Thrift Viability and Traditional Mortgage Lending: A Simultaneous Equations Analysis of the Risk-Return Trade-Off

*M. Cary Collins**
*Van Son Lai***
*James E. McNulty****

Abstract. **A number of studies have argued that the thrift industry is not viable as it is presently structured and regulated because mortgage yields are inadequate to cover interest and operating costs. This hypothesis suggests that observed profitability is primarily the result of the tendency of the industry to "ride" the yield curve by borrowing short and lending long. To evaluate this argument, we construct a simultaneous-equations model of thrift risk (maturity gap positions) and return (net interest margin). We find support for the notion that the industry could not be reasonably profitable if it did not take on significant interest-rate risk. For instance, a zero gap position produces a return on assets of only 19 basis points and a return on equity of only 4%. We also estimate the amount of interest-rate risk the industry can employ to increase returns on equity and assets. Our estimates show that over 50% of thrift profits earned during this period are the result of negative gap positions and interest-rate speculation. As earlier research shows, changes in regulations affecting thrift asset and liability choices can be counterproductive.**

Introduction

Researchers, regulators and the U.S. Congress have questioned the viability of the thrift industry in recent years. First, a major increase in interest rates substantially weakened the industry in the early 1980s. Then, under regulatory pressure to restore adequate capital levels, as well as market pressure to restore adequate net interest margins, many thrift financial managers substituted credit risk for interest-rate risk, which resulted in an extraordinary volume of bad real estate loans. This risk increase led to a substantial number of thrift failures. The surge in thrift profitability in 1992, as interest rates fell to their lowest levels in almost twenty years, is a further indication that these institutions continue to operate with a short-funded capital structure and that their underlying profitability may be almost entirely a result of this structure.[1]

The regulatory issues associated with the viability of these specialized mortgage-lending institutions are numerous. For example, the 1989 Financial Institutions, Reform, Recovery and Enforcement Act (FIRREA) substantially increased regulatory pressure on the thrift industry. Other authors have noted that the qualified thrift lender (QTL) test in FIRREA increases instability by forcing thrifts to remain specialized mortgage

*Department of Finance, 421 Stokely Management Center, College of Business Administration, The University of Tennessee, Knoxville, Tennessee 37996.
**Department of Finance and Insurance, Faculty of Administrative Sciences, Pavillion Palasis Prince, Laval University, Quebec, Canada G1K 7P4.
***Department of Finance and Real Estate, College of Business, P. O. Box 3091, Florida Atlantic University, Boca Raton, Florida 33431-0991.
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lenders. The 1991 Federal Deposit Insurance Corporation Improvement Act (FDICIA) mandates early intervention and prompt corrective action for poorly capitalized financial institutions. Nonetheless, many analysts argue that the thrift industry's simultaneous dependence on mortgage-related assets and on short-term liabilities creates an untenable, long-run situation and a significant strain on the U.S. financial system. These analysts point to the large number of major thrift failures over the last ten years and to the more recent taxpayer bailout of the thrift insurance fund as ample evidence that an industry composed of specialized mortgage lenders is not viable.

The purpose of this paper is to evaluate the viability argument by focusing on the role of maturity gap positions and the traditional net interest margin (NIM) in determining thrift profitability.[2] Using a simultaneous-equations system on thrifts spanning the period 1984 through 1988, we find support for the notion that the industry could not be reasonably profitable if it did not take on significant interest-rate risk. For instance, a zero maturity gap position produces a return on assets of only 19 basis points and a return on equity of only 4%. In estimating the amount of interest-rate risk the industry can employ to increase returns on equity and assets, we show that over 50% of thrift profits earned during the 1984 through 1988 period are the result of negative gap positions and interest-rate speculation. As earlier theoretical research shows, changes in the regulations constraining thrift asset choices can have a significant and unintended effect on thrift profitability. Our evidence suggests that the most prudent regulatory course is one expanding the asset and liability powers of thrifts, rather than the more recent regulatory attempts to restrict investment in non-mortgage assets.

The next section reviews the existing literature to develop a framework for investigating thrift viability. In the third section, we present a simultaneous-equations model of NIM and various maturity gaps with empirical and theoretical underpinnings. We discuss the empirical results of our analysis in the fourth section, presenting our conclusions in the final section.

Literature Review

Microeconomic theories of the banking firm have been developed by Klein (1971), and Sealey and Lindley (1977), as well as others. O'Hara (1983) develops a model in which the asset portfolio, the composition of the bank's deposit liabilities and other borrowings, firm scale, and the equity capital level are all endogenously determined. She shows, among other things, that holding only one type of asset is non-optimal. The implication is that the specialized lending strategy followed by most thrifts as a result of regulatory constraints is non-optimal. Contrary to Klein (1971), she finds that the optimal structure of the asset portfolio is dependent on the structure of the bank's liability portfolio and vice versa. Her model can be summarized as follows:

$$Return = f(r, ACOMP, FFR, LCOMP, E).$$

O'Hara shows that the returns to a financial institution are a function of the marginal costs of borrowing (r), the structure of the asset portfolio ($ACOMP$), the amount of firm non-deposit borrowings (FFR), the structure of the deposit liability portfolio, and the level of equity capital in the firm. O'Hara (1983) provides only a partial analysis of the interest-rate risk position of the financial institution, however, since she does not allow

for a simultaneous change in the loan or deposit rates or for a shift in the maturity gap of the institution as rates change.

While O'Hara (1983) and Klein (1971), as well as others, consider the funding and interest-rate environment exogenous for modelling the banking firm, Morgan and Smith (1987) endogenize the funding environment in a theoretical model of financial intermediation. Morgan and Smith provide a detailed analysis of the funding decision, particularly with respect to the maturity intermediation (gap) choices of the firm, and the level and variability of the interest-rate environment. Their findings suggest that the minimum risk maturity gap is not necessarily the zero-gap position, but rather the minimum risk maturity gap is dependent on the market interest-rate level and variability, as well as future loan demand. For instance, risk-averse intermediaries wish to hedge against low future loan demand states of the work, since these are associated with low profits from short-term lending. As long as deposit rates and future loan rates are positively associated, the financial institution can achieve some risk reduction from a negative gap position.

