The Role of Relative Performance in Bank Closure Decisions*

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September 10, 2003

Abstract

This paper studies a banking industry subject to common and idiosyncratic shocks. We compare two types of regulatory closure rules: (1) an 'absolute closure rule', which closes banks when their asset/liability ratios fall below a given threshold, and (2) a 'relative closure rule', which closes banks when their asset/liability ratios fall sufficiently below the industry average. There are two main results: First, relative closure rules imply forbearance during 'bad times', defined as adverse realizations of the common shock. This forbearance occurs for incentive reasons, not because of irreversibilities or political economy considerations. Second, relative closure rules are less costly to taxpayers, and these savings increase with the relative variance of the common shock. To evaluate the model, we estimate a panel-logit regression using a sample of U.S. commercial banks for the period 1992 through 1997. We find strong evidence that U.S. bank closures are based on relative performance. Individual and average asset/liability ratios are both significant predictors of bank closure.

J.E.L. Classification Number: G18, G21

Keywords: Bank regulation, forbearance, tournaments

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1. Introduction

A critical component of any bank regulatory package concerns the timing of bank closures, i.e., when exactly should regulators close or forcibly merge a bank? While other policies, like auditing, capital requirements, and deposit insurance are designed to contain the risks of trouble, bank failures do take place. By the principle of backward induction, how and under what circumstances banks expect to get closed has important consequences for how they behave before they get closed. An efficient closure policy should account for these incentive effects.

The goal of this paper, is to study the incentive effects of bank closure policy. In doing this, we abstract from all other aspects of bank regulation. We do this not only for analytical convenience, but also because our goal is rather modest. We do not attempt to formulate a set of incentive compatible policies that implement an informationally-constrained Pareto optimum. We merely want to compare the cost effectiveness, in terms of expected taxpayer liability, of alternative closure rules. We can do this without taking a stand on exactly what banks do, or should be doing. Instead, we just consider two general types of rules which are simple, transparent, and pragmatic. Both rules are designed to elicit the same response (i.e., risk) by banks. Given this, we can then ask the following question – For any desired level of bank risk, which closure rule is less costly?[1]

There are two key inputs to our analysis. The first is the assumption that banks are subject to both common and idiosyncratic shocks. Interest rate fluctuations provide one example of a common banking shock. The second key input is the assumption that regulators are unable to monitor perfectly bank portfolio

[1] There are studies that explore the interaction between bank closure policy and other policy instruments. For example, Acharya and Dreyfus ([1],1989) study the potential complementarities between deposit insurance pricing and bank closure policy. However, they assume symmetric information and focus their analysis on dynamics and timing issues, while we focus on moral hazard and incentives.

decisions.

Since bank actions are unobserved, closure policy must be based on ex-post realized outcomes. This confronts the regulator with a signal extraction problem. For incentive reasons, an efficient policy should attempt to distinguish between banks that are in trouble as a result of their own actions (i.e., moral hazard), and banks that were simply unlucky. While a policy of "prompt corrective action" can indeed discourage moral hazard and save the taxpayers money, it can also cause banks to be unduly cautious in the presence of idiosyncratic shocks. Alternatively, from a dual perspective, separating moral hazard from bad luck can achieve the same overall level of banking industry risk at lower (expected) cost to the taxpayer.[2]

We show that the key to separating moral hazard from bad luck is to base closure decisions on relative performance. With a large number of ex ante identical banks, relative performance is a good indicator of relative 'effort'.[3] Consequently, a rule which closes banks whenever their asset/liability ratios fall below the cross-sectional average by a given amount is superior to one based solely on each individual bank's asset/liability ratio.[4] An interesting implication of a rel-

[2]Recent literature [e.g. Berger, et al (1998), Flannery (1998)] have discussed the limits to government information and argued that private sector information could be superior in certain situations. To the extent that this is true, regulators would also want to incorporate the private information concerning relative performance in the manner modeled below.

[3]The advantages of relative performance contracts were first discussed in the labor literature. See, e.g., Lazear and Rosen ([22],1981) or Nalebuff and Stiglitz ([29],1983). It should be noted that while our model presumes ex ante identical banks, our empirical work attempts to control for one potentially important source of heterogeneity, namely, size.

[4]One might wonder whether such a rule would be consistent with the dictates of FDICIA, calling for 'prompt corrective action', and which contains no explicit reference to relative performance. However, as discussed in more detail by Mailath and Mester ([24],1994), the FDICIA also directs regulators to resolve troubled banks in the least costly way, and grants regulators a

ative closure rule is that it leads to forbearance during "bad times", defined as adverse realizations of the common shock. It is important to realize, however, that this forbearance occurs solely for ex ante incentive reasons, not because of irreversibilities or political economy considerations.[5]

In fact, if he could, our regulator would like to renege ex post on the announced relative closure rule once the bank's portfolio decision was made. The regulator would like to close unlucky banks in order to keep them from "gambling for resurrection". However, this finite-horizon time inconsistency problem would be mitigated in a repeated framework. In a repeated game, regulators would have an incentive to follow through on their announced closure policies if failing to do so would lead to loss of future credibility.[6] Moreover, legal and institutional constraints (e.g., FDICIA), even when they contain generous opt outs, undoubtedly provide some degree of commitment.

We are not the first to point out the potential incentive benefits of a relative closure rule for moral hazard reasons. Nagarajan and Sealey (1995) also make this point. Our value-added is to formulate the problem in a way that leads to empirically testable predictions. We do this by explicitly modeling a large number of banks subject to continuously distributed shocks, and by basing our closure rule on the cross-sectional average asset/liability ratio, as opposed to some notion of a 'market return'. One way to think of the difference is that our regulator is more concerned with accounting information, while the regulator in Nagarajan

large degree of discretion in deciding how to do this.

