution; or (ii) *take such other action as the agency determines, with the concurrence of the Corporation, would better achieve the purpose of this section*, after documenting why the action would better achieve that purpose" (p. 2261 of FDICA, italics added). This decision must be reviewed every 90 days, and if the institution is still critically undercapitalized 270 days after it became critically undercapitalized, FDICIA requires the banking agency to appoint a receiver. However, there is even an exception to this requirement: the banking agency may permit the bank to operate as long as it has positive net worth, is in compliance with an approved capital restoration plan, has an upward trend in earnings, and is reducing the ratio of nonperforming loans to total loans, and both the head of the appropriate banking agency and the FDIC chairperson both certify that the institution is viable and not expected to fail (p. 2262 of FDICIA). In addition, if the FDIC, the Federal Reserve, and the Secretary of the Treasury (in consultation with the President) determine that closing a bank would have "adverse effects on economic conditions or financial stability ... the Corporation may take other action or provide assistance ... as necessary to avoid or mitigate such effects" (p. 2275 of FDICIA).

We study the regulator's behavior under two scenarios. In the first, there is no agency problem: the regulator is acting to maximize society's welfare. In this case, the regulator cares about the costs of closing a bank and the net return of the projects funded by the bank. In the second scenario, an agency problem occurs because the regulator, rather than maximizing welfare, acts to minimize its closure costs plus depositor payout costs. The two scenarios differ in that the regulator internalizes the opportunity cost of forgone intermediation in the first, but not in the second. Even if the regulator acts to maximize society's welfare, its lack of commitment power leads to a second-best solution.

The regulator can only credibly threaten closure if, *given* the current and anticipated future asset choices of the bank, it is optimal to close the bank. The regulator's idle threats will be ignored by banks. In particular, excessively risky asset choices need not lead to closure, even if the assets chosen have little value. Interaction of the regulator and bank is *dynamic* in this analysis. The regulator understands that banks not closed will be making future asset decisions. Moreover, banks understand that their current asset choices will affect the closure decision of the regulator. Thus, the regulator's policy regarding closure, if *credible*, will affect the risk-taking behavior of banks. Formally, we study subgame perfect equilibria.

Owing to the second-best nature of equilibria, there are situations, even with perfect monitoring, where the existence of the regulator's option to close a bank reduces welfare. This is true not only for the cost-minimizing regulator, but also for the welfare-maximizing regulator. We derive the optimal policy regarding closure given the bank's endogenous response to the policy and the potential agency problem inherent in the regulatory structure. It will not be a simple cutoff rule in bank value.

We capture the value of a bank's intermediation function indirectly. Since banking services are in scarce supply, any project not financed by the bank is not undertaken. For simplicity, we assume that the bank can finance only one project in each period. A bank is a network of workers skilled in identifying attractive projects and monitoring outstanding loans. As with most service firms, workers generate productive externalities. The *charter value* of a bank, i.e., its value after allowing for tangible assets and liabilities, can be viewed as the uncompensated value of this network of workers.[2] Closing a bank incurs both the direct resource cost

[2] An important issue is how any firm can extract some of this value, since the firm's workers might be able to resign, establish a new firm, and capture the full value for themselves. Mailath and Postlewaite (1990) argue that in order for the workers to capture their full value, they must first solve a bargaining problem of how to divide the value, and that this problem is often insolvable.

Charter value may also include the discounted value of monopolistic rents, as in Chan *et al.* (1992). Given the absence of entry barriers, any monopolistic rents are, in principle, part of closing as well as the opportunity cost of the forgone project. This opportunity cost is the value of the intermediation, which raises the issue of renegotiation that we address in Section 9.

Consistent with not allowing contingent contracts between the regulator and the bank, we do not consider optimal deposit insurance schemes; rather we assume deposit insurance premiums are unrelated to the riskiness of the bank's portfolio.[3]

The rest of the paper is organized as follows. After a brief literature review in Section 2, Section 3 sets out the model. Section 4 derives the credible strategies of the regulator. Section 5 describes the subgame perfect equilibrium of the model for the two different regulator objective functions. Section 6 describes the equilibrium. Section 7 discusses too-big-to-fail and regulatory discretion. Section 8 considers the impact of allowing the regulator to close the bank before any asset choices are made. Section 9 discusses renegotiation, and Section 10 concludes.

2. LITERATURE

Several recent papers have studied banks' portfolio choices and regulatory behavior. Since Acharya and Udell (1991) surveys this literature, we are brief. Unlike other papers in this area, we allow for long-lived assets (returns are not realized before the closure decision or new asset choices are made) and explicitly allow for opportunity costs of forgone intermediation if the bank is closed. Both Acharya and Dreyfus (1989) and Acharya (1991) incorporate a competitive capital market. Acharya and Dreyfus (1989) find that when there is free entry into and competition within the banking industry, healthy banks may be closed. Our paper differs from Acharya and Dreyfus (1989) in that the bank's portfolio choice is explicitly modeled. That is, banks are permitted to react to the regulator's decision. Acharya (1991) derives the regulatory cost-minimizing closure rule and deposit insurance premium, again when assets are short lived. Davies and McManus (1991) study how different closure rules

of the value of the network of workers—if workers did establish a new bank under a new name, they should be able to earn the monopolistic rents. See Mailath and Postlewaite (1990) for an extended discussion.

[3] While FDICIA requires the FDIC to begin charging risk-related deposit insurance premiums by January 1994, the transitional premiums implemented in January 1993, and which will be charged in 1994 as well, vary little across banks. Only five different rates are charged, and the spread between the highest and lowest premiums charged is only 8¢ per \$100 of domestic deposits. (Banks with low capital levels and poor supervisory ratings pay 31¢, while the healthiest banks pay 23¢.) Moreover, about 75 percent of insured commercial banks pay the lowest premium (see Rehm, 1992). We return to this issue in the Conclusion.

(e.g., a rule specifying closure at different capital levels) affect a risk-averse bank's choice of risk. However, they do not require the regulator to act in a credible manner—the closure rule is specified exogenously and the regulator must obey it. They also abstract from dynamic considerations that we take explicitly into account—e.g., the fact that a bank's risk choice today will affect its probability of failure tomorrow and therefore its choice of risk tomorrow. In a related paper, Levonian (1991) also makes the regulator's policy regarding closure exogenous and ignores the credibility issue. In a different context, Stiglitz and Weiss (1983) analyze the incentive effects of banks threatening to deny borrowers credit if they do not repay a previous loan. While Stiglitz and Weiss find that this threat has beneficial incentive effects (with the borrowers choosing less risky projects), they permit the bank to commit to executing the threat in the loan contract, so that the credibility issue (the heart of this paper) is not addressed.

Unlike our paper, Giammarino *et al.* (1993) study the design of an optimal risk-adjusted deposit insurance system in a model with adverse selection and moral hazard. Bank assets have an inherent risk, observable to the bank but not to the regulator, but the bank can lower this risk by monitoring the loan. Deposit insurance premiums can be related to bank risk. The paper derives the optimal premium structure (an issue not addressed in our paper). But since their model is static, they cannot address the credibility issue.

John *et al.* (1991) point out that the bank's limited liability creates the moral-hazard problem of banks taking on excessive risk. While they claim that the flat-rate deposit insurance system is unimportant in the risk incentive problem, it is, in fact the interaction of flat-rate premiums and limited liability that is important. Charging riskier banks a higher insurance premium (or depositors' requiring higher deposit rates) would mitigate risk taking, but the first-best level of risk would still not be selected because of limited liability. They show that with an optimal tax structure and a revenue-neutral insurance premium, the first-best level of risk taking can be achieved.

In a single-period model, Campbell *et al.* (1992) study the optimal incentive contract between depositors and regulators to induce the regulator to provide the optimal level of bank-risk monitoring. While the paper takes regulators' incentives into account, it does not address the credibility issue. Boot and Thakor (1993) study a self-interested regulator who closes banks infrequently to develop a reputation for successful monitoring of bank portfolios. Two other papers study reputation building in financial institution markets. Boot *et al.* (1993) study discretionary financial contracts and argue that discretion allows reputational capital to be depreciated in order to preserve financial capital; discretion expands the incentives for reputation building. In a dynamic model of financial intermediation, Boot and Greenbaum (1993) study the effects of regulation on the incentives of financial institutions to build reputations.