Approaching the thrift viability argument from an empirical standpoint, Carron and Brumbaugh (1989) suggest that the spread between mortgage yields and deposit costs is insufficient to cover a thrift's operating costs. For the period 1982 to the first quarter of 1989, they compute the return on mortgages to be 14.37% (after adjusting for default risk) and the seven-year Treasury rate to be 13.63%, for a net spread of 74 basis points. Using a cost-of-funds figure at 100 basis points over the Treasury, they conclude that purely duration-matched thrifts would have experienced zero profits over the period 1986 through 1989, and losses over the period 1982 through 1985. If their analysis is correct, any sustained profitability observed in this industry during the 1980s must be the result of maturity mismatches between assets and liabilities, i.e., interest-rate speculation.

While it is intuitively appealing, the Carron and Brumbaugh argument has some limitations. First, the authors rely solely on aggregate industry data. This information source cannot capture differences in operating costs across thrifts. For instance, thrifts with lower operating costs can survive with lower spreads between mortgage yields and deposit costs. Carron and Brumbaugh also neglect differences in the ability of thrifts to generate fee income as a means of supplanting net interest margins. Second, the Carron-Brumbaugh analysis is not a theoretical model of thrift viability, but rather a descriptive study of the industry's position. Econometric studies have concluded that the thrift industry could have been profitable in the late 1970s and early 1980s if institutions had hedged their interest-rate risk exposure (Hess, 1987). Finally, Carron and Brumbaugh look at the profitability of mortgage lending in isolation, rather than in a portfolio context. In a portfolio context, low covariances among asset returns can reduce risk substantially. Although studying commercial banks with smaller mortgage portfolios as a fraction of total assets—approximately 45% on average—Eisenbeis and Kwast (1991) show that commercial banks that specialize in mortgage lending are highly profitable and have less risk than their non-mortgage lending counterparts.

Our study empirically tests the thrift-industry viability hypothesis using the critical factors considered by O'Hara (1983), Morgan and Smith (1987) and others. Consistent with Carron and Brumbaugh, we define viability as the ability to operate profitably with a matched-maturity strategy (a zero gap position).[3] In contrast to Carron and Brumbaugh, however, the test is based on individual firm data. Therefore, we do not need to specify *a priori* the net interest margin an institution would require to be profitable.

The Data and a Risk-Return Model of Thrift Viability

Until recently, the conventional method for analyzing the financial performance of financial institutions was a single equation, ordinary least squares regression model. Given the fact that a change on one side of the balance sheet automatically affects the other side, and that the income statement is affected by both, Graddy and Kyle (1979, 1980) first made the case for using simultaneous-equations techniques in the analysis of financial institution performance. Ordinary least squares is inappropriate in this context because the explanatory variables will not be independent of the error term.

A Risk-Return Model of Thrift Viability

In part one of our study, we use three-stage least squares estimation to construct a simultaneous-equations model of interest-rate risk and return for thrift institutions. 3SLS estimation permits us to use the information contained in the covariances among the errors of our reduced-form equations, which asymptotically increases the efficiency of the estimators. The 3SLS method is most appropriate when examining a simultaneous relationship like risk and return trade-offs, because the parameters in the system are estimated jointly. Graddy and Kyle use three-stage least squares (3SLS) in their simultaneous framework, while Clark (1986a, 1986b) and Lindley, Verbrugge, McNulty, and Gup (1992) use two-stage least squares. 3SLS analysis has also been applied to non-financial firms by Jensen, Solberg and Zorn (1992).

Our measure of interest-rate risk is the asset-liability maturity gap, the only measure for which data is available for these institutions. The asset-liability maturity gap is the difference between variable-rate assets and variable-rate liabilities, expressed as a percentage of total assets.[4] While duration is a superior measure of rate risk from a theoretical point of view, thrift duration data are not available. Since the maturity gap measures the sensitivity of the net interest margin (NIM) to changes in interest rates, we use NIM as the appropriate measure of return. Our system of equations is estimated on a pooled cross-section, time-series of approximately 35,000 quarterly observations from 1984 through the second quarter 1988.

Modeling Net Interest Margin. We posit the following functional relationship and expected signs for the determination of NIM:

$$\begin{aligned} NIM = f(& \overset{\pm}{r}, \ \overset{\pm}{\sigma_r}, \ \overset{\pm}{g}, \ \overset{-}{A}, \ \overset{-}{ACOMP}, \ \overset{+}{FFR}, \ \overset{-}{LCOMP}, \ \overset{+}{E}, \\ & \overset{+}{CR3}, \ \overset{-}{GAP12}, \ \overset{-}{GAP60}) , \end{aligned} \tag{1}$$

where:

r = market rate of interest;
σ_r = the variance of market interest rates;
g = one-year growth rate of assets;
A = the natural logarithm of total assets;
$ACOMP$ = asset composition, the ratio of nontraditional assets (real estate development loans, commercial and consumer loans) to total assets;

FFR = free funds ratio, non-interest-bearing liabilities divided by total deposits;
$LCOMP$ = liability composition, the ratio of borrowed funds (federal funds purchased, repurchase agreements, Federal Home Loan Bank advances, mortgage-backed bonds and commercial paper) to total liabilities;
E = equity capital to total assets;
$CR3$ = the three-firm concentration ratio (the percent of deposits held by the top three financial institutions in the market);
$GAP12$ = the difference between rate-sensitive assets and rate-sensitive liabilities, where rate sensitivity is measured over the upcoming zero-to-twelve-month period, divided by total assets; and
$GAP60$ = the twelve-to-sixty month maturity gap.

These factors can be summarized into six categories: interest rates and volatility, growth in assets and asset size, asset composition, liability composition and leverage, competition, and gap ratios. In the following paragraphs, we discuss the basis in the literature for each of these hypothesized relationships.[5]

Interest rates and volatility. Hanweck and Kilcollin (1984) show that, in addition to maturity mismatches of existing assets and liabilities, current and past rates on assets and liabilities and portfolio shifts affect NIM following changes in interest rates. Because they lacked data on portfolio composition and liability cost, Hanweck and Kilcollin posit a reduced-form equation in which NIM is a function of only current and past market interest rates, reflecting the returns financial institutions can earn by adding assets. The expected sign of (r) could be either positive or negative, depending on the thrift's funding or gap positions. For instance, a negative sign would reflect the fact that thrifts are short-funded and suffer when rates rise.