[5]Kane ([21],1989) discusses forbearance based on regulatory malfeasance. Demirguc-Kunt ([10],1991) and Fries, Mella-Barral, and Perraudin ([13],1997) analyze forbearance based on irreversibility and the resulting option value of waiting. Boot and Thakor ([8], 1993) base forbearance on a principal-agent problem between the bank regulator and the taxpayer.

[6]See Mailath and Mester ([24], 1994) for a detailed analysis of the time consistency problem in bank closure policy.

and Sealey's paper is more concerned with stock prices.[7]

Other arguments against constant regulatory rules have been made in the literature. Blum and Hellwig (1995) argue that capital adequacy regulations can reinforce macroeconomic fluctuations. In their model, economic downturns reduce the quality of bank balance sheets. Because their regulatory constraints are now more binding, banks respond by reducing their lending, exacerbating the economic downturn. A relative closure rule would mitigate this problem by easing the regulatory constraints faced by banks in aggregate downturns.

Other arguments in favor of state-contingent bank regulation have been made in the literature. For example, Blum and Hellwig (1995) argue that fixed capital requirements can accentuate macroeconomic fluctuations. In their model, economic downturns reduce the quality of bank balance sheets. Because regulatory constraints are now more binding, banks cut back their lending, which exacerbates the downturn. State-dependent capital requirements could mitigate this problem. More generally, our results relate to the literature on optimal bankruptcy procedures and the evaluation of Chapter 11 proceedings. For example, Baird (1991) argues that Chapter 11 protection can encourage managers to initiate bankruptcy procedures, while Aghion et al (1999) argue that strict bank closure policies can discourage managers from truthfully disclosing their bank's asset position, while Mooradian (1994) argues that Chapter 11 protection may serve as a mechanism for achieving a separating equilibrium, by making it prohibitively costly for inefficient firms to mimic efficient ones in debt restructurings.[8]

[7] Nagarajan and Sealey (1998) have recently extended this framework to a setting of adverse selection as well as moral hazard, although in this more recent analysis they only focus on the pricing of deposit insurance, not bank closure policy.

[8] The literature on the merits of Chapter 11 proceedings is mixed. Strict closure rules can provide managerial discipline, so that Chapter 11 protection of borrowers may exacerbate moral hazard problems [Gertner and Scharfstein (1991), Weiss and Wruck (1998)]. However, Chapter 11 protection may yield benefits when contracting technology is limited [Aghion and Bolton

To evaluate our model, we estimate a panel-logit regression using a sample of annual data for over 12,000 US commercial banks during the period 1992 through 1997.[9] We find strong evidence that US bank closures are based on relative performance. Our results demonstrate that both individual and average asset/liability ratios are significant predictors of bank closure, and their coefficient estimates are consistent with the theory. Moreover, the results are robust to the exclusion of small banks from the sample, as well as to the inclusion of other controlling variables. Overall, we conclude that relative performance is a valuable input to bank closure decisions, and that US bank regulators seem to be aware of this.

2. A Simple Model of Bank Closure

2.1. Bank investment decision

We begin with a very simple model of bank closure. We assume that there are an infinite number of homogenous banks of measure zero. We model a representative bank i, which decides the amount of "effort," μ_i, to invest in enhancing the quality of its asset portfolio.[10] The cost of supplying an amount of effort equal to μ is assumed to satisfy the function $V(\mu)$, where $V_\mu > 0$ and $V_{\mu\mu} > 0$. For simplicity, we assume that effort costs are borne up front. This simplifies the analysis by making this cost independent of the probability of bankruptcy, but drives none of our results.

(1992), Hart and Moore (1998), Berkovich, et al (1998), and Harris and Raviv (1995)].

[9] See Thomson (1991) for an empirical analysis of the determinants of bank closure during the 1980s. Interestingly, Thomson includes various measures of macroeconomic conditions, and finds that they are usually significant predictors of bank failure. However, he does not really discuss why these variables should be important.

[10] Similar frameworks for studying bank regulation can be found in Dewatripont and Tirole [9, (1993)] and Giammarino, Lewis and Sappington [15, (1993)].

There are two shocks; a common shock, θ, which affects all banks, and an idiosyncratic shock, ε_i, which falls on bank i alone.[11] We assume that ε_i and θ are distributed on the intervals $[\underline{\varepsilon}, \overline{\varepsilon}]$ and $[-\infty, +\infty]$ respectively.

The model has one period, although our analysis extends to the repeated case if shocks are i.i.d. The timing of the model is as follows: First, the regulator announces a closure rule. Next, the bank chooses its effort level, μ_i. At the end of the period, the shocks are realized and the value of bank assets minus liabilities are determined, which we define as A_i. We assume that A_i satisfies

$$A_i = \mu_i + \theta + \varepsilon_i \tag{2.1}$$

Finally, the regulator makes its closure decision consistent with its announced rule.

To make the model interesting, we assume the regulator only observes the total value of A_i, not the values of its components. We therefore limit the regulator to closure rules conditional on A_i. Moreover, as we noted in the introduction, we assume that the regulator can commit to a closure rule. Later we discuss the implications of constraining the regulator to time-consistent rules.

Banks are assumed to have limited liability, having zero value under bankruptcy. As in Marcus ([25],1984), we assume that if the bank is allowed to continue, it has a charter value. We allow the charter value, $C(\mu_i)$ to be increasing in current bank effort. The charter value represents the expected future profits from continued banking operations.

[11] We do not model the lending choices of banks directly. In particular, we do not allow banks to manipulate the relative importance of common and idiosyncratic shocks to their portfolios. While the literature has expressed some concern that banks will respond to tournaments by adjusting their portfolios to give less weight to idiosyncratic shocks [e.g. Goodhart, et al [16], 1998], it is difficult to see how such coordinated action could be sustained in a competitive banking system.

