

The Role of Relative Performance in Bank Closure Decisions¹

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March, 1999

Abstract. This paper studies a competitive banking industry subject to common and idiosyncratic shocks. The induced correlation across bank portfolio returns can be used by a regulator to improve inferences about bank portfolio choices. We compare two types of closure rules: (1) an ‘absolute closure rule’, which closes banks when their own individual asset/liability ratios fall below a given threshold, and (2) a ‘relative closure rule’, which closes banks when their asset/liability ratios fall below the industry average by a given amount.

Two main results emerge from the model. First, a relative closure rule implies 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, a relative closure rule is less costly to taxpayers, and the cost 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, and their coefficient estimates are consistent with the theory. We conclude that relative performance is a valuable input to bank closure decisions, and that U.S. bank regulators seem to be aware of this.

JEL Classification #'s: G18, G21.

¹We would like to thank Simon Kwan and Mark Levonian for helpful comments. Remaining errors are our own. We also thank Laura Haworth and Hiroshi Kokame for excellent research assistance. Please address correspondence to: Mark Spiegel, Research Department, Federal Reserve Bank of San Francisco, 101 Market Street, San Francisco, CA 94105.

1. Introduction

In the wake of recent financial turmoil, proposals for improved bank regulation are once again the topic of the day among economic policymakers. A critical component of any package of bank regulatory policies concerns the timing of bank closures, i.e., when exactly are regulators supposed to pull out the plug and close down (or forcibly merge) a bank? Other policies, like auditing, capital requirements, and deposit insurance are designed to keep banks out of trouble, or at least to contain the risks of trouble. Unfortunately, shocks happen, and 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, therefore, 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 some notion of 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

¹There are studies that explore the interaction between bank closure policy and other policy

There are two key inputs to our analysis. The first is the assumption that banks are subject to common and idiosyncratic shocks. This should not be a controversial assumption. While banks do tend to specialize, both geographically and in terms of the kinds of loans they make, there is undoubtedly correlation in the risks they face. Interest rate fluctuations provide one example. The second key input is the assumption that regulators are unable to monitor perfectly bank portfolio decisions. This too should be uncontroversial. After all, specialized knowledge about borrowers is the *raison d'être* of bank lending.

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.

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'.² We show

 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.

²The advantages of relative performance contracts were first discussed in the labor literature. See, e.g., Lazear and Rosen ([7],1981) or Nalebuff and Stiglitz ([14],1983). It should be noted

that 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.³ An interesting implication of a relative 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.⁴ In fact, if he could, our regulator would like to renege ex post on the announced relative closure rule. Having achieved his goal of getting banks to make the right portfolio decision, the regulator would then like to close unlucky banks in order to keep them from "gambling for resurrection".

Although time inconsistency is a potential problem, we regard the commitment issue as fundamentally an empirical one. Legal and institutional constraints (e.g., FDICIA), even when they contain generous opt outs, undoubtedly provide some degree of commitment. The real question is how much. To the extent that regulators lack credibility, our empirical results should reveal this by indicating the that while our model presumes ex ante identical banks, our empirical work attempts to control for one potentially important source of heterogeneity, namely, size.

³One 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 ([10],1994), the FDICIA also directs regulators to resolve troubled banks in the least costly way, and grants regulators a large degree of discretion in deciding how to do this.

⁴See Demirguc-Kunt ([3],1991) and Fries, Mella-Barral, and Perraudin ([4],1997) for analyses of forbearance based on irreversibility and the resulting option value of waiting. See Kane ([6],1989) for a discussion of forbearance based on regulatory malfeasance.

irrelevance of relative performance in closure decisions.⁵ Besides, it is well known that two-period models, like the one in this paper, provide unduly pessimistic predictions about time consistency problems, since they rule out intertemporal considerations (e.g., reputation building) that can sometimes overcome the temptation to renege.⁶

We should emphasize that we are not the first to point out the potential incentive benefits of a relative closure rule. 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 and Sealey’s paper is more concerned with stock prices. Still, our analysis should be regarded as an extension of their work.⁷

Finally, to evaluate the model, we estimate a panel-logit regression using a sample of over 12,000 US commercial banks during the period 1992 through 1997.⁸

⁵Of course, the converse isn’t necessarily true. That is, finding relative performance matters does not prove that regulators can commit, since relative performance might be important for ex post political economy reasons. See, e.g., Kane ([6], 1989).

