

Regulatory Regime Changes and Acquisition Attributes: The Case of Commercial Bank and Thrift Acquisitions of Thrifts

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Significant changes in regulations affecting bank/thrift activities during the 1990s provide us with an opportunity to examine shifts in acquisition characteristics as deregulation leads to changes in behavior. Consistent with a regime change hypothesis, we find a structural change in acquisition attributes for pre- and post-deregulation periods. We also report significant differences in target attributes depending on acquirer identity. Our results demonstrate a higher likelihood in the deregulated period after 1994 for banks to acquire profit inefficient thrifts, while thrift acquirers focus mainly on building size. In contrast, regulatory concerns appear to dominate in prior years, with capitalization as a key acquisition characteristic by thrift acquirers. The results suggest that research needs to control for regimes to allow generalizations beyond period-specific implications.

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Introduction

Economic behavior seldom is unaffected by distortions brought on by regulatory regimes in which agents operate. These distortions typically have an effect on the behavior of all parties involved. Objective functions change; strategies are altered; moral hazards are created; and empirical evidence is influenced. This is especially evident and potentially more pronounced for financial institutions, as they hold the distinction of being among the most regulated industries in the United States. In the 1990s U.S. banks witnessed significant deregulation, prompted by changes in technology and global competition, allowing greater acquisition and merger activity.¹ As Calomiris and Karceski (2000) observe, the removal of branching restrictions was essential to the U.S. depository institution merger wave. Similarly, Moore (1996) and Moore and Siems (1998) propose that with deregulation, the way banks do business changes, resulting in less profitable firms being more likely to be acquired.

In this study we focus on the case of bank and thrift acquisitions of thrifts in the 1990s, a period of dramatic transition in regulatory regimes. The early 1990s were characterized as a time of re-regulation and regulatory stringency. Thrifts were scrambling to meet more stringent regulatory product restrictions, special insurance premiums, and higher risk-based capital requirements [phased in under the Financial Institution, Reform, Recovery, and Enforcement Act (FIRREA) of 1989 and the Federal Deposit Insurance Corporation Act (FDICIA) of 1991]. Kane (1999, p. 671) notes that few diversified acquirers were eager to enter “what appeared to be a moribund” thrift industry, with thrifts required to maintain portfolios that were heavily specialized in home mortgage financing, making them unattractive to diversified acquirers in the aftermath of the thrift crisis.

In contrast, the post-1994 era was characterized by economic expansion, regulatory normalcy, significant deregulation under the Riegle Neal Act of 1994, and the removal of impediments to acquisitions of thrifts by banks (including greater freedom to convert acquired thrifts into branching networks). Congress also significantly reduced regulatory burdens for thrifts in 1996, as noted by Kane (1999), including an easing of the qualified thrift lender test, increasing the percentage of commercial loans that could be held, and reducing previously high insurance premiums, as well as relaxing requirements that restricted banks from integrating acquired thrifts into bank branching networks. (See Williams, 2002, for a detailed summary.) These changes helped intensify interest in thrift acquisitions by more diversified commercial banks.

The deregulation and, in particular, the elimination of both branching and other restrictions for thrift/bank mergers after 1994 provide us with an opportunity to

¹See Calomiris and Karceski (2000) and Berger and Mester (2003) for a detailed review of these developments. As noted by Kane (1981) regulatory changes often follow a regulatory dialectic forcing the eventual removal of obsolete regulations, so institutions can compete. Also, see Pilloff (2004).

examine the effects of such changes on the attributes of acquired firms. In an attempt to capture the effects of regime changes on depository institutions behavior, we examine 582 non-regulatory assisted thrift acquisitions by banks and thrifts occurring during 1991 to 2001 (FDIC website, www2.fdic.gov/hsob). In particular, we test a regime change hypothesis that predicts that the attributes that make an acquisition desirable for different types of acquirers will change under different regulatory environments. This research extends upon previous literature by being the first study: (1) to examine the entire thrift merger wave from 1991 to 2001; (2) to test for the differences in acquisition characteristics by regulatory regime and acquirer type; and (3) to employ profit efficiency, as a proxy for management quality, as an additional acquisition attribute.

Consistent with the regime change hypothesis, the empirical results indicate a structural change for acquisition attributes in the post-deregulation period, as well as different acquisition attributes for acquisitions by commercial banks versus thrift acquirers. In the period prior to 1994, regulatory concerns appear to dominate, with capitalization as a key acquisition characteristic for thrifts acquired by other thrifts. In the later period, however, thrift acquirers appear to focus on building size, suggesting the desire by thrifts to meet the expected entry of larger commercial banks. In contrast, commercial banks demonstrate a higher likelihood to acquire profit-inefficient thrifts in the later period, suggesting revenue turnaround strategies.

Related Studies

Regulatory restrictions on bank/thrift mergers frequently have been criticized as blocking an effective disciplinary device for poor managers. Consistent with this premise, research examining characteristics of acquisitions for periods prior to IBBEA, by Prowse (1997), Hadlock, Houston, and Ryngaert (1999), and Wheelock and Wilson (2000) for banks and Cook, Hogan, and Kieschnick (2004) for thrifts, accordingly, do not find evidence of acquisition discipline leading to removal of poorly-managed firms from the industry. Only Moore (1996) finds some evidence supporting discipline of poorly performing banks, characterized by lower earnings, slower asset growth, low capital ratios, and low market share during 1993 to 1996. A more recent study by Hannan and Pilloff (2006) examining the acquisition characteristics of targets for a large sample of individual banking organizations from 1996 to 2003 also finds evidence of less profitable banks being acquired during this period.

Other studies examining differences in bank performance for banks in more or less liberal banking environments find support for improved overall bank industry performance in more deregulated environments (Calomiris, 1993; Stiroh and Strahan, 2003; James, 1984; Berger and Mester, 2003). Gorton and Rosen (1995) similarly find evidence of bank manager entrenchment, which they attribute partially to significant restrictions on bank acquisitions, allowing inefficient managers to con-

tinue to operate their banks. Hence, we examine changes in acquisition attributes as significant changes in regulations occurred during the 1990s.

We improve upon previous studies by including both profit and cost efficiency as proxies for firm efficiency, avoiding potential biases associated with the use of solely cost efficiency, which excludes revenue efficiency effects. As noted by Berger and Mester (2003) and Akhavein, Berger, and Humphrey (1997), excluding revenues can create a bias, because higher costs may be needed to produce higher revenues and higher profits for a firm. Similarly, accounting measures, as proxies for managerial efficiency, may have problems by not explicitly considering decisions within management's control, such as the allocative and technical efficiency of managers (Akhavein, Berger, and Humphrey, 1997). We also improve on previous studies by examining differences in acquisition characteristics by type of acquirer (commercial banks versus thrifts) and by focusing on thrift acquisitions, which rarely have been studied.