Define ε^* as the minimum realization of ε_i under which the regulator chooses to allow the bank to continue in operation. Clearly, ε^* will depend on the regulator's closure rule. Because regulators are constrained to follow closure rules based on A_i, their observable indicator of bank financial health, ε^* will in practice be the level of ε_i which yields the minimum value of A_i which does not result in closure. For now, we note that for all the closure rules we entertain below, ε^* is a decreasing function of both bank effort μ_i and the common shock θ, since A_i is increasing in both these arguments.

The representative bank's investment decision is to choose μ_i to maximize expected bank value net of effort cost, which is

$$\int_{-\infty}^{+\infty}\left[\int_{\varepsilon^*}^{\overline{\varepsilon}} [A_i + C(\mu_i)]\, f(\varepsilon)\, d\varepsilon\right] g(\theta)\, d\theta - V(\mu) \tag{2.2}$$

where $f(\cdot)$ is the density of ε and $g(\cdot)$ is the density of θ.

The bank's first-order condition satisfies

$$\int_{-\infty}^{+\infty}\left[\int_{\varepsilon^*}^{\overline{\varepsilon}} (1 + C_\mu)\, f(\varepsilon)\, d\varepsilon - \left(\frac{\partial \varepsilon^*}{\partial \mu_i}\right)(\mu_i + \theta + \varepsilon^* + C)\, f(\varepsilon^*)\right] g(\theta)\, d\theta = V_\mu \tag{2.3}$$

The two arguments on the left-hand side of equation 2.3 represent the marginal benefits of additional effort. The first term reflects the increased expected payoff in non-bankruptcy states, holding the probability of bankruptcy constant. The second term reflects the value of the change in the probability of bankruptcy which results from a marginal change in effort.

2.2. Case 1: Regulatory standard based on absolute performance

We first consider a closure rule based solely on absolute bank performance. Suppose that a bank is closed if

$$A_i \leq m \tag{2.4}$$

where $m = 0$ is obviously a special case where banks are closed on insolvency. Under this closure rule, ε^* satisfies

$$\varepsilon^* = m - \mu_i - \theta \tag{2.5}$$

and

$$\frac{\partial \varepsilon^*}{\partial \mu_i} = -1. \tag{2.6}$$

Substituting these into the bank's first-order condition, we obtain

$$(1 + C_\mu) \left[1 - \int_{-\infty}^{\infty} F(m - \mu_i - \theta) g(\theta) d\theta \right] = V_\mu - (m + C) f(\varepsilon^*). \tag{2.7}$$

Consider the special case $m = 0$, i.e. the closure rule is to close all banks on the loss of solvency. In this case, the bank's first-order condition becomes

$$\mu_i^p = V_\mu^{-1} \{(1 + C_\mu)(1 - E[F(-\mu_i^p - \theta)]) + Cf(-\mu_i^p - \theta)\} \tag{2.8}$$

where μ_i^p is the privately optimal choice of effort.

Now, suppose instead that one were trying to maximize the expected "social" stream of revenues from the bank plus bank charter value, net of effort costs. This stream would include expected regulatory liabilities under insolvency. The non-truncated stream of revenues is

$$\int_{-\infty}^{+\infty} \left[\int_{\underline{\varepsilon}}^{\overline{\varepsilon}} A_i f(\varepsilon) d\varepsilon + \int_{\varepsilon^*}^{\overline{\varepsilon}} Cf(\varepsilon) d\varepsilon \right] g(\theta) d\theta - V(\mu). \tag{2.9}$$

Defining μ^s to be the social optimum, the first-order condition for μ^s satisfies

$$\mu^s = V_\mu^{-1} \{1 + C + C_\mu (1 - E[F(-\mu_i^p - \theta)])\}. \tag{2.10}$$

A comparison of 2.8 and 2.10 leads to our first result

PROPOSITION 1: *With a closure rule based on insolvency, the level of privately chosen bank effort is below that consistent with maximizing the total "social revenue stream."*

The proof follows directly from the fact that $V_{\mu\mu} > 0$, since $f(-\mu_i^p - \theta) < 1$ and $E[F(-\mu_i^p - \theta)] > 0$. This is the standard moral hazard result with limited liability: Since its losses are bounded from below, the private bank chooses a lower level of effort because it does not share in the gains to returns in bankruptcy states. These are instead completely enjoyed by the regulator as a reduction in liabilities.

Also, note that when the level of effort is lower, the expected probability of bankruptcy, and hence the regulator's expected liability, will be higher.

2.3. Case 2: Bank is insured against common shocks by introducing relative performance

Next, we assume the regulator bases closure on relative performance. Before showing how this can enhance efficiency, we should emphasize that for simplicity we allow the bank to alter the mean of its net asset position, but not its variance. If banks can also (independently) choose the variance of their net asset positions then relative performance schemes can produce bad equilibria, in which contestants choose very risky actions and low effort levels.

For example, Hvide (2002) shows that if effort is costly but risk-taking is not, then it will be optimal for the contestants to choose maximally risky outcome distributions with very low effort. Intuitively, injecting a lot of variance into the outcome reduces the marginal benefit of effort, since the noise is so great, which then permits low effort levels to be sustained in equilibrium. This is optimal if effort is costly but risk-taking isn't. Alternatively, the literature has expressed some concern that banks will respond to tournaments by adjusting their portfolios to give less weight to idiosyncratic shocks [e.g. Goodhart, et al [16], 1998]. In both of these cases, the importance of adjustment of overall variance or the weight on idiosyncratic vs. common shocks will be dependent on the costliness to the bank of making such an adjustment. When such adjustments are costly, it is unlikely that much adjustment would take place in a uncoordinated environment.[12]