⁶See Mailath and Mester ([10], 1994) for a detailed analysis of the time consistency problem in bank closure policy.

⁷Nagarajan 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.

⁸See Thomson (1991) for an empirical analysis of the determinants of bank closure during the 1980s. Interestingly, Thomson includes various measures of macroeconomic conditions, and

We find strong evidence that US bank closures are based on relative performance. 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 size as a controlling variable. 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.⁹ 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.

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

finds that they are usually significant predictors of bank failure. However, he does not really discuss why these variables should be important.

⁹Similar frameworks for studying bank regulation can be found in Dewatripont and Tirole [2, (1993)] and Giammarino, Lewis and Sappington [5, (1993)].

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 ([11],1984), we assume that if the bank is allowed to continue, it has a charter value of C , which is taken as exogenous.¹⁰ This represents the expected future profits from continued banking operations.

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.

¹⁰ C is taken as exogenous for simplicity. Levonian ([8],1991) has demonstrated that the impact of closure rules on bank behavior can be dependent on charter values.

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 satisfies

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

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

The bank's first-order condition satisfies

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

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

$$A_i \leq m \quad (2.4)$$

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

$$\varepsilon^* = m - \mu_i - \theta \quad (2.5)$$

and

$$\frac{\partial \varepsilon^*}{\partial \mu_i} = -1. \quad (2.6)$$

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

$$1 - \int_{-\infty}^{\infty} F(m - \mu_i - \theta) g(\theta) d\theta = V_\mu - (m + C) f(\varepsilon^*). \quad (2.7)$$

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

$$\mu_i^p = V_\mu^{-1} \{1 + C f(-\mu_i^p - \theta) - E[F(-\mu_i^p - \theta)]\} \quad (2.8)$$

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 satisfies

$$\int_{-\infty}^{+\infty} \left[\int_{\underline{\varepsilon}}^{\bar{\varepsilon}} (A_i + C) f(\varepsilon) d\varepsilon \right] g(\theta) d\theta - V(\mu) \quad (2.9)$$

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

$$\mu^s = V_\mu^{-1} \{1 + C\} \quad (2.10)$$

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

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

$$\theta = \bar{A} - \bar{\mu} \quad (2.11)$$

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

$$E(\mu_i - \bar{\mu}) = A_i - \bar{A}. \quad (2.12)$$

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

$$A_i - \bar{A} \leq n \quad (2.13)$$

Under this closure rule

$$\varepsilon^* = n + \bar{\mu} - \mu_i \quad (2.14)$$

and

$$\frac{\partial \varepsilon^*}{\partial \mu_i} = -1. \quad (2.15)$$

substituting these into the first-order condition yields

$$\int_{n+\bar{\mu}-\mu_i}^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon + [\bar{\mu} + E(\theta) + n + C] f(\varepsilon^*) = V_\mu. \quad (2.16)$$

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

$$\int_n^{\bar{\varepsilon}} f(\varepsilon) d\varepsilon + [\mu_i + E(\theta) + n + C] f(\varepsilon^*) = V_\mu. \quad (2.17)$$

2.4. Comparison of absolute and relative closure rules

2.4.1. Relative stringency of the two closure rules

In this sub-section, we compare the two closure rules. To allow for a common 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.