Alternative Hypotheses, Data, and Methodology

The Regime Change Hypothesis

Previous literature suggests that acquisition behavior should respond to changes in the regulatory environment in which banks operate. Acquisition behavior also should respond, according to the literature, to opportunities for greater acquisition discipline when market frictions are removed. Accordingly, acquisition attributes should reflect the regulatory and competitive environment in which depository institutions operate. To examine this premise, we test a regime change hypothesis that predicts a structural change in acquisition attributes under alternative regulatory regimes, as well as examining for differences in acquisition attributes by respective bank and thrift acquirers. Based on increased regulatory scrutiny and the phasing in of higher capital requirements in the early regime, acquisition attributes in this early period of regulatory stringency would be expected to reflect the desire to avoid regulatory interference and should include a stronger focus on capitalization and operating risk at this time. Because bank acquirers had significant restrictions in their choice of thrifts at this time, demographic market characteristics and other strategic considerations would be expected to be dwarfed by regulatory concerns in this early regime.

The later deregulatory regime marks a period that removed impediments for commercial banks to acquire and convert thrifts into branching networks and also removed the remaining geographic and product restrictions for banks. This was also a period following the phasing in of new capital requirements, as well as completion of the clean-up of the thrift industry. Hence, acquisition attributes reflecting portfolio quality, revenue turnaround motives, and demographic characteristics that offer the potential for future revenue growth would be expected to gain importance in the later regime. In addition, given the removal of impediments for commercial bank acquir-

ers, attributes of thrifts acquired by commercial banks would be expected to differ more than those for thrift acquirers for the two regimes.

Alternatively, it can be argued that desirable characteristics for targets should be consistently desirable, regardless of the regime, an assumption that is implicit in studies examining acquisition attributes over long time periods. From this perspective, key acquisition characteristics of acquired firms should not change significantly over the two regulatory regimes that we examine, nor should they exhibit particular differences by acquirer type.

To test the alternative hypotheses, we estimate a maximum likelihood logit model for acquisition attributes for thrifts for the two periods by both banks and thrifts. We test for a structural change in target characteristics in the two regimes by banks that experienced a significant regulatory change in choice of targets and by thrifts that did not.

Data

We collect data on thrifts from the Office of Thrift Supervision Consolidated Statements of Condition and Operations, as recorded by Thomson Financial for all U.S. stock-chartered thrifts operating in 1990 to 2000.² The number of stock thrifts with available data that were included in our sample varies on a year by year basis from 1,008 in 1990 to 646 in 2000. Because this study focuses on non-regulatory assisted acquisitions, we exclude failed thrifts and regulatory-assisted acquisitions in this analysis.

Previous empirical studies use either: (1) logit models to examine ex-post correlates of takeovers or (2) proportional hazard models to predict time to takeover. Although proportional hazard models are better predictive models for the temporal risk of takeover (Trimbath, Frydman, and Frydman, 2001; Hannan and Pilloff 2006), logit models are simpler and require fewer restrictive assumptions. As Trimbath, et al. (2001) note, logit models may have a potential bias by using beginning of the period characteristics of firms that are not acquired until much later. As the purpose of this study is to examine ex-post correlates of acquisitions versus forecasting, we use the less restrictive logit model. To further avoid a potential bias in logit models that use beginning of the period characteristics of firms that are not taken over until much later, we use the methodology of Cummins, Tennyson, and Weiss (1999) and DeFond and Park (1999), where all surviving thrifts are followed through the testing periods while the acquired ones are included only in the year prior to their takeover.

²We include in our analysis only stock thrifts and exclude de-novo thrifts and recently converted mutual thrifts to avoid a bias with anti-takeover laws for newly converted thrifts that protect thrifts from market discipline, which, as noted by Cole and Mehran (1998), often are extended for five years. We include only converted thrifts that had been operating as stock thrifts for at least five years. We collect data from 1990 to 2000 while focusing on acquisitions from 1991 to 2001 as we model lagged effects.

As a result, we hope to reduce any potential biases that may be introduced by having a firm included as both acquired and not-acquired in the same testing period [as also discussed in Calomiris and Karceski (2000)].

The above procedures yield 2,475 firm-year observations for the logit analysis for acquisitions that occurred during 1991 to 1994 and 2,497 firm-year observations for the analysis for acquisitions that occurred during 1995 to 2001.³ The sample includes 4,353 observations of not-acquired thrifts and 619 of acquired over this period, of which 410 are thrifts acquired by banks.

To identify takeovers, we used the *Thomson Savings Directory* (Skokie, Illinois: Thomson Financial Publishing Company) and acquisition histories for bank/thrifts located on the Federal Reserve Board NIC website. Other data sources used for other independent control variables included: (1) *U.S. Department of Commerce Bureau of the Census County and City Data Book*; and (2) *County and City Extra: Annual Metro, City, and County Data Book* (Lanham, Maryland: Bernan Press), ed. by Courtenay M. Slater and George E. Hall; and (3) the Bureau of Economic Analysis (BEA): Regional Accounts Data, Annual State Personal Disposable Income, and Annual Population by State on the BEA website (www.bea.gov/bea/regional/spi/). Our efficiency scores (cost and profit) are estimated annually using data for all stock thrifts with available data in every year during the testing period of eleven years.

Methodology

For the sake of brevity, the estimation procedures for the cost and profit efficiency variables used in the model, are described in the appendix, and the interested reader is referred to in Berger and Mester (1997) for a detailed discussion of the methodologies used in estimating these variables. We use the maximum likelihood logit models to examine the relationship between acquisition decisions and firm-specific and environmental factors. The model permits an analysis of an outcome as a function of set of factors and is specified in probabilistic form as:

$$\Pr(y^* > 0) = F(\beta x_i)$$

where:

$y^* > 0$ when the observed outcome is positive (Acquired = 1); and

$$F(\beta x_i) = \frac{\exp(x_i \beta)}{1 + \exp(x_i \beta)} = \text{The cumulative logistic distribution.}^4$$

³During the efficiency estimation we lost minimal number of firm-years due to missing information. We further eliminated thrifts with negative potential profits that made the profit efficiency ratios meaningless. The final sample is 4,972 firm-years from 11 years.

⁴STATA, Base Reference Manual, Volume 2, p. 329. See Greene, 1993, p. 642, for details on the *index function model* forms.

The lagged set of factors used (x 's) are defined below, including variables used in the previous studies examining bank acquisition for bank acquirers and an additional profit efficiency variables, as follows:

- $SIZE_i$ = Log of total assets;
 $CEFFIC_i$ = Cost efficiency instrumental variable = 1 if the thrift's cost efficiency score (CEFFRATIO) is above median of the sample, and -1 if below;
 $PEFFIC_i$ = Profit efficiency instrumental variable = 1 if the thrift's profit efficiency score (PEFFRATIO) is above median of the sample, and -1 if below;
 MSH_i = Market share of state thrift assets;
 $TRAD_i$ = The percentage of traditional home-mortgage assets;
 $REPOS_i$ = The percentage of repossessed assets;
 $SERVCO_i$ = The percentage of Service Corporation assets;
 CAP_i = Total equity to total assets;
 $LIQUID_i$ = The percentage of liquid assets;
 MSA_i = Dummy variable indicating operation in a Metropolitan Statistical Area;
 $PERCAP_i$ = Per capita income in thrift's home state;
 $PGROW_i$ = Population growth percentage of the state in which the thrift operates; and
 $YEAR_i$ = Year dummies (with n number of years).