We assume that there are a large number of banks, so that the law of large number yields,

$$\theta = \overline{A} - \overline{\mu} \tag{2.11}$$

where $\overline{A}$ and $\overline{\mu}$ are the cross-sectional average levels of bank asset positions and efforts respectively. By equations 2.1 and 2.11, and since $E(\varepsilon_i) = 0$

$$E(\mu_i - \overline{\mu}) = A_i - \overline{A}. \tag{2.12}$$

By incorporating relative performance, then, the regulator can infer relative effort. We therefore posit a relative closure rule which satisfies[13]

$$A_i - \overline{A} \leq n \tag{2.13}$$

Under this closure rule

$$\varepsilon^* = n + \overline{\mu} - \mu_i \tag{2.14}$$

and

$$\frac{\partial \varepsilon^*}{\partial \mu_i} = -1. \tag{2.15}$$

substituting these into the first-order condition yields

$$\int_{n+\overline{\mu}-\mu_i}^{\overline{\varepsilon}} (1 + C_\mu) f(\varepsilon) \, d\varepsilon + [\overline{\mu} + E(\theta) + n + C] f(\varepsilon^*) = V_\mu. \tag{2.16}$$

[12] We thank one of the referees for alerting us to the pitfalls of tournaments when variance is endogenous. This referee also noted the danger of collusion when closure is based on relative performance.

In principle, this could also be a problem, but in practice we believe that banking is sufficiently competitive that the risk of mass collusion is minimal.

[13] The fact that the benchmark can be taken as the mean, rather than some more general weighting, depends on our homogeneity assumption. If banks differed by size or idiosyncratic risk, then it would no longer be optimal to use the mean as a benchmark. (See, e.g., Holmstrom (1982, pg. 337)).

In equilibrium, since banks are homogenous, all banks make the same effort decision and the first-order condition will satisfy

$$\int_{n}^{\bar{\varepsilon}} (1 + C_\mu) f(\varepsilon)\, d\varepsilon + [\mu_i + E(\theta) + n + C] f(\varepsilon^*) = V_\mu. \qquad (2.17)$$

Note that our model does not allow banks to manipulate the relative importance of common and idiosyncratic shocks to their portfolios. While the literature has expressed some concern that banks will respond to tournaments by adjusting their portfolios to give less weight to idiosyncratic shocks [e.g. Goodhart, et al [16], 1998], it is difficult to see how such coordinated action could be sustained in a competitive banking system.

2.4. Comparison of absolute and relative closure rules

In this sub-section, we compare the two closure rules. To allow for a common basis of comparison, we first find the relative closure rule which elicits the same level of effort as the absolute closure rule. We then compare the expected liability of the regulatory institution under the two closure rules. We designate as preferable the rule which delivers a given level of bank effort with the lowest expected regulatory liability.

2.4.1. Relative stringency of the two closure rules

In order to obtain analytic solutions for the regulator's expected liability, we must put more structure on the distribution of ε_i. Accordingly, without essential loss of generality we assume from here on that ε_i is distributed uniformly on the interval $[\underline{\varepsilon}, \bar{\varepsilon}]$.

Define þ as the level of effort which satisfies equation 2.7, i.e. the equilibrium level of effort implied by the absolute closure rule in equation 2.4. When ε_i is uniformly distributed, 2.7 can be simplified to yield the following relationship between m and þ

$$m = \frac{\left[V_{\text{þ}} - Cf\left(\varepsilon^*\right)\right]\left(\overline{\varepsilon} - \underline{\varepsilon}\right) - \left[\overline{\varepsilon} + \text{þ} + E\left(\theta\right)\right]\left(1 + C_{\text{þ}}\right)}{f\left(\varepsilon^*\right)\left(\overline{\varepsilon} - \underline{\varepsilon}\right) - \left(1 + C_{\text{þ}}\right)} \tag{2.18}$$

Next, substituting into the solution above for the level of effort under the relative closure rule, equation 2.17, the value of n which results in banks choosing effort level þ satisfies

$$n = \frac{\left(\overline{\varepsilon} - \underline{\varepsilon}\right)\left[V_{\text{þ}} - \left[\text{þ} + E\left(\theta\right) + C\right]f\left(\varepsilon^*\right)\right] - \overline{\varepsilon}\left(1 + C_{\text{þ}}\right)}{f\left(\varepsilon^*\right)\left(\overline{\varepsilon} - \underline{\varepsilon}\right) - \left(1 + C_{\text{þ}}\right)}.$$

Combining, $m - n$ satisfies

$$m - n = \text{þ} + E\left(\theta\right) \tag{2.19}$$

To obtain some intuition about how these closure rules compare, define A^m and A^n as the minimum realizations of A_i necessary to avoid closure under the absolute and relative closure rules. By 2.4 and 2.13, it is clear that

$$A^m = m \tag{2.20}$$

and

$$A^n = n + \overline{A} \tag{2.21}$$

Substituting from equation 2.19, and 2.11, and using the fact that in equilibrium $\overline{\mu} = \text{þ}$,

$$A^n - A^m = \theta - E\left(\theta\right). \tag{2.22}$$

This leads to our second result:

PROPOSITION 2: *For a given level of bank effort, closure takes place at higher (lower) levels of A_i under the relative closure rule than under the absolute closure rule when θ exceeds (falls short of) its expected value.*

Intuitively, the proposition states that the relative closure rule will be more stringent in good times, i.e. when the common shock θ is above its mean, and more lenient in bad times.

Note that the implied "forbearance" has nothing to do with the opportunity cost of irreversibly shutting down banks, or with regulatory malfeasance. Rather, forbearance is advantageous here solely for ex-ante incentive reasons. Basing closure on relative performance allows the regulator to more accurately separate banks choosing low effort levels from unlucky banks. If a bank knows its effort level is likely to be detected and incorporated in the regulator's closure decision, it will choose a higher level of effort.