3. THE MODEL

There is one bank and one regulator/insurer.[4] The timing of decisions is denoted by t. At $t = 1$, the bank collects \$1 in deposits and invests in either a safe or a risky asset. The bank's asset choice is observable to the regulator, who at $t = 1\frac{1}{2}$ decides whether to close the bank or leave it open.[5] If the bank is allowed to remain open, then at $t = 2$ the bank collects another \$1 in deposits and again invests in either a safe asset or a risky asset. If the regulator closes the bank, the bank cannot collect any new deposits, nor can it make any new investments.

For simplicity, we assume that the safe assets available in each period are identical, and that the risky assets available in each period differ only in their probability distributions. Safe assets have a gross return of r^s. Risky assets have a gross return of either 0 or $r^r > 0$. We study a nonstationary environment: The risky asset available at $t = i$ has a return of r^r with probability p_i, and $p_1 \neq p_2$. The return of the risky asset available at $t = 1$ is independent of the return of the risky asset available at $t = 2$. The returns on all assets are realized at $t = T > 2$, after all decisions have been made. The interest rate on deposits is zero and the bank has no initial capital.[6] The cost of closing the bank at $t = 1\frac{1}{2}$ or at $t = T$ is denoted c.[7] We denote by c_a, $0 \leq c_a \leq c$, the administrative costs of closure, with $c - c_a$ representing nonadministrative costs of closure. We assume $c_a \leq \min\{r^s - 1, r^r - 1\}$, so that if the bank is closed at $t = 1\frac{1}{2}$ and the period-1 asset pays off administrative costs are recovered.

To focus directly on the time consistency, or credibility, of regulatory policy, we model the case where the regulator observes the bank's portfolio choice. Even with perfect monitoring, the first-best regulatory policy often cannot be implemented. This relies on the absence of contracts contingent on the asset choice of the bank. One simple assumption that will rule out contingent contracts is that asset choice is not verifiable to any third party (especially courts). More generally, in the presence of

[4] While our analysis applies to any depository institution, we use the term "bank" throughout.

[5] Giving the regulator the option of closing the bank at $t = 0$ (i.e., allowing the regulator to move first) does not affect the results. Each possibility that we describe is consistent with the regulator choosing not to close the bank at $t = 0$; see Section 8.

[6] The qualitative nature of our results is unchanged if the gross returns differ across periods, the rate of interest is positive, and the bank has initial capital.

[7] Allowing the costs of closure to differ in the two periods does not change our results qualitatively. Details are in Mailath and Mester (1991).

asymmetric information and imperfect monitoring, such contracts are either infeasible or suboptimal. Since the inefficiency of regulatory policy is due to a lack of commitment power, not asymmetric information, it is easier to assume the absence of such contracts.[8]

Recall that any project not financed by the bank cannot be undertaken. For simplicity, we make the extreme assumption that the bank can finance only one project in each period. Banks are not perfect substitutes in their ability to identify projects, so that different banks identify different projects. If a particular bank does not finance a project, it is, therefore, lost to society. Thus, closing a bank incurs both the direct costs as well as the opportunity cost of the forgone project. This opportunity cost is an important consideration of the welfare-maximizing regulator.

The bank has limited liability, with the regulator repaying depositors when the total gross returns of the bank's assets are insufficient. If the bank is not closed at $t = 1\frac{1}{2}$, the regulator takes no action until the asset returns are realized, i.e., at $t = T$. If at this time the bank is solvent, then the regulator takes no action, and the bank repays depositors and retains the residual.[9] If the bank is insolvent, then the regulator closes the bank and repays depositors.

Alternatively, if the bank is closed at $t = 1\frac{1}{2}$, then the regulator repays depositors at $t = T$; the bank receives the excess realized return after allowing for administrative closure costs and the depositor payout (if any) on the first-period asset. This last assumption requires some discussion. Since we are allowing the regulator to close a solvent bank, we need to specify the holder of the rights to the bank's return should the actual return, determined after the closure decision, turn out to be high.[10] We have in mind a scenario in which bank assets are illiquid, so that the regulator, after closing the bank at $t = 1\frac{1}{2}$, is unable to realize their expected value. Rather, the regulator must retain the assets until their returns are realized. These two considerations motivate our assumption that the bank retains ownership to any excess realized returns.

[8] The credibility, or time consistency, of regulatory practice in environments of asymmetric information raises many interesting issues, such as the ratchet effect (see Freixas *et al.*, 1985, Baron and Besanko, 1987, and Laffont and Tirole, 1988). Besanko and Spulber (1992) find that asymmetric information can mitigate the inefficiencies induced by a lack of regulatory commitment. Their result, however, appears to be model specific.

[9] FDICIA instructs regulators to close banks, in most cases, if their capital/asset ratio falls below 2 percent. In our model, one could define "solvency" as the bank's having capital/assets ≥ 2 percent rather than ≥ 0, without changing any of the results.

[10] In fact, there will be cases when the regulator wants to close the bank after it has chosen the safe asset in period 1. Our assumption that any surplus reverts to the bank is consistent with the Federal Deposit Insurance Act. Section 11, subparagraph (d)(11) of the Act states, "In any case in which funds remain after all depositors, creditors, other claimants, and administrative expenses are paid, the receiver shall distribute such funds to the depository institution's shareholders...."

We denote the bank's asset choices by S (for safe) and R (for risky). If the bank is not closed at $t = 1\frac{1}{2}$, the bank's choices are written as a 2-tuple, with the first letter corresponding to the period 1 choice. The regulator's two choices are denoted O (leave bank open at $t = 1\frac{1}{2}$) and C (close bank at $t = 1\frac{1}{2}$). Outcomes are either of the form (xy, O) or (x, C), where $x, y \in \{S, R\}$.

The bank is risk neutral and makes its asset choices to maximize its expected return. The appropriate objective function of the regulator is less obvious. If the regulator acts in the best interests of society, it will take into account the value of the assets banks finance as well as the expected cost of repaying depositors. However, given the recent deposit insurance turmoil, it seems equally plausible that the regulator cares only about minimizing its own expected costs of resolving bank failures, which include the expected cost of depositor payouts, but *not* the upper end of the assets' distributions. We consider both cases: the *welfare-maximizing regulator* (which we abbreviate as W-M regulator), which maximizes expected return net of the cost of closing the bank, and the *cost-minimizing regulator* (the C-M regulator), which minimizes its costs (the payouts to depositors and the cost of closing the bank).

The W-M regulator maximizes

$$V_{\mathrm{WM}} = \mathrm{ER}_1 + \mathrm{ER}_2 - \rho c,$$

where ER_1 is the expected return of the first-period asset choice of the bank, ER_2 is the expected return of the second-period asset choice if the bank is not closed and zero otherwise, and ρ equals the probability of insolvency if the bank is not closed and 1 if it is closed. Note that c_a does not appear, since this is a transfer between the bank and the regulator. The C-M regulator maximizes

$$V_{\mathrm{CM}} = \begin{cases} -(c - c_a), & \text{if } (S, C), \\ -(1 - p_1)(1 + c) - p_1(c - c_a), & \text{if } (R, C), \\ -E[2 - \tilde{r} + c \mid \tilde{r} < 2]\mathrm{Prob}(\tilde{r} < 2), & \text{if bank left open at } t = 1\tfrac{1}{2}, \end{cases}$$

where $\tilde{r}$ is the random gross return of the bank's two-period portfolio. Thus, the bank is insolvent if $\tilde{r} < 2$ and the probability of insolvency is given by $\mathrm{Prob}(\tilde{r} < 2)$.

The Assets

We assume the safe asset's return and the risky asset's return when it pays off cover the cost of deposits:

A1. $r^s - 1 > 0$ and $r^r - 1 > 0$.

To generate a tension between the regulator's and bank's incentives, we assume society prefers the safe asset over the risky asset in $t = 1$ and 2. That is, the expected return to the safe asset is greater than the expected return to each risky asset:

A2. $p_i r^r - 1 < r^s - 1, i = 1, 2.$

However, this does not imply that after the bank has chosen the risky asset in period 1, society will necessarily prefer it to choose the safe asset in period 2; we discuss this in more detail below.

We also assume that if the bank could make only one asset choice, it would prefer the risky to the safe asset, i.e., there is a moral-hazard problem caused by the bank's limited liability and its cost of deposits being independent of the bank's riskiness:[11]

A3. $p_i(r^r - 1) > r^s - 1, i = 1, 2.$

Note that A3 implies $r^r > r^s$.