Ho and Saunders (1981) and Flannery (1981, 1983) show that financial institution NIMs depend on the variance of interest rates (σ_r). Rate volatility can also affect NIM either positively or negatively depending on an institution's asset-liability structure.

Growth in assets and asset size. Since asset growth results from both voluntary action on the part of thrift management and exogenous and uncontrollable shifts in market conditions, the expected sign for growth in assets (g) is ambiguous. Graddy and Karna (1984) find that the NIMs of small banks, but not of large ones, are negatively related to changes in the rate of firm growth, implying that faster growth requires more rate-sensitive funds and puts downward pressure on NIMs. However, asset growth and NIM could be positively related for thrifts with an overhang of low-rate assets from the 1970s and a management strategy aimed at growing out of the low-NIM problem.

Ho and Saunders (1981) and Allen (1988) suggest that NIMs also depend on asset size (A). When financial institutions are viewed as risk-averse dealers (i.e., making loans or acquiring securities with the same maturity as liabilities to avoid interest-rate risk), Ho and Saunders (1981) find that the pure spread depends on the degree of bank management risk aversion, the bank's market structure, the average size of bank transactions, and the variance of interest rates. Allen (1988) finds this pure spread also depends on demand for various bank products and services, a type of portfolio effect. Here, bank margins consist of the pure spread plus markups for implicit interest expense, the opportunity cost of required reserves and deposit insurance, and default risk

premiums on loans. Furthermore, Allen (1988) finds that as size increases, due to the portfolio effect, the pure margin (the margin needed to compensate for transactions uncertainty) is reduced.

Asset composition. Lindley et al. (1992) use the ratio of real estate development loans, consumer loans and commercial loans to total assets as a measure of asset portfolio riskiness (*ACOMP*). While these higher risk assets should be associated with higher returns, they hypothesize a negative relation. That is, imprudent use of new powers by thrifts produced lower or negative returns.[6] We maintain the same hypothesis. Flannery (1981, 1983) also finds that bank income depends on asset composition as well as the level and volatility of interest rates as noted earlier. Olson and Simonson (1982) and Simonson and Hempel (1982) show that NIM depends not only on a rate effect but also on a volume effect, a mix effect and an earnings power or "free funds" effect. The free funds ratio is defined as the proportion of earning assets financed by non-interest-bearing liabilities. In our study, the rate and volume effects are captured by the variables r and g, respectively.

Liability composition and leverage. We include the ratio of borrowed funds to total liabilities as a measure of reliance on money-market liabilities. Since these are higher cost sources of funds, we expect the sign of *LCOMP* to be negative.

Zarruk (1989) and Zarruk and Madura (1992) show that (under most reasonable assumptions) increases in equity capital (E) or reductions in leverage increase a bank's spread or net interest margin. This result holds because the increase in equity reduces interest expense, both through a lower proportion of assets financed with interest-bearing liabilities and lower rates on these liabilities through lower risk. In addition, as McShane and Sharpe (1985) point out, equity capital is one of the best available measures of risk aversion.

Competition. The literature on the relationship between competition and financial institution profitability is extensive. Gilbert (1984) summarizes specific studies for thrifts, including Verbrugge and Goldstein (1981) and Verbrugge and Schick (1976). This research suggests that higher levels of competition or market concentration (*CR*3) are associated with higher loan rates and lower rates on deposits. As such, the sign of *CR*3 is expected to be positive.

Gap ratios. Since the study period is one in which interest rates were generally declining and the yield curve was upward sloping, thrifts that funded a substantial portion of their long-term assets with short-term funds (i.e., ran negative gaps) would be expected to have higher net interest margins. If an institution has a one-year planning horizon, the net interest margin for this period is dependent on the one-year gap (*GAP*12).[7] However, Simonson and Hempel (1982) show that simply focusing on the short-term gap and ignoring the interest-rate risk that arises in the longer-maturity portions of the balance sheet gives an incomplete picture of an institution's sensitivity to changes in interest rates. For this reason we include the sixty-month gap position (*GAP*60) as a determinant of NIM.

Modeling Maturity Gap. The following equation shows the determinants of the twelve-month maturity gap:

$$\begin{aligned} GAP12 = g\,(& \overset{+}{r}, \ \overset{-}{\sigma_r}, \ \overset{+}{r_{l-s}}, \ \overset{-}{A}, \ \overset{+}{CSTA}, \ \overset{\pm}{E}, \\ & \overset{+}{NIM}, \ \overset{+}{\sigma_{NIM}}, \ \overset{+}{GAP12_{-1}},) \, , \end{aligned} \tag{2}$$

where:

r = the short-term market interest rate;
σ_r = the variance of market rates of interest;
r_{l-s} = the spread between the long-term and short-term rate of interest;
A = the natural logarithm of total assets;
$CSTA$ = cash, marketable securities and trading account securities/total assets;
E = equity capital/total assets;
NIM = the net interest margin;
σ_{NIM} = the variance of NIM; and
$GAP12_{-1}$ = the ratio of the one-year maturity gap in the prior period to total assets.

We use a similar equation for the twelve-to-sixty-month maturity gap.

These factors can be grouped along the following paragraphs: interest rates, asset size and composition, leverage, the level and variance of NIM, and a lagged response.

Interest rates. Ho and Saunders (1981) and Flannery (1981, 1983) among others, suggest that gaps change in the same direction as the level of interest rates (r). This assumes that managers believe that high levels of rates relative to some historical norm mean that the probability of a decline is greater. Thus, they hold a large maturity gap position to speculate on this anticipated decline. Deshmukh, Greenbaum and Kanatas (1983a) consider the effect of interest-rate uncertainty on the inclination of a financial institution to engage in maturity matching. They assert that high interest rates induce banks to increase asset transformation. This again suggests a positive relationship between gap and the level of rates.

Deshmukh et al. (1983a) also suggest that increased rate volatility (σ_r) causes a bank to move toward the brokerage mode with a smaller maturity mismatch. Hence, the sign on σ_r is hypothesized to be negative.

