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The Bank Capital Decision: A Time Series–Cross Section Analysis

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ABSTRACT

This paper seeks to explain the dramatic decline in capital to asset ratios in U.S. commercial banks during the last two decades. It is hypothesized that the rise in nominal interest rates during this period might have contributed substantially to the fall in capital ratios. Time series-cross section estimation supports the hypothesis regarding the interest rate.

BANK CAPITAL IS THE sum of equity plus debt subordinated to deposits. Capital provides a cushion that protects the bank from insolvency when the value of its assets falls; a bank can meet its obligations to depositors as long as losses on its asset portfolio do not exceed its capital. The ratio of capital to total assets in U.S. commercial banks has fallen dramatically in the last two decades, dropping from 11.7 percent in 1961 to 5.7 percent in 1978, the lowest level since World War II.[1] Figure 1 shows the decline in the ratio of capital to noncash assets.

These figures suggest that the Federal Deposit Insurance Corporation (FDIC) and uninsured depositors are being exposed to increased probabilities of losses from bank insolvencies. However, relatively little empirical research has been devoted to the determinants of the bank capital decision. Further, the existing work (see for example, Peltzman [24], Mingo [20], or Mayne [17, 18]) uses only cross-sectional data and therefore does not necessarily explain the decline in capital-to-asset ratios over time.

Previous empirical research has also focused on book values rather than market values of debt and equity, although market values provide better estimates of the protection afforded by capital. This practice might be partly justified by the attention paid to book values by bank regulators. However, the increasing use of qualitative factors as well as book ratios in capital regulation indicates that regulators are aware of the deficiencies in book values. Many of the so-called qualitative considerations are precisely the factors that distinguish market from book value [6, pp. 78–80].

Finally, difficulties arise over the proper measure of capital. The empirical studies cited above treat equity and debt capital symmetrically. Both equity and

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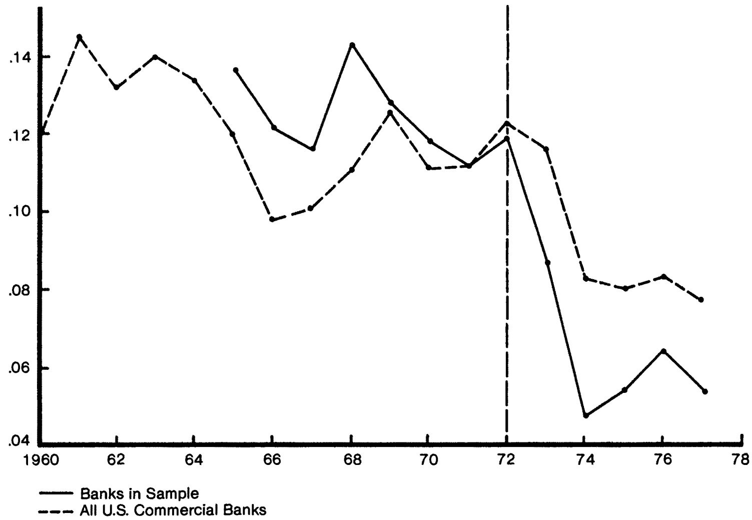
[1] These statistics are based on the market values of capital and assets. The methods used to construct the market value series are described in the Appendix. Capital-asset ratios based on book values also have fallen over the period in question, although not as severely.



Notes

1. Capital equals market value of equity plus market value of subordinated debt. Noncash assets equals capital plus deposits minus cash assets.

2. Construction of data series described in Appendix.

Figure 1. Ratio of Capital to Noncash Assets

subordinated debt lessen the potential liability of the FDIC since both can be used to pay depositors in the event of an insolvency. However, the FDIC not only insures banks, but also tries to inspire public confidence in their safety. Therefore the FDIC should prefer equity to debt capital, because a bank's inability to meet interest or principal repayments on debt would force an insolvency. In fact, the FDIC does consider equity as a separate factor as well as total capital in assessing capital adequacy [6, p. 79].

This paper presents and estimates a model of the determination of bank capital-asset ratios which differ in three ways from earlier research. First, time series-cross section estimation is employed, rather than simple cross section estimation. Second, market values rather than book values of capital are studied. Third, the model allows asymmetric treatment of equity and subordinated debt.

Section I of the paper suggests that much of the fall in capital ratios can be attributed to the interaction of the tax system with the secular rise in inflation and nominal interest rates. The hypothesis is corroborated by econometric estimates reported in Section II. Section III presents a summary and discussion of the policy implications of the paper.

I. The Optimal Capital Ratio

The bank capital decision is a problem in optimal financial structure. Although the Modigliani-Miller Theorem [22] states that in the absence of bankruptcy costs and corporate taxation, the value of the firm in competitive capital markets is independent of capital structure, in practice, taxation, bankruptcy costs, and the regulatory environment are all relevant to the optimal financial structure of a bank. The optimal level of capital balances marginal benefits (due to the tax treatment of interest expenses) with marginal costs (due to pressure for "safe" capital ratios). This framework for analyzing the capital decision recently has been employed by Buser, Chen, and Kane [4] to study explicit and implicit pricing for FDIC deposit insurance.

The U.S. tax system imparts an advantage to debt finance through its treatment of interest payments as a tax-deductible expense.[2] Debt in this context refers largely to deposits. Although the tax system also encourages use of subordinated debt over equity, banks are limited by regulation in the amount of debt that they may use as capital (Crosse and Hempel [6]), and subordinated debt constituted only 0.57 percent of total bank debt in 1978. Deposit finance is further encouraged by the flat fee structure charged for deposit insurance by the FDIC, which permits the bank to increase the value of the insurance, and thus its own value, by increasing its leverage.