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 $\hat{\mu}$ 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 $\hat{\mu}$

$$m = \frac{[V_\mu - C f(\varepsilon^*)] (\bar{\varepsilon} - \underline{\varepsilon}) - [\bar{\varepsilon} + \hat{\mu} + E(\theta)]}{f(\varepsilon^*) (\bar{\varepsilon} - \underline{\varepsilon}) - 1} \quad (2.18)$$

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 $\hat{\mu}$ satisfies

$$n = \frac{(\bar{\varepsilon} - \underline{\varepsilon}) [V_{\hat{\mu}} - [\hat{\mu} + E(\theta) + C] f(\varepsilon^*)] - \bar{\varepsilon}}{f(\varepsilon^*) (\bar{\varepsilon} - \underline{\varepsilon}) - 1}.$$

Combining, $m - n$ satisfies

$$m - n = \hat{\mu} + E(\theta) \tag{2.19}$$

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

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

Substituting from equation 2.19, and 2.11, and using the fact that in equilibrium $\bar{\mu} = \hat{\mu}$,

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

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 $\hat{\mu}$. L_m satisfies¹¹

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

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

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

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

¹¹Note 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

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

By 2.24 and 2.25

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

Assuming that ε_i is distributed uniformly, this simplifies to

$$L_m - L_n = \frac{1}{2} \left[\frac{Var(\theta)}{\bar{\varepsilon} - \underline{\varepsilon}} \right]. \quad (2.27)$$

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.*

2.4.3. Lack of Regulatory Commitment

Our analysis above assumed that the regulator could commit to a pre-announced rule. However, it is easy to see that such a rule is not likely to be time-consistent. For example, suppose that the regulator were only interested in minimizing its expected liability. It is obvious that the regulator would always choose to close the bank when it could, since a closed bank has a zero expected future liability while the expected liability towards an open bank is always positive.

Our analysis therefore only demonstrates the dominance of relative closure rules over the set of rules available to the regulator under the assumption that

the regulator can credibly commit to a closure policy. When the regulator lacks commitment, it will choose prompt closure. The hypothesis that the regulator incorporates relative performance in its closure decision, which test in the following section, is therefore a joint hypothesis that the regulator enjoys the ability to commit to a pre-announced rule as well as the hypothesis that the regulator minimizes the cost of soliciting a given effort level.

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 resolutions is arranged by the FDIC or other regulatory agency.

A_{it} represents 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. Bank equity values also will partially reflect the regulatory environment in which the bank operates, and hence would induce simultaneity. Finally, asset book values are the material that regulator's use in their closure decisions in practice.

The average financial position of banks in period t is represented by \bar{A}_t the cross-sectional mean value of the book asset/liability ratios of banks in period t .¹²

Finally, we also introduce a variable to measure relative bank size. $SIZE_{it}$ is proxied by the book value of bank i in period t . The inclusion of this variable is not suggested by the theory above, but we include it as a nuisance parameter to investigate whether "too big to fail" regulatory policies are influencing our results. 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.

The following binary model then nests both the absolute and relative closure rules discussed above

$$\Pr(F = 1)_{it} = \gamma_t + \beta_1 A_{it} + \beta_2 \bar{A}_t + SIZE + e_{it} \quad (3.1)$$

where γ_t represents a time dummy for period t and e_{it} represents an i.i.d. disturbance term.

3.2. Data

The data set used in this study consists of a panel of 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.¹³

¹²We also ran the specifications with the cross-sectional medians. These specifications yielded similar results and are available from the authors upon request.

¹³While 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

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 ([9], 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 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.¹⁴

sample to limit ourselves to the post-FDICIA period.

¹⁴Because there are no failures in 1997, we are forced to drop two of the time dummies, one

3.3. Empirical Results

The results for LOGIT estimation of the whole banking sample are listed in Table 3. The first and second columns report the results for the absolute and relative closure rules respectively. Absolute bank performance, A_{it} , enters significantly with a 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, \bar{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. Both likelihood ratio and Wald tests of this restriction were strongly rejected. Nevertheless, the similarity in the magnitudes of these coefficients is supportive of the model above.

All of the regression diagnostics strongly favor the relative closure rule specification. Adding \bar{A}_t to the specification reduces the Akaike Information Criteria statistic from 1,253.8 to 762.2. Similarly, the second specification lowers the Schwartz criterion from 1299.1 to 816.6 and the -2 log-likelihood from 1243.8 to 750.2.