2.4.2. Comparing regulator liability

Finally, we turn to the relative liability of the bank regulator. Define L_m as the expected liability of the regulatory institution under the absolute closure policy which elicits level of effort $\hat{b}$. L_m satisfies[14]

$$L_m = -\int_{-\infty}^{+\infty}\int_{\underline{\varepsilon}}^{\varepsilon^*} A_i\left(\hat{b}, \theta, \varepsilon_i\right) f\left(\varepsilon_i\right) d\varepsilon_i g\left(\theta\right) d\theta \tag{2.23}$$

Substituting for ε^*, and using the relationship between m and n and the fact that ε_i is uniformly distributed

$$L_m = -\int_{-\infty}^{+\infty}\int_{\underline{\varepsilon}}^{n-\theta-E(\theta)} A_i\left(\hat{b}, \theta, \varepsilon_i\right) f\left(\varepsilon_i\right) d\varepsilon_i g\left(\theta\right) d\theta \tag{2.24}$$

Define L_n as the expected liability of the regulatory institution under the relative closure policy which elicits the same level of effort $(\hat{b})$. Substituting for

[14] Note that we do not consider the loss of bank charter value as part of the closure cost. This seems to be the natural specification, but the inclusion of charter loss would not change the results systematically with either closure rule anyway.

ε^* as above, L_n satisfies

$$L_n = -\int_{-\infty}^{+\infty}\int_{\underline{\varepsilon}}^{n} A_i\left(\hat{b},\theta,\varepsilon_i\right) f\left(\varepsilon_i\right) d\varepsilon_i g\left(\theta\right) d\theta \tag{2.25}$$

By 2.24 and 2.25

$$L_m - L_n = \int_{-\infty}^{+\infty}\int_{n-\theta-E(\theta)}^{n} A_i\left(\hat{b},\theta,\varepsilon_i\right) f\left(\varepsilon_i\right) d\varepsilon_i g\left(\theta\right) d\theta \tag{2.26}$$

Assuming that ε_i is distributed uniformly, this simplifies to

$$L_m - L_n = \frac{1}{2}\left(\frac{Var\left(\theta\right)}{\overline{\varepsilon}-\underline{\varepsilon}}\right). \tag{2.27}$$

This leads to our third result

PROPOSITION 3: *For closure rules which elicit the same level of bank effort, the relative closure rule has a smaller expected liability to the bank regulator than the absolute closure rule. Moreover, the cost advantage of the relative closure rule is increasing in the variance of the common shock and decreasing in the variance of the idiosyncratic shock.*

Note that this cost advantage implies that sustaining a relative closure rule is valuable to the regulator. In a repeated context, a standard trigger strategy argument can be used to show that concerns about losing these benefits in the future can induce a discretionary regulator to comply with the relative closure rule ex post.

3. Empirical Results

3.1. Estimation method

In this section, we investigate whether relative performance matters for bank closure decisions in the United States. Based on our theoretical model above, we formulate a binary choice model in which the regulator chooses at each point in time either failure or continuation of operations.

The definitions and sources for all variables used in this study are listed in Table 1. We represent the regulator's binary choice as a random variable F which takes the value one if the regulator chooses failure and the value zero if the bank is allowed to continue. Failure is defined as the end of a bank's existence whose resolution is arranged by the FDIC or other regulatory agency.

Our base specifications come directly from the theoretical model above. The base absolute closure rule specifies closure decisions as depending solely on a bank's current asset position, A_{it}. Our base relative closure rule specifies closure decisions as also depending on the average financial position of banks in period t, $\overline{A}_t$.

In addition to the base specifications, we add a number of conditioning variables commonly used in the literature to forecast bank closures [e.g. Wheelock and Wilson (2000)]. First, we introduce a variable to measure relative bank size. $SIZE_{it}$ is proxied by the book value of bank i in period t. It is widely believed that regulators might be more hesitant to close large banks in poor financial conditions because of the potential for adverse systemic implementations of large bank closures. Second, we introduce some proxies for sectoral exposure. $COMMERCIAL_{it}$ represents the share of commercial and industrial loans to total assets. $AGRICULTURE_{it}$ represents the share of agricultural loans as a share of total assets. $REALESTATE_{it}$ represents the share of total assets in the real estate sector. We introduce $NON-INTEREST_{it}$, the ratio of non-interest expenses to total assets, as an indicator of bank efficiency. As an indicator of the composition of bank liabilities, we introduce CD_{it}, the ratio of time deposits exceeding $100,000 as a share of total assets. This indicates the share of uninsured deposits. Finally, as an indicator of asset quality, we introduce $90DAYSLATE_{it}$, total loans and receivables past due 90 days or more as a share of total assets.

We measure A_{it} as the book value of the asset to liability ratio of bank i in period t. The use of book values is consistent with the maintained hypothesis that the bank regulator has imperfect information about individual banks' financial health.[15] Bank equity values would partially reflect the regulatory environment in which the bank operates, and hence would raise simultaneity problems in our specification. Finally, asset book values are used in practice by regulators use in closure decisions. The average financial position of banks in period t is represented by $\overline{A}_t$ the cross-sectional mean value of the book asset/liability ratios of banks in period t.[16]

The following binary model then nests both the absolute and relative closure rules, as well as the conditioning variables discussed above

$$\Pr(F = 1)_{it} = \gamma_t + \beta_1 A_{it} + \beta_2 \overline{A}_t + \beta_3 \xi_{it} + e_{it} \tag{3.1}$$

where γ_t represents a time dummy for period t, ξ_{it} is the vector containing the conditioning variables listed above, and e_{it} represents an i.i.d. disturbance term.[17] A prediction of the structural model above is that $\beta_1 = -\beta_2$.