McNulty, Morgan and Smith (1989) and Morgan and Smith (1987a) show that the gap position that minimizes an institution's risk exposure to unexpected changes in short-term deposit rates depends on the covariance of the short-term deposit rate with (1) profits from short-term lending and (2) the firm's "burden," defined as non-interest expense minus non-interest income. The minimum risk gap is thus a function of (a) the relative magnitude of the spread between short-term and long-term asset yields and short-term and long-term liability costs, and (b) the way the rate spread varies with changes in the level of interest rates. This covariance can be measured by the slope of the yield curve, which is measured by the difference between long- and short-term rates (r_{l-s}).

Asset size and composition. Koppenhaver and Lee (1987) suggest that maturity gap varies inversely with bank size (A). With access to the capital markets, large financial institutions rely less on retail deposits, managing the term structure of their liabilities instead through purchased funds and hedging. Morgan and Smith (1987b) also suggest that the gap position and the degree of economies of scope should be negatively related. Since size and economies of scope are positively associated, they expect that asset size and gap should be negatively related.

Deshmukh et al. (1983a) point out that a financial intermediary's decision to borrow funds to actively assume interest-rate risk may be interpreted as a choice of operating more as an asset transformer than as a broker. A broker takes deposits and makes loans

or buys securities of the same maturity, while an asset transformer does not allow the maturity composition of its liabilities to dictate the structure of its loans and other assets. In this framework, the choice of the degree of intermediation is influenced by uncertainty regarding conditions of loan demand and funds supply. Therefore, the initial loanable funds inventory (*CSTA*) can be considered a measure of the institution's maturity mismatch, its management style and aggressiveness, its asset transformation policy, and its subsequent interest-rate exposure. A larger loanable funds inventory suggests an asset transformation management style, hence a larger gap (Ho and Saunders, 1981; Koppenhaver, 1985, 1990).

Leverage and the equity capital position. A reduction in leverage may increase the ability of an institution to take on interest-rate risk. McNulty (1987) argues that one of the main determinants of interest-rate risk positions is the level of capital (*E*). Any firm must take some risk in order to be profitable; for thrift institutions, one way of earning profits is to ride the yield curve to some extent. Thrifts can afford to ride out an adverse interest-rate move if they have a strong capital position. On the other hand, low levels of capital increase the incentives to take risks and thus increase the moral hazard problem. Thus, gaps may increase in absolute size as equity declines or leverage increases.

Level and variance of NIM. NIM is included to capture the simultaneous relationship between NIM and gap (Graddy and Kyle, 1979, 1980; Clark, 1986b). If we assume that the yield curve is upward sloping, then an institution borrowing short and lending long (i.e., with a larger, more negative maturity gap) will exhibit a larger NIM.

Since bank asset and liability management is measured by the degree to which a high and stable NIM is achieved over time with interest-rate uncertainty, we hypothesize that the larger the variance of NIM (σ_r), the larger the gap. In other words, institutions that are able to earn only a small spread on a matched-maturity basis will be forced to take a larger interest-rate risk position in order to earn a competitive return.

Lagged responses. Because thrifts hold relatively illiquid, longer-term assets, an adjustment to a new gap position cannot be achieved immediately. Therefore we include the lagged value of the gap to total assets ratio as an independent variable in a partial adjustment proxy.

Modeling Return on Assets. In the second part of our analysis, we construct an equation for overall thrift profitability, return on assets (*ROA*). The *ROA* equation is not a behavioral equation. It is an accounting equation, derived directly from the thrift income statement, which we use to estimate the *ROA* associated with a given NIM. Since *ROA* and *ROE* are the most important profitability ratios, we need to translate NIM into a return on assets ratio in order to discuss the impact of maturity gap on profitability. As suggested above, if thrifts with low maturity gaps and resulting low NIMs can control operating expenses better or earn more fee income than other thrifts, then they can achieve comparable *ROA*s without as much interest-rate risk. Therefore, both NIM and *ROA* need to be considered.

Since it is simply an accounting equation, *ROA* is not estimated as part of the simultaneous-equations system. It is only used after the simultaneous system is estimated. Holding other variables in the NIM equation constant at their respective means, we estimate NIM for various one-year gap positions. These estimated NIMs are then used in the *ROA* equation, holding the additional independent variables constant at their means, to arrive at an estimated return on assets. Since most gap values are in the 0–50% range,

we estimate the NIM associated with each of these gap positions from equation (1), at 5% increments. We then calculate the *ROA* associated with each NIM from equation (3). The form of the equation is as follows:

$$ROA = h\,(\overset{+}{PREDNIM},\ \overset{+}{NONII},\ \overset{-}{NONIE},\ \overset{-}{PLL},\ \overset{-}{TAX})\,, \tag{3}$$

where:

ROA = return on assets;
PREDNIM = the predicted net interest margin, as estimated from equation (1) of our system of equations;[8]
NONII = non-interest income (primarily income from fees and service charges) relative to total assets;
NONIE = non-interest expense (wages and salaries, office occupancy expense, advertising, etc.) relative to total assets;
PLL = provisions for loan losses divided by total assets; and
TAX = total state and federal taxes relative to total assets.

We use predicted net interest margins rather than actual NIMs in order to capture the effect of GAP as a determinant of NIM from the simultaneous-equations system.[9] This approach is superior to Carron and Brumbaugh (1989) who implicitly assume that all thrifts must earn the same net interest margin to attain a certain level of profitability.

In the final part of our analysis, we estimate the gap position that a thrift needs to hold to earn a given net interest margin. This sensitivity estimation will enable us to determine how much interest-rate risk thrifts must accept to attain various levels of profitability. We also determine whether thrift portfolio managers can be considered risk-averse in the context of modern financial theory.

Data Sources

The data for this study represent a pooled cross-section and time series of over 35,000 observations. Selected characteristics of the sample are shown in Exhibit 1. Data are quarterly balance sheet and income statement items from the first quarter 1985 to the second quarter 1988 for savings and loan associations that were filing financial reports with the Federal Home Loan Bank Board, insured by the FSLIC, and solvent on the basis of generally accepted accounting principles.[10]

We divide our sample into the following five asset-size groups:

Group 0: All thrifts
Group 1: Total assets less than $50 million
Group 2: Total assets between $50 and $100 million
Group 3: Total assets between $100 and $300 million
Group 4: Total assets between $300 million and $1 billion
Group 5: Total assets above $1 billion.

The sample sizes change from year to year as institutions fail, are merged out of existence, or created through de novo charters.