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 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.¹⁵

The third and fourth columns add bank *SIZE* to the specification in the form of total book value of assets. 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. As such, our analysis provides little support for the contention that regulators pursued a too big to fail policy over the sample period.

More importantly, the consideration of bank size fails to have much affect on the closure rule estimates we obtained in the earlier specifications. A_{it} and \bar{A}_t enter in the presence of a bank size variable with quite similar coefficient estimates as they obtained in absence of a proxy for bank size. Again, the diagnostic and classification statistics strongly support the relative closure rule specification over a simple absolute closure rule.

To investigate whether our results were driven by the large number of small

¹⁵1992 through 1995 time dummy estimates are available upon request. Time dummies were positive and significant when \bar{A}_t was excluded from specification. With \bar{A}_t included, time dummies from 1992 through 1994 were still positive and significant, although coefficient estimates were significantly lower. 1995 time dummy was insignificant.

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.

These results are quite similar to those in the previous sample. The coefficient estimates are all highly significant and of the predicted signs. \bar{A}_t enters significantly positive with a coefficient of opposite sign and a similar magnitude as the absolute performance measure, A_{it} .¹⁶ 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.¹⁷

Finally, we again find 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.

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. Moreover, the results are robust to the inclusion of a proxy for bank size as well as the exclusion of small banks from the sample.

¹⁶However, the two variables again fail to enter with equal and opposite coefficients estimates, which would satisfy a strong restriction implied by the formal model.

¹⁷Time dummies performed similarly to the entire sample and are available upon request from the authors.

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 in the paper, neither the relative performance rule nor the absolute performance rules we consider above will be time consistent in a static one-shot game. Instead, a regulator whose loss function solely involves minimizing expected regulatory will always choose prompt closure when regulatory rules allow such behavior. In light of our empirical results, which suggest that relative performance is incorporated in closure decisions, the source of commitment capacity of the regulatory agency poses interesting questions beyond the scope of this paper. An interesting extension of the analysis in this paper would be to endogenize the commitment power of the regulator as a function of the closure strategy followed. One might conjecture that this would strengthen the superiority of a relative closure rule, because the regulator could more easily commit to a less costly closure strategy, which a relative closure rule would be.

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 an 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
- \bar{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

Table 2: Summary Statistics¹

<u>Year</u>	<u>\bar{A}_t</u>	<u>Number of Bank Failures</u>	<u>Average value of A_{it} for Failed Banks</u>
1992	1.1036576	70	1.0239674
1993	1.1094140	26	1.0187820
1994	1.1102285	9	1.0396652
1995	1.1199680	4	1.0076993
1996	1.1235926	4	1.0139213
1997	1.1310269	0	

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

Table 3: Logit Analysis Results: Entire Sample 1992-1997¹

Dependent Variable: *FAIL*

<u>Variables</u>	Absolute Closure Rule	Relative Closure Rule	Absolute Closure Rule (SIZE added)	Relative Closure Rule (SIZE added)
A_i	-43.4310** (3.0450)	-92.3343** (4.1180)	-43.5164** (3.0287)	-92.0875** (4.1055)
\bar{A}		81.1730** (3.8871)		81.0328** (3.8785)
<i>SIZE</i>			$-2.21E - 7$ ($1.891E - 7$)	$-3.17E - 7$ ($2.55E - 7$)
<u>Diagnostic</u>				
AIC	1253.800	762.224	1252.579	760.957
Schwartz	1299.096	816.580	1306.935	824.373
-2 Log L	1243.800	750.224	1240.579	746.957
#Obs	63534	63534	63534	63534
<u>Classification</u>				
Type I error	107/113 = 0.95	86/113 = 0.76	107/113 = 0.95	85/113 = 0.75
Type II error	0.00	0.0005	0.00	0.0005
Total Correct	99.8%	99.8%	99.8%	99.8%

¹See 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.