Explanatory variables are lagged one year to allow a reasonable time lag between thrift's firm-specific and environmental conditions and its takeover activity (Hannan and Rhoades, 1987). With the exception of profit efficiency, $PEFFIC$, all the firm-specific variables used are standard variables that are shown to be related to acquisition activities in the extant literature (Hannan and Rhoades, 1987; Moore, 1996; Wheelock and Wilson, 2000). The size variable is incorporated into the analysis to account for different acquirer preferences for different size institutions.⁵

Previous studies have employed measures of cost inefficiency as a proxy for management quality (Wheelock and Wilson, 2000, Cook, et al. 2004). In addition to the standard cost efficiency measure, $CEFFIC$, we include $PEFFIC$, the profit efficiency variable. Because the frontier methodology (as described in the appendix) removes random elements and efficiency scores are based on how thrifts perform relative to other thrifts, $PEFFIC$ provides a direct measure of management quality in terms of competitive profit generation. Hence, this measure avoids a common problem with accounting profitability measures that may reflect economic conditions versus managerial skills. To address the possible bias introduced by potential errors-

⁵To test for the sensitivity of our results and the possibility of non-linearity in size, we substituted size dummies of three different size groups for the log of total assets, with similar results.

in-variables problem in efficiency estimates, we use the two-group method in which we split the data into two equal size groups ordered based on their scores, with the instrumental variable taking the value of +1 and -1 if the efficiency score is above and below the median value of the variable and replaced the efficiency measures with these instrumental variables. The justification for this approach is to average out the measurement error to lessen its influence on the estimation (Kennedy, 2001).⁶ As a robustness check, we ran our model using rank-based efficiency variables as instruments instead. We employed two different rank specifications. First we put the firms in ascending order based on their efficiencies (cost and profit) and used their raw ranks as instrumental variables in our first estimations. Second, we converted these raw ranks to a scale over [0,1] by dividing each individual rank by the total number of firms in each period, and used those ranks as our instrumental efficiency variables (Berger, et al., 2005). As an additional sensitivity test, we estimated the model using more traditional profitability and cost efficiency ratios. We replaced PEFfic with ROA, and CEFFic with a cost ratio of non-interest expense over total assets. In all estimations, the results are essentially the same as reported here.

To incorporate an alternative measure of efficiency in terms of marketplace success, we include a firm's market share, MSH, as suggested by Moore (1996). A thrift's market share in this study is measured in terms of its assets as a percentage of total assets of all thrifts in the state in which it operates.⁷ As Moore (1996) observes, thrifts that have low market shares may be attractive for their turnaround potential to acquirers that are more successful in the marketplace, or lower market shares may be attractive to avoid regulatory interference with mergers.

To control for asset portfolio differences that may affect the likelihood of takeover, we include, TRAD, the percentage of home mortgage assets. In an industry

⁶The model was re-estimated using the levels with unchanged results in terms of both direction and significance to the ones reported here. To test the sensitivity of our results, we also performed the regressions including only one of the efficiency measures (cost or profit efficiency) with similar signs and results.

⁷Radecki (1998) argues that state, rather than city or county, provides better boundaries for retail banking markets. Geographic restrictions on within state branching were removed across the U.S. in almost all states by the end of 1992. To acquire thrifts, the Federal Reserve must determine that the performance activities will produce benefits to the public that "outweigh any possible adverse effects, including undue concentration of resources, a decrease or unfair competition, conflicts of interest, or unsound bank practices. All bank markets that the acquirer and the thrift compete directly in are reviewed for competitive effects of the merger proposal including the number of competitors that remain in markets, the characteristics of the markets, and the projected in the concentration of total deposits in all markets under the Department of Justice Merger guidelines." Even if DOJ guidelines are exceeded as measured by the Herfindahl-Hirschman index (HHHI), a merger may be allowed if competition remains, deposit growth is expected, and the market is attractive for entry by out-of-market firms, along with other considerations that would result in net public benefits. See FRB Press Release Approval Notice of Barnett Banks to acquire a saving association, September 15, 1997, for a discussion of guidelines and illustration of considerations for this approval: (<http://www.federalreserve.gov/boarddocs/press/bhc/1997/19970915/>).

where asset portfolio variation is limited, higher levels of TRAD may signal a lack of innovativeness on the part of management and/or a lack of market breadth and depth with low potential for creativity in product offerings. Alternatively, acquirers may have preferences for more traditional thrifts with larger holdings of home mortgage assets.

To control for differences in loan quality or risk that might be associated with takeovers, REPOS, the ratio of repossessed assets to total assets, and SERVCO, the percentage of investment in service corporations, are included. Service corporation assets are holding companies for non-traditional thrift activities and include real estate property development and property management, insurance agency and brokerage services, and other activities, which often entail greater risk. REPOS proxies for the quality of a thrift's loan portfolio, as larger REPOS might make a thrift a less attractive target. Capital adequacy, CAP, a firm's equity-to-assets ratio, is one of the variables often cited as a possible factor that affects acquisition activity (Hannan and Rhoades, 1987; Moore, 1996; Wheelock and Wilson, 2000). As noted by McCoy, Frieder, and Hedges (1994, p. 15), less than adequately capitalized thrifts may have offered a cheaper expansion alternative to banks during the early 1990s. However, because lower capital ratios may signal a lower safety buffer against insolvency risk, a lower CAP could make a firm less attractive as a target, particularly in the early regime, when new capital requirements were implemented. LIQUID, the percentage of liquid assets (total cash, deposits, and investment securities) to total assets, is also included because evidence suggests that bank acquirers may prefer firms with better liquidity (O'Keefe, 1996).

Three additional variables are included to control for the economic environment in which the firms operate. An MSA dummy is employed to distinguish different types of markets in which the thrifts are located. Moore (1996), for example, finds a greater probability of acquisition for banks operating in urban markets that offer greater opportunity for growth. A state's annual population growth rate, PGROW, is also included to account for expansion opportunities in the target market. All else equal, growth prospects of the market may encourage the acquirers to target thrifts in high growth areas (Hannan and Rhoades, 1987). PERCAP, per capita income of the thrift's home state, is included to reflect the economic environment in which a firm operates. Acquirers may be more attracted to thrifts operating in economically-robust states; although thrifts in less robust states may be less expensive (and therefore more attractive) targets. Finally, time dummy variables are included, with the last year omitted, to account for the year effects.