Either $p_i r^i - 1 > 0$ or $p_i r^i - 1 < 0$ is possible; i.e., the risky asset can have positive or negative expected value. The first-best pair of asset choices is (S, S). If the regulator could impose a contingent tax on the bank, then, under A1, A2, and A3, the first best can be achieved without closure.[12] We have ruled out such contingent claims because, in the presence of asymmetric information and imperfect monitoring, they are either infeasible or suboptimal.

Since the value of a bank that has selected two assets depends on the gross return of both assets, we need an assumption about the size of returns when only one pays off. We assume that the return to a single asset is not enough to cover losses on the other asset.[13] That is, if the bank chose a risky asset that failed, then the bank is insolvent. This assumption can be written as follows:

A4. $r^r - 2 < 0$ and $r^s - 2 < 0.$

Given A4, if the bank were to choose the safe asset at $t = 1$, it might be induced to choose the safe asset at $t = 2$, since a risky asset that fails would dissipate any returns from the $t = 1$ asset.

[11] Since the regulator repays depositors at $t = T$ if the bank is insolvent, we have effectively assumed that the bank pays a flat rate insurance premium of zero. Introducing a strictly positive flat-rate insurance premium does not alter our results.

[12] One contingent tax policy that yields the first best is to tax the bank if it chooses the risky asset in period i an amount $p_i(r^r - 1) - (r^s - 1) + \varepsilon$, $\varepsilon > 0$. This removes the incentive to choose the risky asset.

[13] Another interesting possibility is when the return to the risky asset in the good state, r^r, is high enough to cover losses on the other asset, but the return on the safe asset, r^s, is not. Until Section 9 where we discuss renegotiation and introduce a third asset, we focus on the case in the text, since it is the one in which the moral-hazard problem is most severe.

We restrict $p_1 > \frac{1}{2}$ and $p_2 > \frac{1}{2}$, so that an increase in p_i implies a decrease in the risky asset's variance as well as an increase in its expected return:

A5. $p_1 > \frac{1}{2}$ and $p_2 > \frac{1}{2}$.

Finally, we assume that all of the above is common knowledge.

For notational convenience, let $\gamma \equiv (r^r - 1)/(r^s - 1)$; γ is the potential gain on the risky asset if it pays off relative to the gain on the safe asset. By A3, $\gamma > \max(1/p_1, 1/p_2)$, but is unbounded above. Also, A1 and A4 imply $0 < r^r - 1 < 1$ and $0 < r^s - 1 < 1$.

4. CREDIBILITY OF REGULATORY POLICY

When the bank chooses an asset in period 1, it takes into account the regulator's policy regarding closure. We require that any closure threats by the regulator be credible. For example, suppose in seeking to induce the bank to select a safe asset at $t = 1$, the regulator threatens to close the bank if it chooses the risky asset. For certain parameter values, this threat will be idle, for once the bank has selected the risky asset, it will not be in the regulator's best interests to close the bank. Moreover, even though welfare is maximized when the bank chooses the safe asset in periods 1 and 2, it is not always in society's best interest to close the bank after it selects the risky asset in period 1. Once the bank has chosen an asset in period 1, the decision cannot be undone by any subsequent action of the regulator. Society may then prefer to keep the bank open if the desired period-2 asset is the safe one, which it will be for certain parameter values.

While some closure threats are idle, not all are. The regulator's threatened action will then affect the bank's asset selection. For a portion of the parameter space, the threat of closure will cause the bank to select the safe asset at $t = 1$. On the other hand, when the potential gain to the risky asset is sufficiently high relative to the gain from the safe asset, the bank will select the risky asset and will be closed by the regulator at $t = 1\frac{1}{2}$.

The W-M regulator implements the socially optimal policy regarding closure, which yields the second-best outcome (i.e., it maximizes welfare subject to the constraint that the bank is free to choose its assets as long as it is open). The C-M regulator may have stronger or weaker incentives to leave the bank open than is socially optimal.

The model is a game of perfect information (the bank or regulator possesses all of the relevant information whenever making a decision). To guarantee the credibility of policies regarding closure, as well as the credibility of the bank's choice at $t = 2$, we study subgame perfect equilibria.

Bank's Desired Asset Choices

We first describe the optimal asset choices of the bank if it is left open regardless of its asset choice at $t = 1$. Of course, the bank's optimal asset choice depends on the total expected return to the bank from the four possible choices:

$$\text{Bank's expected return from } (S, S) = 2(r^s - 1)$$

$$\text{Bank's expected return from } (S, R) = p_2(r^s - 1 + r^r - 1)$$

$$\text{Bank's expected return from } (R, S) = p_1(r^r - 1 + r^s - 1)$$

$$\text{Bank's expected return from } (R, R) = 2p_1p_2(r^r - 1).$$

The bank's optimal asset choice at $t = 2$ is described in the following lemma, whose proof is straightforward.

LEMMA 1. *If the bank had chosen S at $t = 1$, then the bank strictly prefers S at $t = 2$ if and only if $\gamma < \underline{\gamma} \equiv (2 - p_2)/p_2$. If the bank had chosen R at $t = 1$, then the bank strictly prefers S at $t = 2$ if and only if $\gamma < \bar{\gamma} \equiv 1/(2p_2 - 1)$.*

Note that $\underline{\gamma} < \bar{\gamma}$ if $p_2 \neq 1$, so that a bank that had chosen the risky asset at $t = 1$ is less likely to choose the risky asset at $t = 2$ than a bank that had chosen the safe asset at $t = 1$. This is because even if the period-2 risky asset pays off, the bank receives this return only if the period-1 asset pays off (by A4), which occurs with a higher probability if the period-1 asset is the safe asset (in fact, it would occur with probability 1). This lemma implies that, in general, the regulator will not decide on closure using a simple cutoff in bank asset value.

Regulator's Behavior: Is Early Closure a Credible Threat?

For both the W-M and the C-M regulators, the decision to close the bank after observing its first-period asset choice depends on the difference between the expected depositor payout if the bank is closed early or late. The W-M regulator also cares about the revenue the bank's assets generate if they succeed.

Closing the bank at $t = 1\frac{1}{2}$ results in closure costs with certainty, while leaving the bank open results in closure costs only if the bank is insolvent at $t = T$. Early closure limits the deposits the regulator is obligated to repay should the bank fail by limiting the bank to one asset choice. However, if the bank desires a safe asset at $t = 2$, then permitting the bank to remain open *reduces* the potential liability of the regulator, since the safe asset always pays off. The W-M regulator also benefits from the expected profits the bank earns by remaining open the additional period. So, if the bank desires the safe asset at $t = 2$, or if the regulator is W-M, then, in general, banks will be allowed to remain open more often.

The regulator can follow one of four policies: *closure* (close the bank irrespective of the bank's $t = 1$ choice), *forbearance* (leave the bank open irrespective of the bank's choice), *incentive* (close the bank if it chooses the risky asset, and leave it open if it chooses the safe asset), and *preemptive* (close the bank if it chooses the safe asset, and leave it open if it chooses the risky asset). The closure policy is self-explanatory. Forbearance is the policy that leaves a bank open even if it has a negative expected value. The incentive policy, if credible, gives the bank an incentive to choose the safe asset. The preemptive policy prevents a bank from choosing a risky asset at $t = 2$ after selecting a safe asset at $t = 1$.

The credibility of the different policies depends on what the regulator expects the bank to do at $t = 2$ if it is left open, as well as the costs of closing. Each of the four policies is a combination of decisions following the bank's choice at $t = 1$. The expected cost of delay of closure depends upon the bank's current state (i.e., did it choose R or S at $t = 1$) and its predicted choice at $t = 2$ if left open. These costs are expected, since the bank need not be closed at $t = T$ if all assets pay off.