Balance sheet and income statement data are taken from the Quarterly Thrift Financial (QTF) Report, as submitted to the Federal Home Loan Bank Board (now Office of Thrift Supervision). Data for the calculations of gap ratios are extracted from Section H of the QTF Report.

To measure growth, we use the four-quarter rate of change in total assets, g. The log of total assets, A, reflects the fact that many financial institution return and operating characteristics vary with firm size. The free-funds ratio, FFR, is represented by the ratio of non-interest-bearing deposits to earning assets. $ACOMP$, the asset composition measure, is the ratio of nontraditional assets (real estate development loans, consumer loans and commercial loans) to total assets. On the other hand, $LCOMP$, the liability composition measure, is the ratio of nontraditional liabilities (FHLB advances, Negotiable CDs, Fed funds, and Repos) relative to total liabilities. We use total equity capital according to GAAP standards as our measure of the thrift's capital position, E. We measure the inventory of loanable funds, $CSTA$, by the total of cash, marketable securities and assets held in trading accounts. The percent of deposits held by the top three financial institutions is a proxy for the level of competition in the market, $CR3$. All the explanatory variables except the market concentration ratio are scaled by total assets.

Interest rates (r) are weekly average three-month U. S. Treasury bill rates, as reported by the Board of Governors of the Federal Reserve System, converted to quarterly averages. The spread between long-term and short-term rates (r_{l-s}) is the ten-year rate less the three-month rate computed from the same source. The variance of market interest rates (σ_r) is a moving variance—the data for each quarter are computed from weekly average Treasury bill rates for the three-quarter period prior to and including the quarter under consideration.

Exhibit 1 indicates that the average firm in the sample has total assets of $345 million, an annualized net interest margin of 2.04% (.0051 multiplied by 4), and an annualized return on assets of 52 basis points. Lower levels of profitability are reported for the larger institutions in the sample. Equity capital ratios average 5.7%, with lower levels at the larger thrifts. The average level of the one-year gap is –16.7% of assets. As the figures in Exhibit 1 show, this study period is characterized by generally declining interest rates and an upward-sloping yield curve.

Results

NIM Equation

Exhibit 2 shows the results of the NIM equation. As expected, short-term interest rates have a negative effect on thrift institutions' NIM because these institutions generally have excess short-term liabilities relative to short-term assets. As a result, their margins narrow when rates rise and increase when rates fall. As indicated, this effect was highly significant (t=33.1). This is in contrast to the results of Ho and Saunders (1981), Flannery (1981, 1983) and Hanweck and Kilcollin (1984) for commercial banks. There is no evidence that asset growth has the expected negative effect on NIM as found by Graddy and Karna (1984) for small banks. In addition, NIMs decrease as asset size increases, consistent with the theoretical and empirical work of Ho and Saunders (1981) and Allen (1988). The positive sign of the equity capital variable is consistent with the theoretical work of Zarruk (1989) and Zarruk and Madura (1992). The free funds ratio had the expected

Exhibit 1
Descriptive Statistics

Panel A

Variable	Full Sample	Groups by Size 1	2	3	4	5
Asset/Liability Management Variables						
Quarterly Return on Assets (*ROA*)	0.0013	0.0015	0.0015	0.0012	0.0010	0.0009
Quarterly Net Interest Margin (*NIM*)	0.0051	0.0061	0.0053	0.0048	0.0040	0.0032
Four-quarter σ of NIM_{t-1}	0.0011	0.0 012	0.0010	0.0010	0.0011	0.0011
0-to-12 month maturity GAP	−0.1670	−0.1579	−0.1554	−0.1787	−0.1800	−0.1751
12-to-60 month maturity GAP	−0.2618	−0.2730	−0.2609	−0.2595	−0.2551	−0.2358
Asset Ratios						
Nontraditional assets-to-total assets (*ACOMP*)	0.0514	0.0471	0.0505	0.0500	0.0582	0.0681
Free-Funds Ratio (*FFR*)	0.0172	0.0129	0.0155	0.0192	0.0215	0.0259
Inventory of loanable funds-to-Total Assets (*CSTA*)	0.1695	0.2013	0.1752	0.1520	0.1424	0.1295
Liability and Equity Ratios						
FHLB advances & other borrowings-to-total liabilities (*LCOMP*)	0.0619	0.0254	0.0448	0.0635	0.1054	0.2070
Equity capital-to-total assets (*E*)	0.0569	0.0680	0.0565	0.0510	0.0485	0.0486
Size, Growth and Concentration						
Log of total Assets (*A*)	11.5480	10.1288	11.1549	12.0057	13.1018	14.6579
Growth rate in assets (*g*)	−0.6692	−1.0191	−0.9653	−0.8334	−0.3557	2.2164
Three-firm Concentration Ratio (*CR*3)	0.6106	0.6922	0.6268	0.5755	0.5378	0.4635
Other Descriptive Statistics						
Total assets ($000s)	345,826	28,487	71,263	171,922	521,946	3,299,83
Total common equity ($000s)	17,452	1,815	4,020	8,656	25,267	165,287
Sample size	34,897	10,336	8,200	10,016	4,129	2,216

Notes: The sample means are for the full sample, and then for each size-category subgroup. Averages are calculated from the first quarter 1985 through the second quarter 1988.

Panel B

Variable	Mean	1984	1985	1986	1987	1988
Interest-Rate Environment Proxies						
3–month Treasury bill rate (*r*)	7.04	9.45	7.50	6.00	5.75	5.95
σ of the 3–month T-bill rate (σ_r)	1.37	2.10	1.08	1.35	1.28	0.75
Treasury spread (10-year - 3–month) ($r_{l\text{-}s}$)	2.59	2.90	3.20	1.55	2.65	2.70

Notes: The sample means are for the full period, and then for each year. Averages are calculated from the first quarter through the fourth quarter for each year, excpet for 1988 where only the first two quarters are used.