Table 4: Logit analysis: Small banks excluded 1992-1997¹

Dependent Variable: *FAIL*

<u>Variables</u>	Absolute Closure Rule	Relative Closure Rule	Absolute Closure Rule (SIZE added)	Relative Closure Rule (SIZE added)
A_i	-42.9745** (4.2799)	-86.7543** (5.0782)	-43.2636** (4.2602)	-86.5658** (5.0533)
\bar{A}_i		76.7253** (4.8526)		76.7334** (4.8360)
<i>SIZE</i>			$-2.76E - 7$ ($2.169E - 7$)	$-4.42E - 7$ ($2.924E - 7$)
<u>Diagnostics</u>				
AIC	728.302	490.896	726.295	487.912
Schwartz	770.045	540.987	776.386	546.353
-2 Log L	718.302	478.896	714.295	473.912
#Obs	31213	31213	31213	31213
<u>Classification</u>				
Type I error	61/66 = 0.92	54/66 = 0.82	61/66 = 0.92	53/66 = 0.80
Type II error	0.00	0.0007	0.00	0.0006
Total Correct	99.8%	99.8%	99.8%	99.8%

¹Excludes 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.

References

- [1] Acharya, Sankarshan, and Jean-Francois Dreyfus (1989), "Optimal Bank Reorganization Policies and the Pricing of Federal Deposit Insurance," *Journal of Finance*, 44, no. 5, December, 1313-1333.
- [2] Dewatripont, Mathias, and Jean Tirole (1993), *The Prudential Regulation of Banks*, MIT Press, Cambridge MA.
- [3] Demirguc-Kunt, Asli (1991), "Principal-Agent Problems in Commercial-Bank Failure Decisions," Federal Reserve Bank of Cleveland Working Paper no. 9106, April.
- [4] Fries, Steven, Pierre Mella-Barral, and William Perraudin (1997), "Optimal Bank Reorganization and the fair Pricing of Deposit Guarantees, *Journal of Banking and Finance*, 21, 441-468.
- [5] Giammarino, Ronald M., Tracy R. Lewis, and David E. M. Sappington (1993), "An Incentive Approach to Banking Regulation, *Journal of Finance*, 48, no. 4, September, 1523-1542.
- [6] Kane, Edward J. (1989), *The S&L Insurance Mess: How Did It Happen?*, MIT Press, Cambridge, MA.
- [7] Lazear, Edward P., and Sherwin Rosen. (1981), "Rank-Order Tournaments as Optimum Labor Contracts," *Journal of Political Economy*, 89(5), October, 841-864.
- [8] Levonian, Mark (1991), "What Happens if Banks are Closed 'Early'?", mimeo, Federal Reserve Bank of San Francisco.

- [9] Maddala, G. S. (1983), *Limited-Dependent and Qualitative Variables in Econometrics*, Cambridge University Press, New York NY.
- [10] Mailath, George J. and Loretta J. Mester (1994), "A Positive Analysis of Bank Closure," *Journal of Financial Intermediation*, 3, 272-299.
- [11] Marcus, Alan (1984), "Deregulation and Bank Financial Policy," *Journal of Banking and Finance*, 8, 557-565.
- [12] Nagarajan, S. and C. W. Sealey (1995), "Forbearance, Deposit Insurance Pricing, and Incentive Compatible Bank Regulation," *Journal of Banking and Finance*, 19, 1109-1130.
- [13] Nagarajan, S. and C. W. Sealey (1998), "State-Contingent Regulatory Mechanisms and Fairly Priced Deposit Insurance," *Journal of Banking and Finance*, 22, 1139-1156.
- [14] Nalebuff, Barry J. and Joseph E. Stiglitz (1983), "Prizes and Incentives: Towards a General Theory of Compensation and Competition," *Bell Journal of Economics*, 14(1), Spring, 21-43.
- [15] Thomson, James B. (1991), "Predicting Bank failures in the 1980's," *Federal Reserve Bank of Cleveland Economic Review*, 27, no. 1, 9-20.