We denote by ζ^{jk} and χ^{jk} the expected benefit of delay in terms of closure costs for the W-M and C-M regulators, respectively, when the bank chooses j at $t = 1$ and is predicted to choose k at $t = 2$. Then,

$$
\begin{aligned}
\zeta^{SS} &= c, & \chi^{SS} &= c - c_a, \\
\zeta^{RS} &= c - (1 - p_1)c = p_1 c, & \chi^{RS} &= c - p_1 c_a - (1 - p_1)c = p_1(c - c_a), \\
\zeta^{SR} &= c - (1 - p_2)c = p_2 c, & \chi^{SR} &= c - c_a - (1 - p_2)c = p_2 c - c_a, \\
\zeta^{RR} &= c - (1 - p_1 p_2)c = p_1 p_2 c, & \chi^{RR} &= c - p_1 c_a - (1 - p_1 p_2)c = p_1(p_2 c - c_a).
\end{aligned}
$$

Note that for $p_2 < p_1$, $\zeta^{RR} < \zeta^{SR} < \zeta^{RS} < \zeta^{SS}$, and for $p_1 < p_2$, $\zeta^{RR} < \zeta^{RS} < \zeta^{SR} < \zeta^{SS}$. Similar inequalities hold for the expected benefits of delay for the C-M regulator (as long as $p_2 c \geq c_a$). Note that if $c_a = c$, then χ^{SR}, $\chi^{RR} < 0$, i.e., there is no benefit to delaying, since a risky asset is being chosen in period 2, and if the period-1 asset pays off, then the regulator incurs no costs.

If the regulator predicts that the bank will choose the safe asset in period 2, then the bank will not be closed at $t = 1\frac{1}{2}$. This follows immediately from the observation that even if the bank becomes insolvent as a result of the period-1 asset not paying off, the period-2 safe asset helps to defray the cost of repaying depositors. Moreover, there is a positive probability that the bank will not be insolvent at T.

If the bank chose S at $t = 1$, then the W-M regulator prefers to close the bank if $\underline{\gamma} < \gamma$ and $\zeta^{SR} < -(p_2 r^r - 1)$. The first of these conditions implies that the bank would choose R at $t = 2$ if left open, and the second condition implies that the expected benefit to the W-M regulator of not closing at $t = 1\frac{1}{2}$ is less than the expected cost of delaying closure. For the C-M regulator we get an analogous result: If the bank chose S at $t = 1$, then the C-M regulator prefers to close the bank if $\gamma < \underline{\gamma}$ and $\chi^{SR} < -(1 - p_2)(r^s - 2)$. Similarly, if the bank chose R at $t = 1$, then the W-M regulator prefers to close the bank if $\bar{\gamma} < \gamma$ (bank will choose R at $t = 2$) and $\zeta^{RR} < -(p_2r^r - 1)$ (expected benefit from delay is less than the expected cost of allowing the bank its choice of R at $t = 2$). Analogously for the C-M regulator, if the bank chose R at $t = 1$, then the regulator prefers to chose the bank if $\bar{\gamma} < \gamma$ and $\chi^{RR} < -\phi$ (where $\phi \equiv [(1 - p_1)p_2 + p_1(1 - p_2)](r^r - 2) - 2(1 - p_1)(1 - p_2) + (1 - p_1))$.

In describing the parameter regions for which each policy is credible, some simplification is possible, since $\underline{\gamma} < \bar{\gamma}$ and $\zeta^{RR} < \zeta^{SR}$.

LEMMA 2. *For the W-M regulator:*

(1) *The closure policy is credible if* $\zeta^{SR} < -(p_2r^r - 1)$ *and* $\bar{\gamma} < \gamma$.

(2) *The forbearance policy is credible if any of the following conditions holds*: (*i*) $\gamma < \underline{\gamma}$; (*ii*) $\underline{\gamma} < \gamma < \bar{\gamma}$ *and* $-(p_2r^r - 1) < \zeta^{SR}$; *or* (*iii*) $\bar{\gamma} < \gamma$ *and* $-(p_2r^r - 1) < \zeta^{RR}$.

(3) *The incentive policy is credible if* $\bar{\gamma} < \gamma$ *and* $\zeta^{RR} < -(p_2r^r - 1) < \zeta^{SR}$.

(4) *The preemptive policy is credible if* $\underline{\gamma} < \gamma < \bar{\gamma}$ *and* $\zeta^{SR} < -(p_2r^r - 1)$.

A necessary condition for the W-M regulator to close the bank (i.e., for the *closure*, *incentive*, or *preemptive* policies to be credible) is that the second-period risky project have a negative expected value, i.e., $p_2r^r - 1 < 0$.

LEMMA 3. *For the C-M regulator, let* $\phi \equiv [(1 - p_1)p_2 + p_1(1 - p_2)](r^r - 2) - 2(1 - p_1)(1 - p_2) + (1 - p_1)$.

(1) *The closure policy is credible if* $\chi^{SR} < -(1 - p_2)(r^s - 2)$, $\bar{\gamma} < \gamma$, *and* $\chi^{RR} < -\phi$.

(2) *The forbearance policy is credible if any of the following conditions holds*: (*i*) $\gamma < \underline{\gamma}$; (*ii*) $\underline{\gamma} < \gamma < \bar{\gamma}$ *and* $-(1 - p_2)(r^s - 2) < \chi^{SR}$; *or* (*iii*) $\bar{\gamma} < \gamma$, $-(1 - p_2)(r^s - 2) < \chi^{SR}$, *and* $-\phi < \chi^{RR}$.

(3) *The incentive policy is credible if* $\bar{\gamma} < \gamma$, $-(1 - p_2)(r^s - 2) < \chi^{SR}$, *and* $\chi^{RR} < -\phi$.

(4) *The preemptive policy is credible if either of the following conditions holds*: (*i*) $\underline{\gamma} < \gamma < \bar{\gamma}$ *and* $\chi^{SR} < -(1 - p_2)(r^s - 2)$; *or* (*ii*) $\bar{\gamma} < \gamma$, $\chi^{SR} < -(1 - p_2)(r^s - 2)$, *and* $-\phi < \chi^{RR}$.

TABLE Ia

SUBGAME PERFECT EQUILIBRIUM WITH A W-M REGULATOR WHEN $p_2 < p_1$

Parameter values			Regulator's policy	Outc with
				Wit
1. $\gamma < (2 - p_1)/p_1$			Forbearance	$(SS,$
2. $(2 - p_1)/p_1 < \gamma < \underline{\gamma}$			Forbearance	$(RS,$
3. $\underline{\gamma} < \gamma < \bar{\gamma}$,	$-(p_2 r^r - 1) < \zeta^{SR}$		Forbearance	$(RS,$
4. $\underline{\bar{\gamma}} < \gamma < \bar{\gamma}$,	$\zeta^{SR} < -(p_2 r^r - 1)$		Preemptive	$(RS,$
5. $\bar{\gamma} < \gamma$,	$-(p_2 r^r - 1) < \zeta^{RR}$		Forbearance	$(RR,$
6. $\bar{\gamma} < \gamma$,	$\zeta^{RR} < -(p_2 r^r - 1) < \zeta^{SR}$,	$\hat{\gamma} < p_2/(p_1 - p_2)$	Incentive	$(SR,$
7. $\bar{\gamma} < \gamma$,	$\zeta^{RR} < -(p_2 r^r - 1) < \zeta^{SR}$,	$p_2/(p_1 - p_2) < \hat{\gamma}$	Incentive	$(R, C$
8. $\bar{\gamma} < \gamma$,	$\zeta^{SR} < -(p_2 r^r - 1)$		Closure	$(R, C$

Note. $\gamma \equiv (r^r - 1)/(r^s - 1)$, $\underline{\gamma} \equiv (2 - p_2)/p_2$, $\bar{\gamma} \equiv 1/(2p_2 - 1)$, $\hat{\gamma} \equiv \gamma - [p_1 c_a/(r^s - 1)(p_1 - p_2)]$.

5. BANK'S RESPONSE TO CREDIBLE POLICIES OF THE REGULATOR

Given the results in the previous section, it is straightforward to calculate the bank's period-1 asset choice. Tables Ia and Ib completely describe the subgame perfect equilibrium when the regulator is welfare maximizing. Tables IIa and IIb do the same for the regulator that is cost minimizing.

LEMMA 4. *The subgame perfect equilibrium for the case of the W-M regulator is described in Tables Ia and Ib.*

Proof. Consider first $p_2 < p_1$. Lemma 2 describes the credible strategies of the W-M regulator. Most of the rows of Table Ia then follow directly; rows 6 and 7 require checking. The equilibrium outcomes for rows 6 and 7 follow, since the bank earns higher expected profits from (SR, O) then from (R, C) if and only if $p_1(r^r - 1 - c_a) < p_2(r^s + r^r - 2)$, i.e., $\hat{\gamma} < p_2/(p_1 - p_2)$.