Under the regime change hypothesis, a structural change in acquisition attributes is expected for pre- and post-deregulation periods. The acquisition attributes should

Table 1—Descriptive Statistics for Not Acquired and Acquired Thrifts for Period 1 (pre-IBBEA) and Period 2 (post-IBBEA)

Variables	Sample	Period 1 N	Mean	t-stat ^a	Period 2 N	Mean	t-stat ^a	t-stat ^b
SIZE	All	2475	12.048		2497	12.284		-5.62***
	Not Acquired	2257	12.015		2096	12.273		
	Acquired	218	12.383	-3.45***	401	12.343	-0.88	0.32
CAP	All	2475	0.072		2497	0.089		-14.58***
	Not Acquired	2257	0.071		2096	0.088		
	Acquired	218	0.082	-4.01***	401	0.093	-1.95*	-2.90***
MSH	All	2475	0.034		2497	0.057		-7.38***
	Not Acquired	2257	0.034		2096	0.058		
	Acquired	218	0.039	-0.79	401	0.054	0.55	-1.72*
MSA	All	2475	0.751		2497	0.694		4.56***
	Not Acquired	2257	0.748		2096	0.678		
	Acquired	218	0.788	-1.32	401	0.773	-3.75***	0.45
PERCAP	All	2475	17,809		2497	21,364		-46.33***
	Not Acquired	2257	17,795		2096	21,529		
	Acquired	218	17,961	-1.06	401	20,499	6.09***	-10.66***
PGROW	All	2475	1.322		2497	1.615		-7.84***
	Not Acquired	2257	1.325		2096	1.536		
	Acquired	218	1.289	0.62	401	2.026	-5.38***	-5.00***
CEFFIC	All	2475	-0.000		2497	0.000		
	Not Acquired	2257	-0.019		2096	-0.013		
	Acquired	218	0.192	-2.98***	401	0.072	-1.57	1.55
PEFFIC	All	2475	-0.000		2497	0.000		
	Not Acquired	2257	0.012		2096	0.025		
	Acquired	218	-0.128	1.98**	401	-0.132	2.90***	0.04
TRAD	All	2475	0.462		2497	0.462		0.07
	Not Acquired	2257	0.464		2096	0.464		
	Acquired	218	0.446	1.45	401	0.453	1.12	-0.45
REPOS	All	2475	0.011		2497	0.004		17.18***
	Not Acquired	2257	0.011		2096	0.004		
	Acquired	218	0.013	-1.06	401	0.003	1.96**	8.79***
SERVCO	All	2475	0.005		2497	0.001		15.25***
	Not Acquired	2257	0.005		2096	0.001		
	Acquired	218	0.005	0.24	401	0.001	0.77	6.29***
LIQUID	All	2475	0.162		2497	0.170		-2.15**
	Not Acquired	2257	0.159		2096	0.167		
	Acquired	218	0.189	-3.67***	401	0.182	-2.03**	0.533

^a t-tests comparing the means of the acquired versus not-acquired **within** the testing period

^b t-tests comparing the means **between** two testing periods

***, **, * p < 0.01, 0.05, and 0.10, respectively

SIZE = (in thousands; Log Assets)

MSH = (thrift's fraction of total state thrift assets)

PERCAP = (per capita income in home state)

CEFFIC = (Cost Efficiency; =1 if > median)

TRAD = (% traditional home mortgage assets)

SERVCO = (% service corporation assets)

CAP = (equity to assets)

MSA = (Dummy =1 if in MSA; 0, otherwise)

PGROW = (population growth in home state)

PEFFIC = (Profit Efficiency; 1 if > median)

REPOS = (% repossessed assets)

LIQUID = (% liquid assets)

reflect greater concerns for avoiding regulatory interference and for building capitalization in the early regime. In contrast, acquisition attributes would be

expected to reflect more strategic concerns for bank acquirers in the later regime, such as revenue turnaround and market expansion motives.

Empirical Results

The data used in this study span more than a decade during which the banking industry saw enormous regulatory changes. Before reaching conclusions about the results of estimations on the pooled data over this period, we run tests to see if there has been a structural change between the first period from 1991 to 1994 and the second period from 1995 to 2001. In other words, we search for any structural change in the relationship between the acquisition decisions and these institutional and environmental characteristics during our testing period. We estimate the full period model, period 1 (1991-1994) model and period 2 (1995-2001) model simultaneously and test the period 1 and 2 coefficients against each other. The Wald-chi square test results reject the null hypothesis of equal coefficients for the two periods and implies that the parameters should be estimated separately for the two periods.

When the regime-switch point is unknown, there are methods that can be employed to identify the demarcation point over a testing period empirically (Butler et al., 2006). The choice of 1994 as a switch year is a logical one in our study due to the effects of several acts coming together at this time. To test the possibility of other years providing a better switch point (with information leakage), we repeated the Wald test for all neighboring years as switch points and let the data help us determine the best regime change point. The results confirmed 1994 as the significant switch year with the only significant χ^2 statistic. Hence, based on these results, we use the respective pre- and post-IBBEA periods for our logit analysis.

Descriptive Statistics

Table 1 shows the descriptive statistics for not-acquired versus acquired thrifts using data for period 1, 1990-1994, and for period 2, 1995-2001. The test for differences in means for period 2 suggests that on average acquired firms tended to be located in urban markets (MSA dummy) with lower average per capita income (PERCAP), but higher average population growth (PGROW) than non-acquired firms. None of these environmental variables are significantly different for acquired versus non-acquired in period 1. Looking at firm-specific attributes, acquired firms for period 1, on average, are more cost efficient than not-acquired firms. Such firms exhibit a significantly higher mean on CEFFIC, but also on average are less profit-efficient, with a significantly lower mean on PEFFIC, in both periods.⁸ Acquired

⁸The cost efficiency scores have a mean of 0.88 over the total sample period, while the profit efficiency has a mean of 0.54. Both efficiency levels seem to be stable *within* the testing periods but show an overall decline from period 1 to period 2. (The mean of cost efficiency goes from 0.90 to 0.86 while the mean of profit efficiency goes from 0.57 to 0.52.) As expected, we found a high correlation (at < 0.001 level of significance) between our measures

firms also on average are significantly larger (higher mean on SIZE) in period 1 and better capitalized (higher mean CAP) than the not-acquired thrifts in both periods (with a much larger t-statistic in period 1). Acquired firms also have less risky assets, REPOS, in period 2 versus non-acquired firms, and more liquid assets. Such firms have a higher mean on LIQUID in both periods.