Exhibit 2
Three-Stage Regression Results for the Net Interest Margin

Explanatory Variables	Full Sample	Groups by Size				
		1	2	3	4	5
Intercept	0.0104*** (58.129)	+	+	+	+	+
3–month Treasury bill rate	−0.0005*** (−33.122)	−	−	−	−	−
σ of the 3–month T-bill rate	−0.0005*** (−11.982)	−	−	−	−	−
Growth rate in assets	1.1E-6 (0.469)	•	−	•	•	•
Log of total assets	−0.0004*** (−36.969)	−	−	−	−	•
Equity capital-to-total assets	0.0313*** (85.383)	+	+	+	+	+
Nontraditional assets-to-total assets	0.0065*** (27.559)	+	+	+	+	+
FHLB advances & other borrowings-to-total liabilities	−0.0067*** (-29.467)	−	−	−	−	−
Free-funds ratio	0.0025*** (3.275)	+	−	+	•	•
0-to-12 month maturity GAP	−0.0052*** (−40.215)	−	−	−	−	−
12-to-60 month maturity GAP	−0.0001 (−1.060)	−	•	+	+	•
Three-firm concentration ratio	0.0002*** (4.815)	+	+	•	−	+
Durbin-Watson test statistic	1.96	1.98	1.97	1.93	1.83	2.07
System-weighted R^2	.72	.74	.72	.70	.67	.70

Notes: Results appear for the entire sample of solvent, FSLIC-insured savings and loan associations from the first quarter of 1985 through the second quarter of 1988, as well as for each of the subgroups. *T*-statistics appear in parentheses beneath the regression coefficients. *** indicates significance at the .01 level. For each of the subgroups, a "+" sign indicates that the coefficient in the regression is positive and significant, a "−" sign indicates that the coefficient in the regression is negative and significant, and a "•" indicates that the coefficient in the regression was not significant at the least restrictive .10 level.

positive sign, consistent with Olsen and Simonson (1982) and Simonson and Hempel (1982). The nontraditional asset ratio has a positive effect on NIM. Lindley et al. (1992) use this ratio as a measure of the extent to which individual thrift institutions ventured outside their traditional areas of specialization, into such areas as high-risk real estate development lending. The positive coefficient for NTA is in contrast to their finding of a negative relationship between NTA and thrift profitability for a sample of new institutions.

The results also show that thrifts that use a higher percentage of Federal Home Loan Bank advances and other borrowed funds have lower net interest margins, and that this effect is highly significant. This is a reasonable and expected result since these liabilities

have higher costs. The zero-to-twelve-month gap has a highly significant negative coefficient ($t=40.2$). Since the vast majority of thrift institutions have negative gap positions in the zero-to-twelve-month range, a *decrease* in $GAP12_i$ reflects an *increase* in interest-rate risk, i.e., a move to a *more negative* gap. Such an increase in interest-rate risk produces a statistically significant *increase* in thrift NIM, according to the results in Exhibit 2. This suggests that there were tremendous advantages to "riding the yield curve" during this period. The Carron and Brumbaugh hypothesis would suggest that most observed thrift profitability is the result of interest-rate speculation. The results presented here are consistent with their argument that the industry is not viable on a matched-maturity basis. The coefficient of the three-firm concentration ratio also had the expected positive sign and is significant. This is consistent with a large body of literature that suggests that market structure affects financial institution performance.[11] The fit of the equations is much higher than that of many cross-sectional financial institution studies. R^2 equals .72 for the sample as a whole, and never falls below .67 for any subsample.

Gap Equations

The regression results for equation (2), the first gap position equation, appear in Exhibit 3 and provide evidence that thrift financial managers are not risk averse. For example, the significant coefficient for the Treasury bill rate indicates that thrifts *do adjust their gaps* as interest rates change, rather than setting the gap at a predetermined level dictated, for example, by the institution's asset-liability management policy.[12] Furthermore, their behavior involves interest-rate speculation. Specifically, the sign of the coefficient of the rate variable is negative, indicating that as rates increase, the gap becomes more negative (it *increases*). This indicates that movements to a higher interest-rate risk position occur when the rewards from such a move are high. This is consistent with the argument of Deshmukh et al. (1983a,b) that high interest rates induce financial institutions to undertake more asset transformation and assume more balance sheet mismatch.

The standard deviation of interest rates has a significant negative coefficient, indicating that as rate volatility increases, gaps become more negative (they increase). This again suggests an increase in interest-rate speculation when the potential rewards are high. This behavior is contrary to that which would be predicted by the theoretical argument of Deshmukh et al. (1983a,b) that increased volatility in interest rates causes a bank to move more to the brokerage mode, with less maturity mismatch. A risk-averse financial manager faced with greater rate variability would, no doubt, reduce his gap position to reduce the probability of insolvency. On balance, however, institutions in this industry did the opposite. This moral hazard problem facing institutions with federally insured deposits has been widely discussed in the financial institutions literature.

In contrast to Koppenhaver and Lee's (1987) results for commercial banks, there is no significant relationship between gap and asset size. The inventory of loanable funds (liquid assets as a percent of total assets) is our proxy for the intermediary's decision to borrow funds in advance to actively assume interest-rate risk. Based on the argument of Deshmukh et al. (1983a,b), such an inventory represents a management decision to operate more as an asset transformer than as a broker. This decision would suggest that an increase in loanable funds would be associated with a larger (i.e., more negative) gap. However, this variable has a significant and positive coefficient. The coefficient reflects

Exhibit 3
Three-Stage Regression Results for the 0-to-12 Month GAP

Explanatory Variables	Full Sample	Groups by Size 1	2	3	4	5
Intercept	−0.0404*** (−8.261)	−	•	•	•	•
3–month Treasury bill rate	−0.0027*** (−5.800)	+	+	+	•	•
σ of the 3–month T-bill rate	−0.0041*** (−3.237)	•	•	−	−	•
Treasury spread (10-year–3-month)	0.0034*** (5.704)	+	+	+	•	+
Log of total assets	−0.0004 (−1.483)	−	•	•	•	•
Inventory of loanable funds-to-total assets	0.0328*** (10.516)	+	+	+	•	+
Prior quarter equity capital-to-total assets	−0.0176 (−1.610)	−	•	•	•	+
Prior quarter 0-to-12 month maturity GAP	0.8676*** (374.676)	+	+	+	+	+
Prior quarter quarterly net interest margin	−0.5565*** (−3.843)	+	−	−	−	−
Prior quarter standard deviation of NIM	−0.0335 (−0.118)	•	•	•	•	•
Durbin-Watson test statistic	2.35	2.25	2.05	2.05	1.89	2.08

Notes: T-statistics appear in parentheses beneath the regression coefficients. *** Indicates significance at the .01 level. For each of the subgroups, a "+" sign indicates that the coefficient in the regression is positive and significant, a "−" sign indicates that the coefficient in the regression is negative and significant, and a "•" indicates that the coefficient in the regression was not significant at the least restrictive .10 level. Three-stage least squares does not produce equation-specific R^2 figures, producing instead a system weighted R^2. This R^2 figure can be found in Exhibit 2.

the definition of gap (rate sensitive assets less rate sensitive liabilities); ceteris paribus, an institution with more short-term assets has less interest-rate risk.