Consider now $p_1 < p_2$. The only cases in Table Ib that require checking are rows 3 and 8. In row 3, the regulator's policy is preemptive, so that the bank is comparing the outcome (S, C) with (RS, O). The outcome (RS, O) yields higher expected profits if $r^s - 1 < p_1(r^r - 1 + r^s - 1)$, i.e., if $(1 - p_1)/p_1 < \gamma$. This inequality holds for the parameter values in row 3 because $\underline{\gamma} < \gamma$ and $(1 - p_1)/p_1 < \underline{\gamma}$ (since $\frac{1}{2} < p_1$ and $p_2 < 1$). The outcome in row 8 follows because the bank earns higher expected profits from (SR, O) than from (R, C), since $-p_2/(p_2 - p_1) < \gamma$.

Q.E.D.

TABLE Ib

SUBGAME PERFECT EQUILIBRIUM WITH A W-M REGULATOR WHEN $p_1 < p_2$

Parameter values		Regulator's policy	Outcomes with and without regulator: With	Without
1. $\gamma < \underline{\gamma}$		Forbearance	(SS, O)	SS
2. $\underline{\gamma} < \gamma < \bar{\gamma}$,	$-(p_2 r^r - 1) < \zeta^{SR}$	Forbearance	(SR, O)	SR
3. $\underline{\gamma} < \gamma < \bar{\gamma}$,	$\zeta^{SR} < -(p_2 r^r - 1)$	Preemptive	(RS, O)	SR
4. $\bar{\gamma} < \gamma < 1/(2p_1 - 1)$,	$-(p_2 r^r - 1) < \zeta^{RR}$	Forbearance	(SR, O)	SR
5. $\bar{\gamma} < \gamma < 1/(2p_1 - 1)$,	$\zeta^{RR} < -(p_2 r^r - 1) < \zeta^{SR}$	Incentive	(SR, O)	SR
6. $\bar{\gamma} < \gamma < 1/(2p_1 - 1)$,	$\zeta^{SR} < -(p_2 r^r - 1)$	Closure	(R, C)	SR
7. $1/(2p_1 - 1) < \gamma$,	$-(p_2 r^r - 1) < \zeta^{RR}$	Forbearance	(RR, O)	RR
8. $1/(2p_1 - 1) < \gamma$,	$\zeta^{RR} < -(p_2 r^r - 1) < \zeta^{SR}$	Incentive	(SR, O)	RR
9. $1/(2p_1 - 1) < \gamma$,	$\zeta^{SR} < -(p_2 r^r - 1)$	Closure	(R, C)	RR

Note. $\gamma \equiv (r^r - 1)/(r^s - 1)$, $\underline{\gamma} \equiv (2 - p_2)/p_2$, $\bar{\gamma} \equiv 1/(2p_2 - 1)$.

TABLE IIa

SUBGAME PERFECT EQUILIBRIUM WITH A C-M REGULATOR WHEN $p_2 < p_1$

Parameter values			Regulator's policy	Outcomes with and without regulator: With	Outcomes with and without regulator: Without
1. $\gamma < (2 - p_1)/p_1$			Forbearance	(SS, O)	SS
2. $(2 - p_1)/p_1 < \gamma < \underline{\gamma}$			Forbearance	(RS, O)	RS
3. $\underline{\gamma} < \gamma < \bar{\gamma}$,	$-(1 - p_2)(r^s - 2) < \chi^{SR}$		Forbearance	(RS, O)	RS
4. $\bar{\underline{\gamma}} < \gamma < \bar{\gamma}$,	$\chi^{SR} < -(1 - p_2)(r^s - 2)$		Preemptive	(RS, O)	RS
5. $\bar{\gamma} < \gamma$, $-\phi < \chi^{RR}$,	$-(1 - p_2)(r^s - 2) < \chi^{SR}$		Forbearance	(RR, O)	RR
6. $\bar{\gamma} < \gamma$, $-\phi < \chi^{RR}$,	$\chi^{SR} < -(1 - p_2)(r^s - 2)$		Preemptive	(RR, O)	RR
7. $\bar{\gamma} < \gamma$, $\chi^{RR} < -\phi$	$-(1 - p_2)(r^s - 2) < \chi^{SR}$,	$\hat{\gamma} < p_2/(p_1 - p_2)$	Incentive	(SR, O)	RR
8. $\bar{\gamma} < \gamma$, $\chi^{RR} < -\phi$	$-(1 - p_2)(r^s - 2) < \chi^{SR}$,	$p_2/(p_1 - p_2) < \hat{\gamma}$	Incentive	(R, C)	RR
9. $\bar{\gamma} < \gamma$, $\chi^{RR} < -\phi$	$\chi^{SR} < -(1 - p_2)(r^s - 2)$		Closure	(R, C)	RR

Note. $\gamma \equiv (r^r - 1)/(r^s - 1)$, $\underline{\gamma} \equiv (2 - p_2)/p_2$, $\bar{\gamma} \equiv 1/(2p_2 - 1)$, $\hat{\gamma} \equiv \gamma - [p_1 c_a/(p_1 - p_2)(r^s - 1)]$, $\phi \equiv [(1 - p_1)p_2 + p_1(1 - p_2)](r^r - 2) - 2(1 - p_1)(1 - p_2) + (1 - p_1)$.

LEMMA 5. *The subgame perfect equilibrium for the case of the C-M regulator is described in Tables IIa and IIb.*

Proof. Consider first $p_2 < p_1$. Lemma 3 describes the credible strategies of the C-M regulator. Most of the rows in Table IIa then follow directly; rows 7 and 8 require checking. The equilibrium outcomes given in rows 7 and 8 follow, since the bank earns higher expected profits from (SR, O) then from (R, C) if and only if $p_1(r^r - 1 - c_a) < p_2(r^s + r^r - 2)$, i.e., $\hat{\gamma} < p_2/(p_1 - p_2)$.

Consider now $p_1 < p_2$. The cases in Table IIb that require checking are rows 3, 5, and 10. In row 3, the regulator's policy is preemptive, so that the bank is comparing the outcome (S, C) with (RS, O). The outcome (RS, O) yields higher expected profits if $r^s - 1 < p_1(r^r - 1 + r^s - 1)$, i.e., if $(1 - p_1)/p_1 < \gamma$. This inequality holds for the parameter values in row 3 because $\underline{\gamma} < \gamma$ and $(1 - p_1)/p_1 < \underline{\gamma}$ (since $\frac{1}{2} < p_1$ and $p_2 < 1$). Similarly, in row 5, the regulator's policy is preemptive. Here, the bank is comparing the outcome (S, C) with the outcome (RR, O). The outcome (RR, O) yields higher expected profits if $r^s - 1 < p_1p_2(r^r - 1 + r^r - 1)$, i.e., if $1/2p_1p_2 < \gamma$. This inequality holds for parameter values in row 5 because $\bar{\gamma} < \gamma$ in this region and $1/2p_1p_2 < \bar{\gamma}$. Finally, the outcome in row 10 follows because the bank earns higher expected profits from (SR, O) than from (R, C), since $-p_2/(p_2 - p_1) < \gamma$.

Q.E.D.

For comparison, in each table we also show the result of Lemma 6, the bank's optimal choice in the absence of a regulator (but still with deposit insurance).

TABLE IIb
SUBGAME PERFECT EQUILIBRIUM WITH A C-M REGULATOR WHEN $p_1 < p_2$

Parameter values			Regulator's policy	Outcomes with and without regulator: With	Without
1. $\gamma < \underline{\gamma}$			Forbearance	(SS, O)	SS
2. $\underline{\gamma} < \gamma < \bar{\gamma}$,		$-(1 - p_2)(r^s - 2) < \chi^{SR}$	Forbearance	(SR, O)	SR
3. $\underline{\gamma} < \gamma < \bar{\gamma}$,		$\chi^{SR} < -(1 - p_2)(r^s - 2)$	Preemptive	(RS, O)	SR
4. $\bar{\gamma} < \gamma < 1/(2p_1 - 1)$,	$-\phi < \chi^{RR}$,	$-(1 - p_2)(r^s - 2) < \chi^{SR}$	Forbearance	(SR, O)	SR
5. $\bar{\gamma} < \gamma < 1/(2p_1 - 1)$,	$-\phi < \chi^{RR}$,	$\chi^{SR} < -(1 - p_2)(r^s - 2)$	Preemptive	(RR, O)	SR
6. $\bar{\gamma} < \gamma < 1/(2p_1 - 1)$,	$\chi^{RR} < -\phi$,	$-(1 - p_2)(r^s - 2) < \chi^{SR}$	Incentive	(SR, O)	SR
7. $\bar{\gamma} < \gamma < 1/(2p_1 - 1)$,	$\chi^{RR} < -\phi$,	$\chi^{SR} < -(1 - p_2)(r^s - 2)$	Closure	(R, C)	SR
8. $1/(2p_1 - 1) < \gamma$,	$-\phi < \chi^{RR}$,	$-(1 - p_2)(r^s - 2) < \chi^{SR}$	Forbearance	(RR, O)	RR
9. $1/(2p_1 - 1) < \gamma$,	$-\phi < \chi^{RR}$,	$\chi^{SR} < -(1 - p_2)(r^s - 2)$	Preemptive	(RR, O)	RR
10. $1/(2p_1 - 1) < \gamma$,	$\chi^{RR} < -\phi$,	$-(1 - p_2)(r^s - 2) < \chi^{SR}$	Incentive	(SR, O)	RR
11. $1/(2p_1 - 1) < \gamma$,	$\chi^{RR} < -\phi$,	$\chi^{SR} < -(1 - p_2)(r^s - 2)$	Closure	(R, C)	RR