Table 2—Pearson Correlations between Independent Variables

Panel A: Period 1

	CEFFIC	PEFFIC	CAPRAT	MSH	MSA	PGROW	PERCAP	TRAD	REPOS	SERVCO	LIQUID
PEFFIC	-.055***										
CAPRAT	.094***	-.096***									
MSH	.073***	.113***	-.041**								
MSA	.024	.085***	-.055***	.100***							
PGROW	-.064***	.036*	-.071***	.017	.071***						
PERCAP	.032	.074***	-.076***	-.009	.317***	-.010					
TRAD	.008	-.022	.026	-.137***	-.066***	-.012	.015				
REPOS	-.060***	.010	-.183***	.017	.083***	.102***	-.035*	-.185***			
SERVCO	.054***	-.017	-.011	.115***	.061***	.014	.026	-.151***	.170***		
LIQUID	.045**	-.221***	.258***	-.054***	-.091***	-.079***	-.070***	-.382***	-.034*	-.010	
SIZE	.183***	.131***	-.159***	.425***	.310***	.042**	.242***	-.183***	.131***	.218***	-.144***

Panel B: Period 2

	CEFFIC	PEFFIC	CAPRAT	MSH	MSA	PGROW	PERCAP	TRAD	REPOS	SERVCO	LIQUID
PEFFIC	-.185***										
CAPRAT	.050**	-.156***									
MSH	.068***	.024	-.034*								
MSA	-.067***	.069***	-.091***	.077***							
PGROW	-.040**	.036*	-.018	-.068***	.005						
PERCAP	-.078***	.010	-.060***	.022	.262***	-.428***					
TRAD	.047**	.041**	-.095***	-.082***	-.022	.028	-.063***				
REPOS	-.122***	.036*	-.097***	-.037*	.086***	.060***	.021	.009			
SERVCO	.053***	-.035*	-.020	.001	-.005	.088***	-.102***	.038*	.051***		
LIQUID	.036*	-.189***	.346***	-.039**	-.050**	-.011	.021	-.477***	-.079***	-.050**	
SIZE	.135***	.013	-.181***	.481***	.283***	-.071***	.218***	-.104***	-.023	.015	-.164***

***, **, * p < .01, p < .05, and p < .10, respectively

of profit and cost efficiency scores and more traditional profitability and cost ratios of ROA and non-interest expense over total assets. Due to the concerns of measurement error in efficiency scores as discussed before, they have been replaced with their instrumental variable counterparts and tabulated along with the rest of the variables on Table 1.

We further examine if there are any changes in the significance of these attributes for the total sample and the acquired firms only from one period to the other (shown in the last column of Table 1). The results suggest that the nature of this industry has changed. With the exception of TRAD, all firm-specific and environmental attributes have changed significantly, resulting in bigger, more liquid, and better capitalized firms with less risky assets in period 2. Note that we don't report the comparison for the efficiency variables because by instrumental variable design they both have zero means in both periods. But when we examine those variables (especially comparing their levels for the acquired firms), the profit efficiency level doesn't appear to change over time in acquired firms. The cost efficiency level, however, drops. These results convince us to look further into the possible differences between these two periods.

Table 2 presents Pearson correlations between independent variables included in the logit analysis. One item is worth noting: the variables CEFFIC and PEFfic are negatively correlated at significant levels in both periods, similar to the relationship that Berger and Mester (1997) and Berger and Mester (2003) find for large commercial bank samples. They present two possible explanations for this result. One possibility is that firms with high market power can generate high revenues without feeling the need to control their costs. An alternative explanation is that firms with high quality services generate sufficiently high revenues to offset the high costs that their products create, resulting in higher costs but also even higher profit efficiency. This relationship is consistent with the argument of a possible bias if profit efficiency is excluded in measuring managerial performance.

Logit Model Results for the Determinants of Acquisitions

Table 3 presents the logit results for each of the two periods. As shown by the significant Wald chi-square statistics, the models have a good fit for each sub-period.

Results for All Acquisitions for the Early Regime, Period 1

Examining the results for the respective periods in Table 3, for the pre-deregulation period (period 1), the most significant firm-specific characteristic is SIZE (at a < 0.01 level) which indicates a preference for large thrifts for acquisition. For all acquisitions, the other variable that is significant is CAP, with a significant positive coefficient at a < 0.05 level. The results suggest a desire by acquirers to build capital to meet higher regulatory requirement. Financially-fit firms are more likely to survive and to avoid regulatory intervention. These results likely reflect the greater importance of capital and size for thrift acquisitions in a period following the thrift crisis.

In addition, the coefficients on CEFFIC and LIQUID are positive and mildly significant (at a < 0.10 level), which indicates a preference by acquirers for thrifts

Table 3—Logit Model Results for the Determinants of All Acquisitions

Below the coefficient for each variable are the marginal effect and the z-statistic in parentheses. Dependent variable is an indicator variable that takes the value of 1 if the thrifts is acquired, 0 if not. Independent variables are as defined in Table 1

	Period 1	Period 2
Constant	-4.909	-3.703
SIZE	0.215	0.068
Marginal effects ^a	0.015	0.008
z-stat	(3.30)***	(1.03)
CEFFIC	0.135	0.054
	0.009	0.006
	(1.66)*	(0.79)
PEFFIC	-0.115	-0.153
	-0.008	-0.018
	(-1.40)	(-2.29)**
MSH	-0.818	-0.387
	-0.058	-0.045
	(-0.84)	(-0.56)
TRAD	0.232	-0.420
	0.016	-0.049
	(0.42)	(-0.90)
REPOS	5.004	-23.511
	0.359	-2.784
	(1.58)	(-2.37)**
SERVCO	-7.433	-39.167
	-0.534	-4.639
	(-0.89)	(-2.52)**
CAP	4.906	1.310
	0.352	0.155
	(2.12)**	(0.76)
LIQUID	1.469	0.139
	0.105	0.016
	(1.83)*	(0.21)
MSA	0.104	0.511
	0.007 ^b	0.056 ^b
	(0.49)	(2.88)***
PERCAP	-0.00002	-6.03e-06
	-2.11e-06	-7.15e-07
	(-0.63)	(-0.16)
PGROW	-0.090	0.037
	-0.006	0.004
	(-0.79)	(0.71)
N	2,475	2,497
Acquired N	218	401
Pseudo-R ²	0.04	0.07
Wald chi ²	49.13***	143.36***

***, **, * p < 0.01, p < 0.05, and p < 0.10, respectively

^a Marginal effects reported are calculated at the means of independent variables

^b Marginal effect is for discrete change of dummy variable from 0 to 1

that are more cost efficient and liquid and suggests an avoidance of hidden operating risks, as noted by Wheelock and Wilson (2000), and liquidity risk (O'Keefe, 1996).

The results on CAP are consistent with some of the previous studies that find greater risk aversion by banks and thrifts in the early 1990s (e.g., Wagster, 1999; Cook, Hogan, and Kieschnick, 2004). The results contrast with other pre-IBBEA studies (e.g., Wheelock and Wilson, 2000; Hannan and Rhoades, 1987). The results on SIZE are consistent with Moore (1996), for 1993 to 1996, but differ from those of Wheelock and Wilson (2000). The results on cost efficiency are similar to Wheelock and Wilson's for the pre-IBBEA period. We note that most of these studies utilize different time periods of testing and often utilize long time periods that encompass several different regulatory environments for banks. Given the results of our structural change tests, we refrain from making direct references to these studies because the results are not comparable.