The sign of the coefficient of the equity capital variable is negative, indicating that as capital levels increase, gaps become more negative (they increase). This suggests that interest-rate risk increases as institutions are more able to bear it. However, the sign is not statistically significant. Thus, there is no evidence in this equation that deteriorating capital positions lead institutions to speculate on interest rates.

As the slope of the yield curve (measured here by the spread between ten-year and three-month rates) increases, the profits from borrowing short term and lending long term clearly increase. The results indicate that, as the yield curve becomes steeper, gaps become more positive (they decrease). This result suggests that, on balance, thrifts are not attempting to obtain additional returns from interest-rate speculation when the yield curve steepens.

The sign of the coefficient for prior quarter NIM is negative and significant, indicating that, as NIM increases, gaps become more negative (they increase). While we are using a simultaneous-equations system, we cannot separate cause and effect. It could be that the

increase in the GAP is causing the increase in the net interest margin, rather than the reverse. This is likely since the coefficient of GAP in the NIM equation (Exhibit 2) was negative and highly significant ($t = 40.2$). In other words, the combination of the previous period gap and interest rates determines the current net interest margin. The coefficient for the previous period gap is positive with a sign slightly less than one and is highly significant. Since thrift institutions hold primarily long-term assets, the adjustment to a new gap position comes only slowly.

The results for the twelve-to-sixty-month gap equation are shown in Exhibit 4 and are generally consistent with those for the short-term gap with the exception of the capital variable and the slope of the yield curve. The coefficient of the lagged equity capital variable is negative and significant. In other words, increased capital levels are associated with larger (more negative) gaps. This provides one of the few indications of risk-averse behavior—interest-rate risk is assumed by those institutions that are best able to bear such risk. The slope of the yield curve variable is negative and significant. This suggests that, for this particular gap measure, thrifts do take on more risk when the yield curve steepens and the rewards from a mismatched maturity position are high.

ROA Equation

Exhibit 5 contains the results of the regression run on the *ROA* equation. The results show that a 10-basis-point increase in the net interest margin increases *ROA* by 6.3 basis points. A 10-basis-point increase in non-interest income (primarily fee income) increases *ROA* by 7.2 basis points. A 10-basis-point increase in non-interest expense (wages and salaries, advertising, etc.) decreases *ROA* by 7.5 basis points. A 10-basis-point increase in provisions for loan losses decreases *ROA* by approximately the same amount. An increase in taxes has a much smaller effect than any of the other variables. In addition, smaller thrifts are more profitable than larger ones.[13]

Profitability Simulation Results

To illustrate the importance of our findings in determining the thrift's viability as a traditional mortgage lender, we estimate overall thrift profitability in a two-step process employing the net interest margin equation and then, the return on assets equation. The results are as follows:

***GAP*12** (%)	***NIM*** (%)	***ROA*** (%)
0	1.695	0.188
− 5	1.804	0.255
−10	1.910	0.322
−15	2.017	0.389
−17.5[14]	2.070	0.423
−20	2.123	0.456
−25	2.229	0.524
−30	2.335	0.591
−35	2.441	0.658
−40	2.547	0.725
−45	2.653	0.792
−50	2.759	0.859

Exhibit 4
Three-Stage Regression Results for the 12-to-60 Month GAP

Explanatory Variables	Full Sample	Groups by Size				
		1	2	3	4	5
Intercept	0.2397*** (30.852)	+	+	+	+	+
3–Month Treasury bill rate	−0.0299*** (−4 0.922)	−	−	−	−	−
σ of the 3–month T-bill rate	−0.0671*** (−33.589)	−	−	−	−	−
Treasury spread (10-year–3-month)	−0.0172*** (−18.058)	−	−	−	−	−
Log of total assets	0.0022*** (5.377)	+	•	•	•	•
Inventory of loanable funds-to-total assets	0.0901*** (18.440)	+	+	+	+	+
Prior quarter equity capital-to-total assets	−0.0620*** (−3.587)	•	−	−	+	•
Prior quarter 12-to-60 month maturity GAP	0.8561*** (359.988)	+	+	+	+	+
Prior quarter quarterly net interest margin	−1.1480*** (−5.081)	−	+	•	•	•
Prior quarter standard deviation of NIM	4.1716*** (9.375)	+	+	+	+	•
Durbin-Watson test statistic	2.16	1.97	1.82	1.93	1.82	2.08

Notes: T-statistics appear in parentheses beneath the regression coefficients.
*** indicates significance at the .01 level. For each of the subgroups, a "+" sign indicates that the coefficient in the regression is positive and significant, a "−" sign indicates that the coefficient in the regression is negative and significant, and a "•" indicates that the coefficient in the regression was not significant at the least restrictive .10 level. Three-stage least squares does not produce equation-specific R^2 figures, producing instead a system-weighted R^2. This R^2 figure can be found in Exhibit 2.

The net interest margin of 1.70% associated with a zero maturity gap produces a return on assets of only 19 basis points. Given a 5% capital position (an equity multiplier of 20), this translates into a return on equity of only 4%. However, the rewards from interest-rate speculation are substantial. Thrifts can increase their net interest margins by over 100 basis points and their return on assets by about 65 basis points by maintaining a negative gap position and riding the yield curve. Given a 5% capital position (an equity multiplier of 20), a thrift institution that wanted to earn a 12% return on equity would have had to run a gap of about −30%. The risks from a −30% gap are substantial if interest rates were to increase.