Note. $\gamma \equiv (r^r - 1)/(r^s - 1)$, $\underline{\gamma} \equiv (2 - p_2)/p_2$, $\bar{\gamma} \equiv 1/(2p_2 - 1)$, $\phi \equiv [(1 - p_1)p_2 + p_1(1 - p_2)](r^r - 2) - 2(1 - p_1)(1 - p_2) + (1 - p_1)$.

LEMMA 6. *If the regulator cannot close the bank, the bank's optimal portfolio is*:

$$\begin{array}{lll} SS, & \text{if } \gamma < \min\left[\dfrac{2-p_1}{p_1}, \underline{\gamma}\right], \\ RS, & \text{if } p_2 < p_1 \text{ and } \dfrac{2-p_1}{p_1} < \gamma < \bar{\gamma}, \\ SR, & \text{if } p_1 < p_2 \text{ and } \underline{\gamma} < \gamma < \dfrac{1}{2p_1 - 1}, \\ RR, & \text{if } \max\left[\dfrac{1}{2p_1-1}, \bar{\gamma}\right] < \gamma. \end{array}$$

Even though the bank would prefer the risky asset to the safe one, if it can choose only one asset (by A3), it will sometimes choose safe assets because, by A4, a loss on one of the assets is large enough to wipe out gains from the other. Thus, if the potential gains on the risky asset when it pays off are small relative to the gains on the safe asset (i.e., γ is small), the bank is induced to take the first-best action SS. Either type of regulator will leave the bank open in both periods in this case.

The bank trades off the gain on the risky asset *should it pay off* relative to that on the safe asset (i.e., γ) against the probability that the risky asset pays off. As γ increases, the potential gain on the risky asset increases relative to the gain on the safe asset sufficiently to compensate the bank for taking the risk. For very high γ, the bank desires the risky assets in both periods. For γ in the mid-range, the bank desires one of the risky assets, with the bank preferring to take on risk when the probability of success is higher.

6. ANALYSIS OF THE EQUILIBRIUM

We now analyze the equilibrium in terms of the social welfare of the possible outcomes. Let w^{jk} represent the social welfare of the outcome of the bank choosing asset j at $t = 1$ and asset k at $t = 2$, and let w^i represent the social welfare of the outcome of the bank choosing asset i at $t = 1$ and then being closed at $t = 1\frac{1}{2}$. Then,

$$\begin{aligned} w^{SS} &= 2(r^s - 1), \\ w^{RS} &= (p_1 r^r - 1) + (r^s - 1) - (1 - p_1)c, \\ w^{SR} &= (p_2 r^r - 1) + (r^s - 1) - (1 - p_2)c, \\ w^{RR} &= (p_1 r^r - 1) + (p_2 r^r - 1) - (1 - p_1 p_2)c, \end{aligned}$$

$$w^R = (p_1 r^r - 1) - c,$$

$$w^S = (r^s - 1) - c.$$

Note that for $p_2 < p_1$, $w^{RR} < w^{SR} < w^{RS} < w^{SS}$, and for $p_1 < p_2$, $w^{RR} < w^{RS} < w^{SR} < w^{SS}$.

There are several interesting features of the subgame perfect equilibrium for each type of regulator.

(1) If the bank is going to choose S at $t = 2$, then the bank is never closed. Delaying closure always yields benefits with respect to the costs of closure, since closure may not be necessary at $t = T$, and if the bank was going to choose S at $t = 2$, there is no cost of delaying closure from either regulator's viewpoint—the certain return on the project chosen at $t = 2$ offsets any loss on the project chosen at $t = 1$.

(2) *Forbearance* can be a credible strategy for the regulator, and it may lead to the socially optimal outcome. See row 1 of the tables. This requires that the gain from a risky asset when it pays off not be too large relative to the safe asset's payoff, i.e., $\gamma < \underline{\gamma}$.[14] Even if forbearance does not lead to the socially optimal outcome, it can still be credible (row 2, for example), and it can be credible even if the costs of closing the bank are zero. The avoidance of costs is not necessary to explain regulatory forbearance.

(3) If $p_2 < p_1$, then the existence of a regulator can never lower welfare, and may sometimes increase it. To see this, compare the social welfare from the equilibrium outcome, which is given in the fourth column of Table Ia or IIa, with the social welfare from the outcome that would occur without the regulator (but still with deposit insurance), given in the last column of each table, and consider row 6 of Table Ia. Here, the outcome without the W-M regulator is RR, but the outcome with the regulator is (SR, O). This higher welfare outcome is achieved by the regulator using the *incentive* policy, closing the bank if it chooses R at $t = 1$ to prevent the bank from choosing R at $t = 2$ (since $w^R > w^{RR}$). This threat induces the bank to select S in period 1, and the regulator responds by leaving the bank open. The same thing happens with the C-M regulator: consider row 7 of Table IIa.

(4) If $p_1 < p_2$, then the existence of the regulator may lower welfare. This occurs precisely because of the inability of the regulator to commit to a policy. Consider row 3 of Table Ib. In this case, social welfare is higher with SR, the outcome if there were no regulator, than with outcome (RS, O), the equilibrium outcome with the W-M regulator. Observe that the W-M regulator uses the *preemptive* policy, closing the bank if it chose S at $t = 1$ to prevent the bank from choosing R at $t = 2$ (since $w^S > w^{SR}$).

[14] In the S&L industry, forbearance was practiced at the same time S&Ls were being permitted to invest in riskier assets, with larger potential payoffs.

But the bank, taking this into account, chooses R at $t = 1$. The regulator's new choice, then, is between (R, C) and (RS, O), since once the bank chooses R at $t = 1$, it will choose S at $t = 2$ if permitted to continue. Since $w^R < w^{RS}$ in this region of the parameter space, the regulator allows the bank to continue. While society would be better off if the regulator could commit to not closing the bank once the bank chose S at $t = 1$, this is not a credible commitment.

For a similar reason, the C-M regulator can also lower welfare when it uses the *preemptive* policy (see row 5 of Table IIb). In addition, the C-M regulator's use of the *closure* policy can also lower welfare. This results from the C-M regulator's caring only about its own costs rather than society's welfare. Consider row 7 of Table IIb. Here, the outcome without the regulator would be SR, and with the regulator, it is (R, C). *Closure* is credible because the bank will choose R at $t = 2$, and therefore, the regulator's expected depositor payout is high enough to induce the C-M regulator to close the bank regardless of its choice at $t = 1$.