Results for All Acquisitions for the Later Regime, Period 2

Consistent with a regime change hypothesis and with tests that indicated the two sample data periods should not be pooled, significant acquisition characteristics are different in the post-IBBEA period (shown in the second column of Table 3). For firm-specific characteristics, the coefficient for PEFIC is negative and significant (at a < 0.05 level), supporting the notion that acquirers prefer profit-inefficient thrifts in period 2, perhaps for their revenue turnaround potential (Moore, 1996). This result is consistent with the removal of impediments for bank acquisitions and mergers with thrifts that allow banks to more readily engage in revenue turnaround motives and cross-selling opportunities. As suggested by Wheelock and Wilson (2000), revenue turnaround motives, such as instituting new pricing policies or implementing cross-selling strategies for new products, also may be easier for banks to implement. For risk-related variables, the coefficients on REPOS and SERVCO are significant and negative, characteristics linked to depository institution failures in previous studies (Berger and Humphrey, 1992; Cebenoyan, Cooperman, and Register, 1993; among others). Acquirers also seem to prefer urban thrifts, with a significant positive coefficient on MSA. The coefficient on CAP is no longer significant, as expected in the well-capitalized environment of period 2.

Multinomial Logit Model Results: By Bank and Thrift Acquirer Type.

To examine the potential differences arising from acquirer identity, we perform a multinomial logit estimation, which includes as the dependent variable the three outcomes for each period of no acquisition, acquisition by a bank, and acquisition by a thrift. Table 4 reports these results. The significant Wald chi-squares indicate a good fit for these models as well. It is worth noting that the number of acquisitions for the sample increased more dramatically by 117 percent for bank acquirers (from 129 to 281) versus 35 percent for thrift acquirers (89 to 120) from the early to the

Table 4—Logit Model Results for Determinants of All Respective Bank and Thrift Acquisitions

Below the coefficient for each variable are the marginal effect and the z-statistic in parentheses. Dependent variable is a multi-indicator variable that takes the value of 1 if the thrift is acquired by bank, 2 if by thrift, 0 if not acquired. Independent variables are as defined in Table 1

	Period 1		Period 2	
	Banks	Thrifts	Banks	Thrifts
Constant	-5.19	-6.04	-2.98	-7.18
SIZE	0.30	0.10	-0.01	0.25
Marginal Effects ^a	0.01	0.002	-0.001	0.007
z-stat	(4.17)***	(0.83)	(-0.29)	(2.70)***
CEFFIC	0.11	0.17		0.005
	0.004	0.005	0.006	-0.00006
	(1.05)	(1.39)	(0.96)	(-0.02)
PEFFIC	-0.06	-0.18	-0.22	0.01
	-0.002	-0.005	-0.02	0.001
	(-0.63)	(-1.44)	(-3.03)***	(0.32)
MSH	-2.73	0.84	0.28	-2.72
	-0.11	0.02	0.03	-0.08
	(-1.98)**	(0.87)	(0.57)	(-1.90)*
TRAD	0.41	-0.007	-0.37	-0.43
	0.01	-0.0008	-0.03	-0.01
	(0.70)	(-0.03)	(-0.72)	(-0.62)
REPOS	2.46	7.66	-35.75	-9.98
	0.09	0.23	-3.13	-0.19
	(0.64)	(1.77)*	(-2.40)**	(-0.63)
SERVCO	-11.58	-2.88	-44.94	-31.54
	-0.48	-0.07	-3.88	-0.82
	(-1.37)	(-0.19)	(-2.00)**	(-1.50)
CAP	3.81	5.67	0.37	3.43
	0.15	0.16	0.02	0.10
	(1.45)	(1.96)**	(0.14)	(1.44)
LIQUID	1.35	1.64	0.42	-0.65
	0.05	0.04	0.03	-0.02
	(1.44)	(1.27)	(0.64)	(-0.75)
MSA	0.08	0.11	0.48	0.60
	0.003 ^b	0.003 ^b	0.04 ^b	0.01 ^b
	(0.35)	(0.35)	(2.49)**	(2.16)**
PERCAP	-0.00009	0.00004	-9.2e-06	-0.00001
	-3.9e-06	1.5e-06	-7.7e-07	-3.7e-07
	(-1.50)	(0.83)	(-0.21)	(-0.25)
PGROW	-0.07	-0.10	0.12	-0.11
	-0.002	-0.003	0.01	-0.003
	(-0.52)	(-0.56)	(2.11)**	(-1.65)*
N		2,475		2,497
Acquired N	129	89	281	120
Pseudo-R ²		0.04		0.08
Wald chi ²		72.18***		182.67***

***, **, * p < 0.01, p < 0.05, and p < 0.10, respectively

^a Marginal effects reported are calculated at the means of independent variables

^b Marginal effect is for discrete change of dummy variable from 0 to 1

later regime. This suggests that the removal of impediments for bank acquisitions of thrifts in the later regime stimulated acquisitions by bank acquirers.

As shown in Table 4, there are quite different acquisition characteristics for thrifts acquired by banks versus those acquired by other thrifts, with a more pronounced difference in period 2.

Results for Period 1 by Respective Bank and Thrift Acquirers

Examining the results for period 1 (shown in Panel 1 of Table 4), thrift acquirers prefer to acquire better-capitalized thrifts, with a positive coefficient on CAP (at a < 0.05 level). The only other significant variable for thrift acquirers is a positive weakly significant coefficient on REPOS (at a < 0.10 level). This finding suggests a willingness to assume a larger percentage of repossessed assets as long as a thrift is better capitalized. Bank acquirers, in contrast, prefer larger thrifts with a positive coefficient on SIZE (at a < 0.01 level), but with lower market shares with a negative coefficient on MSH (at a < 0.05 level). This suggests a desire by bank acquirers to acquire thrifts with lower market shares, perhaps to avoid regulatory interference with an acquisition in a period of regulatory stringency. Alternatively, these thrifts may be less costly to acquire, or banks may be acquiring thrifts in select markets to fit with an acquiring bank's existing branching network.⁹

Results for Period 2 by Respective Bank and Thrift Acquirers

The acquisition attributes by acquirer type in period 2 (shown in Panel 2 of Table 4) presents different acquisition characteristics in the post-deregulation era. Capitalization (CAP) is no longer a significant variable in period 2 for thrift acquirers, with higher capital requirements and undercapitalized thrifts removed after the Resolution Trust Corporation's cleanup. Thrift acquirers appear, in contrast, to focus on building size in urban environments in period 2, with a greater likelihood for acquisition of larger thrifts and thrifts operating in urban settings (i.e., a positive, significant coefficients on both SIZE (at a < 0.01 level) and on MSA (at a < 0.05 level). With greater competition by banks in deregulated markets, thrift acquirers may have engaged in strategies to build size in urban markets to compete with commercial banks that gained greater freedom to enter new markets in the post-IBBEA regime. Thrift acquirers also demonstrate mild preferences for firms with lower market shares and for firms in states with lower population growth rates (i.e., negative coefficients on MSH and PGROW at a < 0.10 level).