[15] Book values are likely to measure the financial positions of banks with errors. However, market measures were unavailable due to the extremely small number of bank failures among banks that issue equity. Indeed, it appears clear that a sample of equity-issuing banks would have a selection bias towards helthy banks.

Concerning the errors in variables issue here, both A_i and $\overline{A}$ are likely to be measured with error. De Varo and Lacker (1995) demonstrate that the net effect in this case is still some attenuation towards zero.

[16] We also ran the specifications with the cross-sectional medians. These specifications yielded similar results and are available from the authors upon request.

[17] As no failures occured in 1996 or 1997, we do not include time dummies for these years to avoid perfect multicollinearity.

3.2. Data

The data set used in this study consists of a panel of annual data for 12,303 US commercial banks from 1992 through 1997. Starting with the FDICIA reforms of 1992, a relatively homogenous regulatory environment has existed over the course of this period.[18] All data was acquired for individual banks from the Federal Reserve Bank of Chicago's Bank Condition and Income Database.

Because banks both fail and come into existence over the course of our sample, the panel is not balanced. However, this should not lead to biases in the data because the missing variables due to entry or random exit (as in the case of an unassisted merger) are likely to be uncorrelated with the error term in our model. In the case where observations are missing because of bank failure, the reason for the missing data is precisely what we are attempting to identify in our model specification.

Summary statistics for the data are shown in Table 2. Our data set includes 113 bank failures over the 1992-1997 period. Because the number of failures in our sample is very small relative to the number of non-failures, we use a LOGIT specification in all our analysis. The LOGIT specification is insensitive to uneven sampling frequency problems [Maddala ([23], 1983)].

Two patterns stand out in the data. First, the average asset-to-liability ratio of the banking sector increases over the sample, implying an increase in the overall health of the banking system. Unsurprisingly, the number of bank failures diminishes over the panel, reflecting this increase in the financial system's overall health. 1992 is a particularly active year for bank failures, primarily reflecting

[18] While FDICIA was only formally passed by the United States Congress in December of 1992, it is clear that these reforms were already being incorporated in the closure decisions of bank regulators throughout the year. Indeed, the 1991 data also seems to reflect the stricter regulatory activity called for under FDICIA, although we left this year out of our reported sample to limit ourselves to the post-FDICIA period.

closures associated with the new tighter regulatory policies under FDICIA. However, even excluding 1992 it is clear that the number of bank failures diminishes over the sample. To rule out time-specific effects in the data stemming from these trends, we include time dummies, γ_t, in our specifications.[19]

3.3. Empirical Results

The results for LOGIT estimation of the entire sample are listed in Table 3. The first and second columns report the results for the base absolute and relative closure rule specifications respectively. Absolute bank performance, A_{it}, enters significantly with its predicted negative sign in both specifications. However, the coefficient estimate on absolute bank performance is sensitive to the inclusion or exclusion of a relative performance measure. In the specification including relative performance, its value almost doubles.

The mean industry performance measure included in the second column, $\overline{A}_t$ is also highly significant. Moreover, its value is of opposite sign and of the same order of magnitude as the coefficient estimate on A_{it}. The formal theory above predicts that these coefficients would be of equal and opposite sign, but we do not find that to be the case. We conducted likelihood ratio and Wald tests of this restriction, and both were strongly rejected. Nevertheless, the similarity in the magnitudes of these coefficients is supportive of the model above.

Comparing the base specifications, all of the regression diagnostics strongly favor the relative closure rule specification. Adding $\overline{A}_t$ to the specification reduces

[19] Because there are no failures in 1997, we are forced to drop two of the time dummies, one of which must be 1997, to allow for estimation. We include dummies for 1992 through 1995 in the specifications which yielded the results reported in Tables 3 and 4. Our results were not sensitive to which time dummies were included. Estimates of the coefficients on these time dummies, as well as those for specifications including alternative time dummies, are available from the authors upon request.

the Akaike Information Criteria statistic from 1,253.6 to 762.1. Similarly, the second specification lowers the Schwartz criterion from 1298.9 to 816.5 and the -2 log-likelihood from 1243.6 to 750.1. Likelihood ratio tests strongly reject the restriction that the coefficient on $\overline{A}_t$ is equal to zero at a one percent confidence level.

The relative rule specification also does a much better job of predicting bank failures. Under the rule that a bank failure is predicted for probability values greater than or equal to 50 percent, the absolute specification fails to predict any of the bank failures in the sample. In contrast, the relative rule predicts 27 of the 113 bank failures correctly, achieving a respectable level of Type-I error for such a parsimonious specification.

The third and fourth columns add the $SIZE_{it}$ variable to both specifications. A "too big to fail" theory of bank closure policy would suggest a negative coefficient on this variable, as regulators would resist closing large banks due to systemic concerns. While size does have the predicted negative coefficient estimate, it fails to achieve statistical significance in either specification, a disappointing performance in such a large sample. It may be that the impact of too-big-to-fail protection is non-linear, such that bank size is only relevant after banks become large enough that their failures would threaten the stability of the payments system.

More importantly for our purposes, our base specification results are robust to the consideration of bank size. A_{it} and $\overline{A}_t$ enter in the presence of a bank size variable with quite similar coefficient estimates as they obtained in the base specifications. Both are again highly significant and consistent with the prediction of the theory. Again, the diagnostic and classification statistics strongly support the relative closure rule specification over a simple absolute closure rule, although there is little improvement from the inclusion of the $SIZE_{it}$ variable. For the relative absolute closure rule specification (Models 2 and 4), likelihood ratio tests fail to reject the restriction that the coefficient on the $SIZE_{it}$ variable is equal to zero, although the restriction is rejected when comparing the absolute closure rule specifications (Models 1 and 3).