The regulatory importance of these findings is significant. Similar to Carron and Brumbaugh, we conclude that a thrift industry composed primarily of specialized mortgage lenders cannot be reasonably profitable without significant interest-rate risk. In addition, thrift profitability would be cut by an estimated 55% (from 42 basis points to 19) if all institutions followed a matched-maturity strategy. While these results are specific

Exhibit 5
Ordinary Least Squares Regressions for the Return on Assets (*ROA*)

Explanatory Variables	Full Sample	Groups by Size				
		1	2	3	4	5
Intercept	0.0011*** (5.987)	+	+	•	•	+
Predicted net interest margin	0.6333*** (54.555)	+	+	+	+	+
Non-interest income-to-total assets	0.7249*** (155.653)	+	+	+	+	+
Non-interest expense-to-total assets	−0.7493*** (−119.701)	−	−	•	−	−
Provision for loan losses-to-total assets	−0.9788*** (−152.184)	−	−	−	−	−
Total taxes-to-total assets	−0.0792*** (−6.278)	−	−	−	−	−
Log of total assets	−4. 0E-5*** (−3.237)	−	−	•	•	•
Adjusted R^2	.72	.70	.78	.70	.76	.80

Notes: Results appear for the entire sample of solvent, FSLIC-insured savings and loan associations from the first quarter of 1985 through the second quarter of 1988, as well as for each of the subgroups. *T*-statistics appear in parentheses beneath the regression coefficients. *** indicates significance at the .01 level. For each of the subgroups, a "+" sign indicates that the coefficient in the regression is positive and significant, a "−" sign indicates that the coefficient in the regression is negative and significant, and a "•" indicates that the coefficient in the regression was not significant at the least restrictive .10 level.

to the period under consideration, they are illustrative of the returns that thrifts can obtain from interest-rate speculation. A substantial portion of observed thrift profitability is the result of interest-rate speculation. This is consistent with developments in 1992 and early 1993 when interest rates fell and thrift profitability soared.

Conclusions

The traditional thrift strategy of borrowing short term and lending long term contributed substantially to thrift profitability during the period immediately prior to FIRREA. In fact, according to our estimates, over half of thrift profitability during the period under consideration appears to be the result of this type of speculative behavior. Thrifts increase their risk exposure when the gains from this type of strategy are greatest, namely when interest rates are high. Furthermore, the empirical results indicate that thrifts adjust their gaps in ways that suggest that they may not be risk-averse portfolio managers. Specifically, they increase their interest-rate risk exposure, rather than decreasing it, when the variance of interest rates increases. These results suggest that thrift interest-rate risk

was not regulated as strictly as it should have been during the period prior to FIRREA. Like Carron and Brumbaugh (1987, 1989, 1990), we find that the net interest margin associated with a fully matched-maturity position is insufficient for most thrifts to earn acceptable returns on assets and equity. In addition, the rewards from interest-rate speculation are substantial. Thrifts can increase their net interest margins by up to 100 basis points and their return on assets by approximately 65 basis points by increasing their gaps.

Our evidence also suggests that the most prudent regulatory course is one expanding the asset and liability powers of thrifts, rather than the more recent regulatory attempts to restrict investment in non-mortgage assets.

Appendix

	Predicted Values		
Decile Rankings	Annualized (%) Return on Assets	Annualized (%) Net Interest Margin	(%) 0–12 Month Gap
1 (highest)	1.94	2.17	−21.46
2	1.30	2.29	−21.78
3	1.05	2.19	−18.95
4	0.88	2.07	−18.76
5	0.73	1.97	−15.46
6	0.58	1.88	−15.37
7	0.43	1.78	−15.28
8	0.27	1.68	−15.22
9	0.02	1.58	−14.27
10 (lowest)	−0.68	1.65	−15.42

Notes: Decile rankings are based on the predicted values for return on assets from the ordinary least squares regression. The predicted values for net interest margin and the 0–12-month gap are determined using the three-stage least squares system.

Notes

[1] The terms "short funded," "riding the yield curve," "borrowing short and lending long," and "running a negative gap," are used interchangeably throughout this paper.

[2] The maturity gap is the difference between variable-rate assets and variable-rate liabilities, expressed as a percentage of total assets. The net interest margin is the difference between interest income and interest expense, expressed as a percent of total assets.

[3] As Morgan and Smith (1987) and McNulty, Morgan and Smith (1995) point out, there are reasons why a financial institution may want to depart from a zero-gap strategy. Such a strategy prevents institutions from earning the liquidity premium imbedded in the term structure.

[4] Gap is used frequently in academic discussions of interest-rate risk (Flannery, 1981, 1983; Morgan and Smith, 1987; Koch, 1992; Rose, 1993). Alternately, Akella and Greenbaum (1992) use the relative speeds at which revenues and costs adjust to interest-rate changes to estimate the duration of assets and liabilities.

[5] Other factors that may affect NIM, such as those considered by Ho and Saunders (1981) and Allen (1988), are captured through the maturity gap positions that are modelled next. For example, management's tendency to ride the yield curve by borrowing short and lending long reflects its degree of risk aversion.

[6] The theoretical relationship between risk and return is ex ante, while observed returns are ex post. Thrifts expected higher returns from these activities, but these returns frequently did not materialize.

[7] See, for example, Rose (1993), Ch. 15.

[8] Predicted values for net interest margin are derived from the three-stage least squares system using the SAS procedure SIMLIN on the output matrix from the SYSLIN procedure.

[9] When we estimate equation (3) using actual NIMs, R^2 is above 99% and all of the signs are as expected.

[10] The time frame of the study is dictated by the availability of data. Thrift maturity gap data are not available for periods prior to 1984. Significant reporting errors in the 1984 data would argue strongly for exclusion of these earlier reports, even if they were available to the authors. Figures for this three and one-half year period were obtained by the authors in 1991 as the result of a special project. In addition, major changes in the report form in 1990 make it impossible to pool data beyond 1989.

[11] Gilbert (1984) thoroughly reviews this literature.

[12] Such policy statements, while often vague and not widely followed, have been required of thrift managers by federal regulators since 1984.

[13] This is similar to the results of comparisons of return on assets for various asset size groups for commercial banks. See, for example, Koch (1992), p. 134.

[14] This is the approximate sample mean. The 42-basis-point-estimated-ROA at this sample mean compares with an actual mean annualized ROA of 52 basis points ($.0013 \times 4$; from Exhibit 1). This again suggests that the regression results are reasonable. The estimated and actual mean NIMs are even closer, 2.07% vs. 2.04%, respectively.

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