In contrast to period 1, bank acquirers appear to be engaged in more diverse motivations for acquiring thrifts in period 2. Bank acquirers focus on both firm-specific and market characteristics as acquisition attributes. In particular, the coefficient on PEFfic is the most significant variable (at a 0.01 level) with a

⁹We thank an anonymous referee for these alternative explanations.

negative coefficient. This finding indicates a greater willingness by bank acquirers to acquire profit inefficient thrifts, which is consistent with revenue turnaround motives. Bank acquirers in period 2 also appear to be more likely to acquire thrifts in urban markets with higher population growth rates and to acquire thrifts with better asset quality (positive significant coefficients on MSA and PGROW and negative on REPOS and SERVCO (at a < 0.05 level)). The diverse characteristics of thrift acquisitions by banks acquirers suggest greater freedom for bank acquirers in the later regime to engage in a variety of revenue turnaround opportunities, market expansion, and loan portfolio quality enhancement. Consistent with the regime change hypothesis, the changes in characteristics of thrifts acquired by other thrifts do not exhibit as dramatic a change as those displayed by bank acquirers in period 2.

Logit Model Results Differences for only Acquired Thrifts by Bank versus Thrift

To highlight the differences between the acquired thrifts by banks versus acquired by thrifts, we estimated the same model with a dependent variable with only two outcomes: 1 if acquired by bank, 0 if by another thrift. This measure thus excludes all non-acquired thrifts; results are shown in Table 5.

The results demonstrate few significant differences between firms acquired by banks versus thrifts in period 1. The only significant variable is MSH (at a 0.05 level). As a period of regulatory stringency, banks appear to prefer to acquire lower market share firms more than thrift acquirers. In contrast, period 2 shows a greater variety of firm-specific and economic attributes for bank versus thrift acquirers. Significant firm-specific variables include PEFFIC, CAP (at a < 0.05 level), and SIZE (at a < 0.01 level), all negative, and LIQUID (positive at a < 0.05 level). In terms of significant environmental variables, the coefficients are positive on PGROW (at a < 0.05 level) and MSH (at a < 0.10 level). Banks appear more willing to acquire profit inefficient, less well-capitalized, and smaller thrifts with higher market shares that are more liquid and that operate in higher growth areas, than are thrift acquirers. Hence, the results reiterate the tale of two periods and two types of acquirers.

Summary and Conclusion

This study examines the effects of changes in regulatory environment on the attributes of acquired thrifts during the 1990s. The empirical results support the existence of a structural change in acquisition characteristics with changes in the regulatory environment in which depository institutions operate. During the pre-IBBEA period, the primary acquisition motive for both bank and thrift acquirers appears to be capitalization and the avoidance of regulatory interference. This trend suggests the importance of regulatory tightening of standards in this transitory period in the aftermath of the thrift crisis of the 1980s. In contrast, for the post-IBBEA

Table 5—Logit Model Results for Determinants of Bank vs. Thrift in Acquired Thrifts

The sample is all acquired firms. Dependent variable is an indicator variable that takes the value of 1 if the thrift is acquired by bank, 0 if by thrift. Independent variables are as defined in Table 1

	Period 1	Period 2
Constant	0.909	3.734
SIZE	0.183	-0.348
Marginal effects ^a	0.044	-0.068
z-stat	(1.36)	(-2.89)***
CEFFIC	-0.086	0.071
	-0.020	0.014
	(-0.56)	(0.56)
PEFFIC	0.138	-0.276
	0.033	-0.054
	(0.88)	(-2.24)**
MSH	-4.888	4.638
	-1.177	0.911
	(-2.27)**	(1.94)*
TRAD	0.352	0.808
	0.084	0.158
	(0.33)	(0.98)
REPOS	-9.402	-31.610
	-2.264	-6.212
	(-1.56)	(-1.53)
SERVCO	-11.691	-7.777
	-2.816	-1.528
	(-1.13)	(-0.21)
CAP	-1.880	-7.128
	-0.452	-1.400
	(-0.62)	(-2.10)**
LIQUID	-0.875	2.638
	-0.210	0.518
	(-0.61)	(2.25)**
MSA	0.001	-0.050
	0.0002 ^b	-0.009 ^b
	(0.00)	(-0.15)
PERCAP	-0.0001	0.00005
	-0.00002	0.00001
	(-1.49)	(0.94)
PGROW	0.058	0.208
	0.013	0.040
	(0.29)	(2.39)**
N	218	401
Pseudo-R ²	0.05	0.10
Wald chi2	15.54	42.39***

***, **, * p < 0.01, p < 0.05, and p < 0.10, respectively

^a Marginal effects reported are calculated at the means of independent variables

^b Marginal effect is for discrete change of dummy variable from 0 to 1

period, bank acquirers exhibit behavior suggesting potential profit turnaround motives, with a higher likelihood of acquisition for profit-inefficient thrifts. Bank acquirers also were attracted to location and growth potential and loan quality. Thrift

acquisitions by other thrifts appear instead to focus on size and MSA acquisitions. This trend suggests motives to build size in urban areas to compete with banks in a deregulated market. From an industry perspective, the building of size by thrifts should benefit the industry in terms of having the financial strength to compete with large banks in more competitive banking markets.

From the perspective of policy implications, the results also show an important impact of regulatory environments on the motives and behavior of acquirers that are consistent with Boot et al. (2000) who suggest that regulators need to fine-tune indirect, incentive-based regulations carefully in more competitive environments. The results strongly suggest the need for researchers to control for changes in regulatory regimes that can produce changes in financial institution behavior to avoid misleading results and their regulatory implications. By examining a more homogeneous sample of thrifts and having a better defined pre- and post-deregulation periods, our study avoids other intervening factors that can bias results.

As a caveat, whether these results hold for bank acquisitions of other banks and whether agency problems are associated with acquisition attributes are questions that need to be addressed in future research.

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Appendix A: Methodology for Estimating Cost and Profit Efficiency Measures

A.1. Cost Efficiency Measures

Cost inefficiency gives a measure of how much a particular firm's cost deviates from the best practice firm's minimum cost for the same output under the same conditions. This information is derived from a cost function that evaluates the firm's variable costs in terms of variable outputs, variable input prices, fixed inputs, random error, and inefficiency. It can be stated as:

$$C = f(y, w, z, u_c, v_c) \quad (A1)$$

where:

- C = Variable costs;
- y = Vector of variable outputs;
- w = Vector of prices of variable inputs; and
- z = Quantities of any fixed inputs included to account for their effects on variable costs, as they may be substitutable or complementary with variable inputs.