The fifth and sixth columns add the other conditioning variables to the specification. Of the sectoral exposure measures, the $COMMERCIAL_{it}$ and $REALESTATE_{it}$ variables are robustly positive and significant, suggesting that exposure to these sectors increasing the probability of bank closure. In contrast, the $AGRICULTURE_{it}$ variable is insignificant. Of the remaining conditioning variables, the CD_{it} and $90DAYSLATE_{it}$ variables both enter significantly with their predicted positive coefficients. The $NON-INTEREST_{it}$ variable is insignificant.

Again, the base specification results are robust to the inclusion of these conditioning variables. Again, A_{it} and $\overline{A}_t$ enter significantly with quite similar coefficient estimates to those that they obtained in the base specifications. Both are again highly significant. Finally, the diagnostic and classification statistics strongly support the relative closure rule specification over a simple absolute closure rule. Likelihood ratio tests do reject the restrictions that the coefficients on the additional conditioning variables are jointly equal to zero, although there is again little improvement from the inclusion of the $SIZE_{it}$ variable.

To investigate whether our results were driven by the large number of small banks in our sample, we re-ran the specification excluding banks which had less than \$50 million in book value of total assets during the sample period. This truncation reduced the number of both banking entities and bank failures in our specification roughly in half, from 12,303 to 6,052 and from 113 to 66 respectively. The results for this truncated sample are reported in Table 4.

The results are quite similar to those with the entire sample. The coefficient estimates are all highly significant and enter with their predicted signs. $\overline{A}_t$ enters significantly positive with a coefficient of opposite sign and a similar magnitude as the absolute performance measure, A_{it}.[20] Moreover, the diagnostic statistics strongly suggest a role for relative performance in regulatory closure decisions, as specifications including relative measures continue to outperform those excluding relative performance. The inclusion of the relative performance measure strongly enhances sample fit and reduces Type-I error.

Finally, the conditioning variables perform similarly to the entire sample. There is again little evidence that bank size is a useful predictor of bank closure. Bank size fails to enter significantly, and both specifications appear to be insensitive to its inclusion. Among the other conditioning variables, the $COMMERCIAL_{it}$ and CD_{it} variables are again robustly significant, while the $AGRICULTURE_{it}$, CD_{it}, and $NON-INTEREST_{it}$ variables again fail to enter significantly. The notable changes are in the $REALESTATE_{it}$ and $90DAYSLATE_{it}$ variables, which now fail to enter significantly under the relative closure rule specification (Models 4 and 6). This discrepancy probably reflects some degree of collinearity between these variables, which provide information about loan quality and a bank's relative performance.

Our empirical results give a strong indication that US regulators considered relative performance in their closure decisions during the post-FDICIA period. This finding is consistent with the desirable policy in the theoretical model above.[21] Moreover, the results are robust to the inclusion of the conditioning variables we consider as well as the exclusion of small banks from the sample.

[20]However, the two variables again fail to enter with equal and opposite coefficients estimates, which would satisfy a strong restriction implied by the formal model.

[21]However, relative performance might also be important for considerations outside of our model, such as the ex-post political-economy considerations discussed by Kane [[21], 1989].

4. Conclusion

This paper has examined the role of relative performance in bank closure decisions. We showed that when banks are subject to common shocks, a closure rule that incorporates relative performance will be less costly than one based solely on absolute performance. Our empirical results provide robust evidence that relative performance has indeed been considered in bank closure decisions in the United States during the post FDICIA period.

As we note earlier, neither the relative performance rule nor the absolute performance rule is time consistent in a static one-shot game. Instead, a regulator whose loss function solely involves minimizing expected taxpayer liability would always choose prompt closure when regulatory rules allow such behavior. As such, our empirical test should be viewed as a test of the joint hypothesis that the regulator would choose to pursue a relative closure policy and that he has the commitment capacity to do so. Our empirical results suggest that relative performance is incorporated in closure decisions, and therefore that some form of commitment is achieved. The source of this commitment poses interesting questions beyond the scope of this paper. An interesting extension of this paper would be to endogenize the commitment power of the regulator as a function of its closure strategy. One might conjecture that this would strengthen the superiority of a relative closure rule, because the regulator could more easily commit to the pursuit of a less costly closure strategy.

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Table 1: Variable Definitions and Sources

$FAIL$	-	Binary variable which takes value 1 when a bank fails and value 0 when a bank is allowed to continue. Failure occurs when a entity ceases to exist and its resolution was arranged by the FDIC, RTC, NCUA, State or other regulatory agency. Source: FRB Chicago Bank Condition and Income Database
A_{it}	-	Book value of total assets divided by book value of total liabilities. Total assets exclude loan loss reserves. Total liabilities exclude subordinated debt. Source: FRB Chicago Bank Condition and Income Database
$\overline{A}_t$	-	Average value of A_{it} for all entities in sample in a given year. Source: FRB Chicago Bank Condition and Income Database
$SIZE$	-	Book value of total assets excluding loan loss reserves Source: FRB Chicago Bank Condition and Income Database
Commercial	-	Commercial and Industrial loans / total assets Source: FRB Chicago Bank Condition and Income Database
Agricultural	-	Loans to finance agricultural production and other loans to farmers / total assets Source: FRB Chicago Bank Condition and Income Database
Real Estate	-	Loans secured by real estate / total assets Source: FRB Chicago Bank Condition and Income Database
Non Interest	-	Total non interest expense / total assets Source: FRB Chicago Bank Condition and Income Database
CDs	-	Total time deposits of $100,000 or more / total assets Source: FRB Chicago Bank Condition and Income Database
90 days late		Total loans and lease financing recievables: past due 90 days or more and still accruing / total assets Source: FRB Chicago Bank Condition and Income Database

Table 2: Summary Statistics[1]