7. POLICY IMPLICATIONS

7.1. *Too-Big-to-Fail*

One would expect the unrecoverable cost of closure, $c - c_a$, to be related to the size of the bank being closed. Although our model is very simple, investigating how the equilibrium changes as c increases (keeping c_a fixed) provides some insight into what might be expected as the industry continues to consolidate and the average bank size increases. Results of the comparative statics exercise on c indicate that *forbearance* becomes credible over a larger part of the parameter space, while *closure* becomes less credible.[15] This is to be expected, since as the closure cost increases, the benefit of delaying closure, ζ^{jk} for the W-M regulator and χ^{jk} for the C-M regulator, increases. Note that since the *preemptive* policy

[15] For example, consider $p_2 < p_1$ and the W-M regulator (Table Ia). An increase in c increases the expected benefits of delaying closure (ζ^{SR} and ζ^{RR}), since if the bank is permitted to continue operating, its assets might pay off and the regulator would, therefore, avoid the now higher closure cost. Since it is more likely that a bank that selects RR will fail than a bank that selects SR, it is less likely that the regulator will be able to avoid closing a bank that prefers RR than a bank that prefers SR. Hence, the effect of a rise in c on the expected benefits of delaying closure is smaller when the bank's choice is RR than when it is SR. Also note that an increase in c has no effect on the expected costs of delaying closure, since these costs are the regulator's expected depositor repayments. Examining Table Ia we see that as c increases, forbearance becomes credible over a larger area of the parameter space and, therefore, it becomes more likely, while closure becomes less likely. The area of the parameter space over which the incentive policy is credible also increases, but by less than the area where forbearance is credible.

is paired with the *forbearance* policy (e.g., see rows 3 and 4 of Table Ia), as c increases, the region where preemption is credible decreases. Also, since as c increases, the benefit of delaying closure when the bank chooses SR, ζ^{SR} (χ^{SR}), increases more than the benefit of delaying closure when the bank chooses RR, ζ^{RR} (χ^{RR}), the *incentive* policy becomes credible over a wider area of the parameter space as c increases (although the effect of an increase in c on the area where *forbearance* is credible is larger).

These results suggest that "too-big-to-fail" can characterize the equilibrium over large parts of the parameter space. Given that banks prefer the regulator to practice the forbearance policy, since they can pursue the projects they desire under this policy, banks would have an incentive to grow larger to disarm the regulator of credible policies regarding closure. This in turn can lead to excessive risk taking and so reduced welfare.

7.2. *Regulatory Discretion*

We observed earlier that under FDICIA there is still regulatory discretion on bank closure, even though the act sought to remove much of this discretion. A potential benefit of removing discretion is that closure threats are then credible. A potential drawback of removing discretion is that regulators are not permitted to treat previous actions of the banks as sunk; banks that might recover are closed.[16] To examine whether removing discretion would improve welfare, we also consider a regulatory policy of closing the bank at $t = 1\frac{1}{2}$ if and only if the expected value of the bank at that time is negative. In terms of the policies discussed above, this closure rule means that the *preemptive* and *closure* policies are never credible, since each involves closing the bank after it has chosen S at $t = 1$, and S has positive value. The *incentive* policy is credible if and only if $p_1 r^r - 1 < 0$ and *forbearance* is credible if and only if $p_1 r^r - 1 > 0$.

A complete listing of the equilibrium outcomes for $p_2 < p_1$ and $p_1 < p_2$ and for the W-M and C-M regulators is available from the authors; the results are easily summarized. When $p_2 < p_1$, tying the regulator's hands sometimes has no effect and sometimes improves welfare, but often decreases it. Removing the regulator's discretion can only increase welfare when the bank is induced to select the safe project over the risky project in period 1 to avoid closure and then selects the same project in period 2 that it would have chosen if the regulator had discretion. More often, if the closure threat induces the bank to select S over R at $t = 1$, the bank then switches from S to R at $t = 2$. So welfare decreases, since $w^{SR} < w^{RS}$

[16] Boot and Thakor (1993) show that the desire to build a reputation for successful monitoring may discourage a self-interested regulator from closing banks. Boot *et al.* (1993) study the costs and benefits of writing discretionary financial contracts.

when $p_2 < p_1$. If the closure threat does not induce the bank to switch its asset choice at $t = 1$ from R, then the bank is closed, a potentially profitable project is forgone at $t = 2$, and welfare decreases. In some cases, not permitting the regulator to close a bank when its expected return from the period-1 project is positive can also lower welfare, since the bank then chooses a risky project at $t = 2$.

When $p_1 < p_2$, removing the regulator's discretion often has no effect on welfare; it never reduces welfare, but can sometimes increase it. If the bank is going to choose a risky project, society prefers it to take the risk at $t = 2$ rather than at $t = 1$, and tying the regulator's hands achieves this. Here, if the closure threat induces the bank to select S over R at $t = 1$, the bank is allowed to remain open and welfare improves regardless of the bank's second-period asset choice. This is easy to see, since $w^R < w^{Sk}$, $k = S, R$; $w^{Rk} < w^{Sk}$, $k = S, R$; and $w^{RS} < w^{SR}$ when $p_1 < p_2$. In equilibrium, the bank is closed *less often* when the regulator lacks discretion.

These results suggest that the desirability of removing regulatory discretion depends on the economic environment in which banks are operating and, therefore, will not be a panacea. If the economy is expected to improve, then giving the regulator discretion may be beneficial.

8. ALLOWING THE REGULATOR TO MOVE FIRST

We have so far assumed that the regulator can close the bank only after the bank has made its period-1 asset choice. In this section we also allow the regulator to close the bank at $t = 0$. We assume that closing the bank at $t = 0$ still incurs the closure cost c.[17]

Consider first the W-M regulator who compares the social value of the projects funded by the bank with the cost of closing. If the outcome is SS when the bank is left open, then by the analysis in Section 5, the regulator will not close the bank at $t = 0$. In general, if a risky asset chosen by the bank that is permitted to operate is not too negative, then the regulator will let the bank continue operating at $t = 0$. The bounds on the value of the asset are determined by both the cost of closing and the value of any other project the bank might fund if allowed to operate. For example, if the outcome is (RS, O), then the bank will be left open at $t = 0$ if $p_1 r^r - 1 + r^s - 1 - (1 - p_1)c > -c$, i.e., if $-(p_1 r^r - 1) < r^s - 1 + p_1 c$. Similarly, if the outcome is (R, C) when the bank is left open at $t = 0$, so that it is closed at $t = 1\frac{1}{2}$ after the risky asset is chosen, then the bank will be left open at $t = 0$ if $p_1 r^r - 1 - c > -c$, i.e., the risky asset has positive

[17] While we have not modeled the preexisting deposits, we think of this closure cost as the cost of transferring the existing deposits to another bank when the bank is closed at $t = 0$.

expected value ($p_1 r^r - 1 > 0$). We spare the reader the tedious details where these comparisons introduce new (obvious) subcases into the outcomes described by Tables Ia and Ib. It is easy to verify that under the parameter restrictions in rows 1 and 6 of Table Ia and rows 1, 2, 4, 5, and 8 of Table Ib, the regulator will not close the bank at $t = 0$. In these cases, the bank chooses the safe asset in period 1, and the regulator does not want to close the bank at $t = 1\frac{1}{2}$. In all the other cases, there are two nontrivial possibilities, which depend upon the value of the period-1 risky asset.

Now consider the C-M regulator who compares the expected liability from not closing at $t = 0$ with the cost of closing. Clearly, if the outcome is SS if the bank is left open, then, again by the analysis in Section 5, the regulator will not close the bank at $t = 0$. In general, if a risky asset chosen by the bank that is permitted to operate has a sufficiently high probability of success, then the regulator will let the bank continue operating at $t = 0$. The bounds on the probability of success are determined by both the cost of closing and the value of any other project the bank may fund. For example, if the outcome is (RS, O), then the bank will be left open if $c > (1 - p_1)(2 - r^s + c)$, i.e., if $p_1 > (2 - r^s)/(2 - r^s + c)$. Similarly, if the outcome is (R, C) when the bank is left open at $t = 0$, so that it is closed at $t = 1\frac{1}{2}$ after the risky asset is chosen, then the bank will be left open at $t = 0$ if $c > (1 - p_1)(1 + c) + p_1(c - c_a)$, i.e., $p_1 > 1/(1 + c_a)$. Again, we spare the reader the tedious details. It is easy to verify that under the parameter restrictions in rows 1 and 7 of Table IIa and rows 1, 2, 4, 6, and 10 of Table IIb, the regulator will not close the bank at $t = 0$. In these cases, the bank chooses the safe asset in period 1, and the regulator does not want to close the bank at $t = 1\frac{1}{2}$. In all the other cases, there are two nontrivial possibilities, which again depend upon the probability of success of the period-1 risky asset.

9. RENEGOTIATION

If a bank is closed, the period-2 project is not undertaken. If this project is socially valuable, then a social cost results. At the same time, the bank prefers not to be closed. This raises the issue of renegotiation.[18] Renegotiation in this model is "costless" closure; i.e., while the cost, c, of closure is still incurred, the project is not forgone.