The terms u and v are inefficiency and random error terms, respectively. Assuming the inefficiency and random terms are multiplicatively separable from the rest of the cost function, equation (1) above is represented in natural logs as

$$\ln C = f(y, w, z) + \ln u_c + \ln v_c \quad (A2)$$

To estimate the composite error term, $(\ln u_c + \ln v_c)$, in equation (2) and, in turn, calculate each firm's cost inefficiency index u_c , we estimate the following popular multiproduct translog cost specification (suppressing individual thrift subscripts):¹⁰

$$\begin{aligned} \ln(C / w_2 z_2) = & \alpha + \gamma_1 \ln(w_1 / w_2) + \frac{1}{2} \gamma_2 \ln(w_1 / w_2)^2 \\ & + \sum_{j=1}^5 \beta_j \ln(y_j / z_2) + \frac{1}{2} \sum_{j=1}^5 \sum_{l=1}^5 \beta_{jl} \ln(y_j / z_2) \ln(y_l / z_2) \\ & + \delta_1 \ln(z_1 / z_2) + \frac{1}{2} \delta_2 \ln(z_1 / z_2)^2 \\ & + \sum_{j=1}^5 \rho_j \ln(y_j / z_2) \ln(w_1 / w_2) + \eta_1 \ln(z_1 / z_2) \ln(w_1 / w_2) \\ & + \sum_{j=1}^5 \omega_j \ln(y_j / z_2) \ln(z_1 / z_2) + \ln u_c + \ln v_c \end{aligned} \quad (A3)$$

¹⁰See Aigner, Lovell and Schmidt (1977), Meeusen and Broeck (1977), and Jondrow et al. (1982) for a description of this methodology. For more recent applications, see Berger and Mester (1997) and Rogers (1998).

As observed by previous studies, the translog function provides consistent inefficiency rankings relative to other functional forms. It also has the advantage of simplicity.¹¹ In this estimation, five outputs, y_j , are used:

- 1) 1-4 family mortgage loans and mortgage-backed securities;
- 2) multifamily and nonresidential mortgage loans;
- 3) non-mortgage loans including consumer and commercial loans and lease financing;
- 4) cash and other security investments including U.S. government and agency securities, municipals, and other securities; and
- 5) construction and land loans, and real estate and service-corporation investments.

The prices of two variable inputs, w_k , are used: (1) labor and (2) deposits and other borrowings. We measure the price of labor as total expenditures on employees divided by the number of full-time equivalent employees at the end of the year. The price of deposits is total interest expense divided by total deposits and other borrowings. We further impose the usual linear homogeneity in input price restrictions in estimation. Two fixed input quantities, z , also are included: the dollar value of physical capital (premises and other fixed assets) and the dollar value of financial equity capital. All variable output quantities and physical capital are specified as ratios to the equity capital to control for heteroskedasticity and to reduce the scale bias.

In the last step, we define the cost efficiency of thrift i as the ratio of its estimated cost to produce its output if it were as efficient as the best-practice thrift in the industry to thrift i 's actual cost as follows:

$$\text{CEFFRATIO}_i = \frac{\hat{C}^{\min}}{\hat{C}^i}, \quad (\text{A4})$$

where CEFFRATIO_i is the thrift i 's cost efficiency, $\hat{C}^i$ is the estimate of predicted cost for thrift i , and $\hat{C}^{\min}$ is the minimum value of all $\hat{C}^i$'s in the sample. Given the formulation of (2), equation (4) becomes:

$$\text{CEFFRATIO}_i = \frac{\hat{u}_c^{\min}}{\hat{u}_c^i} \quad (\text{A5})$$

where $\hat{u}_c^{\min}$ is the minimum observed cost inefficiency factor, estimated using equation (3). To reduce the effect of extreme values of inefficiency, prior to

¹¹For greater precision in calculating efficiency scores, Berger and Mester (1997) suggest the use of a Fourier-flexible function form. The translog form is easier to use, however. For ranking decisions, studies demonstrate that the translog form provides similar rankings to other forms. Also, Altunbas and Chakravarty (2001) demonstrate that the slightly better fit of Fourier-flexible models does not reliably improve forecasts of bank costs.

substitution of this measure into equation (5), truncation is used to reassign less extreme values at 5th and 95th percentile to the top and bottom 5 percent of the distribution respectively. This truncation is applied within size class (by total assets) quartiles to mitigate the persistent luck effects within their size groups (Berger and Mester, 1997). By design, CEFFRATIO ranges between 0 and 1, with 1 being the best practice thrift in the sample.

A.2. Profit Efficiency Measures

Berger and Mester (1997) note that a profit efficiency concept can be superior to cost efficiency for reviewing a firm's overall performance because the former accounts for inefficiency on the output as well as the input side. Profit efficiency is based on a goal of profit maximization requiring equal managerial attention to the creation of a marginal dollar of revenue as to the elimination of a marginal dollar of costs. Profit efficiency also captures the variance in the quality of output, as higher quality outputs may be generating higher revenues (Berger, Hancock, Humphrey, 1993). A profit function also may be more fitting in a de-regulated and competitive environment. Revenue management can be as important as cost management in such an environment as a road to success, with new products and services offered that often entail higher costs to produce even higher revenues and profits. Berger and Mester (2003) note that studies in the 1990s that exclude revenues when examining bank performance may create misleading results, as this was a period of rising profit productivity for depository institutions.

An alternative profit frontier as suggested by Berger and Mester (1997) replicates the cost function detailed in equations (1) and (2) except that it replaces the dependent variable with variable profits. An alternative profit function holds variable output constant, similar to the cost function, while output prices are allowed to vary and affect profits. The alternative profit function is appropriate for banking studies, because it controls for unmeasured differences in output quality (as frequently is the case with bank/thrift services). It controls for the possibly higher costs by thrifts which offer these high-quality services by including additional revenues that might be generated from these services in the estimation process. As a result, it helps to avoid classifying a firm as (cost) inefficient if the same thrift offsets its high cost with high revenues.

In estimating the equation (3) to get profit inefficiency measures, we replace the dependent variable of cost with variable profits plus a constant [(all interest and fee income-the variable costs included in cost function) + θ]. The constant θ is the minimum profits for the sample plus 1 and is added to every firm's profit so that natural log is taken of a positive number as the minimum profits are usually negative. The profits of the thrift with the minimum profits would become 0 because $\log(1) = 0$. The same truncation process is applied to these profit inefficiency measures before they are converted to efficiencies using a conversion similar to

equation (4). The profit efficiency is defined as the ratio of predicted actual profits to maximum profits that could have been achieved if this firm were the best-practice thrift of the sample, as follows:

$$\text{PEFFRATIO}_i = \frac{\hat{p}^i}{\hat{p}^{\max}}, \quad (\text{A6})$$

where:

PEFFRATIO_i = The thrift i 's profit efficiency;

$\hat{p}^i$ = The estimate of predicted actual profit for thrift i ; and

$\hat{p}^{\max}$ = The maximum profits that the thrift i could have earned at the best-practice thrift's efficiency level in the sample.

Due to the addition of the constant θ to include the thrifts with negative earnings into the estimation process, equation (6) doesn't converge into the simple ratio of $\hat{u}$'s as in the cost equation of (5). Because the inefficiency is not multiplicatively separable from the profit function anymore, we instead calculate the PEFFRATIO using equation (6) with an adjustment to compensate for θ addition in inefficiency estimations.¹² Similar to cost efficiency, the best practice thrift receive a 1 as an efficiency score. In contrast to cost efficiency, however, profit efficiency can be negative because a firm could discard more than 100 percent of its potential profit.

¹²See Berger and Mester (1997) and Rogers (1998) for more details of the application of this methodology.

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