Year	$\overline{A}_t$	Number of Bank Failures	Average value of A_{it} for Failed Banks
1992	1.103	70	1.023
1993	1.109	26	1.018
1994	1.110	9	1.039
1995	1.119	4	1.007
1996	1.123	4	1.013

[1] Source: Federal Reserve Bank of Chicago, Bank Condition and Income Database

Table 3: Logit Analysis Results: Entire Sample 1992-1997[1]
Dependent Variable: FAIL

Variables	Absolute Closure Rule	Relative Closure Rule	Absolute Closure Rule	Relative Closure Rule	Absolute Closure Rule	Relative Closure Rule
A_{it}	-43.42**	-92.32**	-43.50**	-92.07**	-32.59**	-90.56**
	(3.04)	(4.11)	(3.03)	(4.10)	(3.5)	(4.38)
$\overline{A}_t$		81.16**		81.02**		77.39**
		(3.88)		(3.87)		(4.07)
SIZE			-2.19E-7	-3.16E-7	-2.32E-7	-3.13E-7
			(1.88E-7)	(2.54E-7)	(2.0E-7)	(2.63E-7)
D92	41.76**	3.41**	41.90**	3.38**	28.02**	3.77**
	(3.23)	(.53)	(3.22)	(.53)	(3.79)	(.56)
D93	41.18**	3.11**	41.90**	3.07**	27.36**	3.33**
	(3.27)	(.56)	(3.22)	(.56)	(3.82)	(.59)
D94	40.26**	2.31**	40.40**	2.28**	26.44**	2.5**
	(3.29)	(.62)	(3.28)	(.62)	(3.85)	(.66)
D95	39.69**	1.05	39.85**	1.03	25.63**	1.18
	(3.33)	(.75)	(3.32)	(.76)	(3.88)	(.76)
Commercial					6.71**	5.98**
					(1.06)	(1.28)
Agricultural					-1.12	1.56
					(2.14)	(2.02)
Real Estate					2.55**	2.08**
					(.78)	(.80)
Non Interest					1.16	2.25
					(4.38)	(4.18)
CDs					3.71**	5.16**
					(1.49)	(1.78)
90 days late					35.91**	7.74
					(6.15)	(7.08)
Diagnostics						
AIC	1253.63	762.13	1252.43	760.87	1152.86	728.92
Schwartz	1298.89	816.45	1306.75	824.24	1261.50	846.61
-2 Log L	1243.63	750.13	1240.43	746.87	1128.86	702.92
#Obs	63135	63135	63135	63135	63135	63135
Pseudo R^2	.248	.546	.250	.548	.318	.575
Classification						
Type I error	107/113	86/113	107/113	85/113	104/113	83/113
Type II error	0	30	0	31	6	25
Total Correct	99.8%	99.8%	99.8%	99.8%	99.8	99.8%

[1]See Table 1 for variable definitions and sources. Standard errors are in parentheses. * and ** indicates Wald Chi-square statistic significant at 5% and 1% levels, respectively. Time dummies for years 1992 through 1995 were included in specification. Dummy coefficient estimates are available upon request from authors. Type II error figure represents the number of non-events incorrectly designated as events.

Table 4: Logit analysis: Small banks excluded 1992-1997[1]
Dependent Variable: FAIL

Variables	Absolute Closure Rule	Relative Closure Rule	Absolute Closure Rule	Relative Closure Rule	Absolute Closure Rule	Relative Closure Rule
A_{it}	-42.96**	-86.73**	-43.25**	-86.54**	-35.14**	-86.67**
	(4.27)	(5.07)	(4.26)	(5.05)	(4.81)	(5.37)
$\overline{A}_t$		76.70**		76.71**		75.01**
		(4.85)		(4.83)		(5.08)
SIZE			-2.75E-7	-4.4E-7	-2.68E-7	-4.57E-7
			(2.16E-7)	(2.92E-7)	(2.17E-7)	(3.06E-7)
D92	41.36**	3.35**	41.78**	3.33**	31.24**	3.61**
	(4.55)	(.75)	(4.53)	(.75)	(5.2)	(.80)
D93	40.45**	2.52**	40.87**	2.45**	30.23**	2.68**
	(4.61)	(.799)	(4.59)	(.80)	(5.25)	(.85)
D94	40.25**	2.47**	40.67**	2.41**	30.06**	2.59**
	(4.62)	(.81)	(4.61)	(.82)	(5.26)	(.86)
D95	39.11**	.90	39.55**	.85	28.68**	1.04
	(4.68)	(1.04)	(4.66)	(1.05)	(5.34)	(1.06)
Commercial					5.56**	5.18**
					(1.37)	(1.67)
Agricultural					-.93	2.33
					(4.01)	(3.52)
Real Estate					1.31	.84
					(.99)	(1.03)
Non Interest					6.15	7.86
					(5.32)	(5.15)
CDs					4.22**	4.97**
					(1.76)	(2.14)
90 days late					30.83**	.99
					(8.93)	(11.21)
Diagnostics						
AIC	728.168	490.82	726.18	487.85	695.3	480.02
Schwartz	769.9	540.90	776.25	546.28	795.45	588.53
-2 Log L	718.168	478.82	714.18	473.85	671.3	454.02
#Obs	31143	31143	31143	31143	31143	31143
Pseduo R^2	.239	.493	.243	.498	.289	.519
Classification						
Type I error	61/66	54/56	61/66	53/66	60/66	54/66
Type II error	0	21	0	20	2	20
Total Correct	99.8%	99.8%	99.8%	99.8%	99.8%	99.8%

[1]Excludes banks with total assets below $50 million at any time during sample period. * and ** indicates Wald Chi-square statistic significant at 5% and 1% levels,respectively. Time dummies for years 1992 through 1995 were included in specification. Dummy coefficient estimates are available upon request from authors. Type II error figure represents the number of non-events incorrectly designated as events.