The obvious Pareto-improving contract is for the bank to respond to a closure threat by agreeing not to choose the risky project in period 2. However, this contract is not feasible. The moral-hazard problem that

[18] See Bolton (1990), Dewatripont and Maskin (1990), and Aghion *et al.* (1990) for an introduction to renegotiation in both adverse selection environments and those characterized by irreversibility of decisions.

underlies the banking problem is precisely the inability of the bank to commit to choosing the socially optimal project.

It is commonly argued that bad portfolios of banks lead them to choose socially undesirable projects. Thus, it might seem that a weaker form of renegotiation in which the regulator absorbed the unhealthy assets of the bank, leaving it with a healthy balance sheet, would be preferable to closing the bank. To clarify the issues, consider the following extension of the model. Suppose there are *two* risky assets available in period 2. The first risky asset, still denoted R, has the risk characteristics of the period-2 risky asset already studied. The second, denoted $\hat{R}$, has the potential of saving the bank even if the period-1 asset fails. Renegotiation is an issue if the following rankings hold: (1) a bank that chose the risky asset in period 1 prefers $\hat{R}$ over R and S in period 2, (2) a *de novo* bank prefers R to $\hat{R}$ and S in period 2, and (3) in period 2, the safe project has the highest expected value (and so is socially most desirable), followed by R, and then by $\hat{R}$. It is easy to verify, however, that if $p_1 > \frac{1}{2}$, then this configuration of preferences cannot occur; namely, if the *de novo* bank prefers R in period 2 then so would the bank that operates in both periods. This is quite intuitive. When $p_1 > \frac{1}{2}$, there is a better than even chance that the period-1 risky asset will pay off. So the incentive to choose a period-2 asset that, if it pays off, can "save the bank" is dominated by the single-period risk characteristics of the assets.

We now describe a modification of the model in which renegotiation is an issue. Suppose the information structure of the period-1 risky asset is changed as follows: After the period-1 choice, but before the closure decision is made, both bank and regulator receive a better estimate of the riskiness of the period-1 risky asset, if it had been chosen. While this new information does not *directly* affect the profitability of the period-1 assets, it does affect the optimality of period-2 choices.

The easiest way to model this information structure is to suppose that with some probability, say α_l, the period-1 risky asset has a return of r^r with probability p_1^l, and a return of 0 with probability $(1 - p_1^l)$, and with probability $(1 - \alpha_l)$, the period-1 risky asset has a return of r^r with probability p_1^h, and a return of 0 with probability $(1 - p_1^h)$, with $p_1^h > p_1^l$. Note that the gross return of the risky asset is either r^r or 0, irrespective of the value of p_1^κ, $\kappa = l$, h. When choosing period-1 assets, the bank assigns a probability of $\alpha_l p_1^l + (1 - \alpha_l)p_1^h$ to the risky asset paying a return of r^r. If the bank chose the period-1 risky asset, then before the closure decision, both bank and regulator learn the true probability of the risky asset paying r^r (which is either p_1^l or p_1^h).

We now illustrate the possibility for renegotiation with a numerical example. Suppose the safe asset, in either period, pays $r^s = 1.3$. The period-1 risky asset has characteristics $r^r = 1.7$, $\alpha_l = \frac{1}{2}$, $p_1^l = 0.3$, and $p_1^h = 0.9$. The less risky period-2 risky asset has $p_2 = 0.6$ and $r^r = 1.7$. The more risky period-2 asset has $\hat{r}^r = 3$ and $\hat{p}_2 = 0.2$. The costs of closure are $c = 0.01$ and $c_a = c$. Note that the ex ante characteristics of the period-1 risky asset are the same as those of the less risky period-2 asset.

It is straightforward but tedious to verify that in period 2, if the bank is open, it would choose the safe asset if, in period 1, it has chosen either the safe asset or the risky asset and it turns out to be of low risk. On the other hand, the bank will choose the more risky asset, $\hat{R}$, if it had chosen the risky asset in period 1 and it turns out to be of high risk. The W-M regulator's credible policy is to close the bank if and only if the bank had chosen the risky asset in period 1 and it turns out to be of high risk. The optimal period-1 asset choice (and so also the period-2 asset choice) for the bank is the safe asset, which is society's first best.

This equilibrium is not renegotiation proof: Consider period 2 after the bank had chosen the risky asset and both bank and regulator learn that this asset is of high risk. Since the low-risk period-2 asset has positive expected value (including closing costs), the W-M regulator prefers to absorb the downside of the period-1 asset, since then the bank would choose the less risky asset, R, in period 2, instead of $\hat{R}$. Since the bank retains rights to excess returns of the period-1 asset, the bank also prefers this outcome. Note, though, that if the bank anticipates this renegotiation, it will choose the risky asset in period 1, an outcome strictly worse from the W-M regulator's perspective than that without renegotiation.

We argue, however, that while renegotiation is an important issue for the extended model as strictly interpreted, there is no credible avenue for renegotiation. We are analyzing a snapshot of the regulator–bank interaction and have deliberately chosen a highly simplified model to study the issues we think are important. Consequently, the long-term repeated nature of the relationship between the regulator and banks is ignored. While renegotiation is plausible in a one-time decision, it is less so in a repeated decision scenario. As in our numerical example, the regulator often has an incentive to develop a reputation for *not* renegotiating. It is also clearly possible to write down a reputation model in which the regulator will not renegotiate (along the lines of Kreps *et al.* (1982), Kreps and Wilson (1982), and Milgrom and Roberts (1982)). Moreover, given the regulator's role in implementing public policy under scrutiny, it seems to us unlikely that a regulator will repeatedly bail out (ex post) bad decisions by private agents, with the public bearing the cost.

10. CONCLUSIONS

In this paper we have examined a regulator's incentives to close a bank, recognizing the opportunity cost of forgone intermediation if a bank is closed, and that a bank's risk taking will be influenced by the regulator's policy regarding bank closure. An important part of the analysis is that the interaction of the regulator and bank is dynamic and assets are long lived. The regulator knows the bank will be making future asset decisions if permitted to remain open. The bank understands that its current asset choice will affect the regulator's policy regarding closure. Thus, the regulator's policy will affect the risk-taking behavior of the bank. We obtain the following results: With long-lived assets, the regulator will not decide on closure using a simple cutoff rule on bank asset value. Taking the opportunity cost of forgone intermediation into account leads to more complicated regulatory behavior. It is not always optimal to close a bank with a negative expected value (i.e., the forbearance and preemptive policies can be credible) and it is not always optimal to permit a bank with a positive expected value to continue operating (i.e., the preemptive and closure policies can be credible).[19]

We considered two different objective functions for the regulator—maximizing society's welfare or minimizing the costs of closure—and found that even if the regulator acts to maximize society's welfare, the lack of commitment power on the part of the regulator leads to a second-best solution. If the regulator acts to minimize its costs, then an agency problem arises, since social welfare takes into account the bank's profits from its asset portfolio when the assets pay off, while the cost-minimizing regulator ignores these gains. Another possible source of agency problems is that the regulator may bear a cost when closing a bank beyond the resource cost and depositor bailout cost. This additional cost would reflect any undesirable consequence of closing the bank borne by the regulator—e.g., loss of future job prospects. This second source of agency problem would take us farther away from the second best attainable with the welfare-maximizing regulator and would tend to encourage the regulator to allow banks to remain open, as in Boot and Thakor (1993). These nonpecuniary costs may help explain regulatory forbearance during the S&L crisis.

We have studied a very simple model in which there are no contingent contracts (such as risk-based insurance premia) between the regulator and the bank. While we have not shown that the policies we describe are optimal when there is imperfect monitoring and adverse selection, and there is no reason to believe that they would be, we do believe that the structure of the regulator–bank relationship would include the characteristics we have described. With respect to the risk pricing of insurance premia, Chan *et al.* (1992) have argued that a fairly priced risk-sensitive

[19] Acharya and Dreyfus (1989) show in the context of a model with a competitive capital market, and free entry and competition in banking, that it can be optimal to close some solvent banks. They also show that in the absence of free entry, if the administrative costs of closure are sufficiently high, it is optimal to leave open insolvent banks.

deposit insurance premium schedule is not feasible in competitive banking markets. Moreover, John *et al.* (1991) argue that risk-related deposit insurance premia cannot solve the moral-hazard problem created by the bank's limited liability. This suggests, but does not prove, that the essential point of our analysis would not be invalidated.

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