The advantages of deposit finance are offset by two factors. First, bankruptcy is costly to owners because it entails the loss of the bank charter as well as other direct costs. Second, regulatory pressure for adequate capital results in additional auditing costs, regulatory interference, and, in extreme cases, loss of FDIC deposit insurance. The bank thus maximizes its value by increasing equity to the point at which the marginal value of reduced regulatory pressure and potential bankruptcy costs equals the marginal tax disadvantage of equity finance.

Now consider the effect of rising interest rates on the optimal deposit-to-equity ratio. Higher nominal interest rates increase the gap between the market rate of interest and the after-tax deposit rate. Let i denote the market interest rate. If banks pay competitive rates for deposits (as might be true for certificates of deposit or even for passbook accounts if Regulation Q can be circumvented via implicit interest) then the net of tax cost of deposits is $(1 - t)i$, whereas the opportunity cost of equity is i. The difference, ti, is proportional to i,[3] so that the present value of the stream of tax savings is unaffected by changes in i. In contrast, bankruptcy and regulatory costs are determined by the capital ratio and are independent of the interest rate. Therefore, increases in the interest rate lower the present value of these costs and disturb the marginal balance between regulatory costs and the tax advantages of deposit finance. The induced substitution of deposits for equity lowers the equilibrium ratio of equity to assets. Gordon [9] shows that this result will obtain in a wide class of models with value maximizing firms.

[2] Miller [19] shows that in the presence of personal taxes (but no bankruptcy costs) the tax advantages of debt finance might disappear in equilibrium. However, DeAngelo and Masulis [7] demonstrate that when bankruptcy is costly, financial equilibrium is once again characterized by a positive tax advantage to debt which is offset by the potential bankruptcy costs. Skelton's [28] finding that Miller's financial equilibrium conditions were not satisfied for several years in his sample supports the DeAngelo and Masulis model. That model is lent further support by Gordon and Malkiel [10], who find the ratio of yields of tax exempt debt to taxable debt to be .75. I proceed on the assumption that deposit finance does offer a tax advantage.

[3] The analysis is qualitatively similar, although slightly more complicated when personal taxes are considered. See footnote 2.

It is suggestive that capital-asset ratios fell so steeply during the 1970s at the same time that the nominal interest rate dramatically increased. The next section presents a formal test of the relationship between interest rates and capital ratios.

II. Empirical Results

A. Specification

The target ratio of capital to assets, c^*, is assumed to depend linearly upon a set of exogenous variables, X, and a stochastic disturbance term, u.

$$c^* = Xb + u \tag{1}$$

where u is the disturbance term and b is a vector of coefficients.

Following Peltzman [24] and Mingo [20], I assume that banks adjust capital to desired levels with a lag that can be approximated by the partial adjustment model. The desired change in the capital ratio, $\widehat{\Delta c}$, is assumed to be a linear function of the difference between c^*, and the actual capital ratio, c:

$$\widehat{\Delta c} = \phi_1(c^* - c_{-1}) \tag{2}$$

Adjustment lags are a result of the costs that would be incurred from frequent issue or retirement of equity. Lintner [15] has documented the tendency of firms to maintain stable dividend policies that force capital levels to absorb short run variations in profitability, which supports the notion that lags are important. Taggart [30] also finds significant lags in the adjustment of firms to equilibrium capital structure. Ideally, one would prefer a more general lag structure than is allowed by the partial adjustment model. Unfortunately, data limitations precluded a more general specification.

Banks are also subject to unanticipated shocks to the capital ratio from stochastic capital gains and income and deposit fluctuations. Denote the unanticipated innovation to the capital ratio during the period as I and assume that banks adjust to innovations at rate ϕ_2.[4] Then the net effect of I on the capital ratio will be $(1 - \phi_2)I$ and the actual change in the capital ratio, $c - c_{-1}$, will equal $\widehat{\Delta c} + (1 - \phi_2)I$, or, substituting from (2),

$$c - c_{-1} = \phi_1(c^* - c_{-1}) + (1 - \phi_2)I \tag{3}$$

Finally, substituting for c^* from (1), adding the subscripts i to index banks and t to index time, and allowing for individual bank effects, Equation (3) becomes

$$c_{it} = \alpha_i + (1 - \phi_1)c_{i,t-1} + \phi_1 X_{it} b + (1 - \phi_2)I_{it} + \phi_1 u_{it} \tag{4}$$

where α_i is the time independent individual effect for bank i. Equation (4) is estimated below using both the fixed and random effects specifications for α_i.

[4] The construction of an empirical proxy for I is discussed below. The specification actually estimated will allow for different speeds of adjustment to income, capital gains, and deposit growth.

B. Variables

Bank capital is defined as the sum of the market values of equity and debt. Equity values for each bank are directly observable; the techniques used to calculate debt values are described in the Appendix. The value of assets was calculated from the balance sheet identity as the sum of the market values of equity, debt, and deposits.

The dependent variable in Equation (4) will be the ratio of capital to noncash assets, because cash items are riskless and can be excluded from the assets requiring capital backing.[5] The capital measure includes subordinated long term debt as well as equity.

The innovation to the capital ratio, I, arises from unforeseen capital gains and income and deposit fluctuations. To proxy for I, actual values of these variables were used to measure the change in the capital ratio that would have resulted if the bank had neither paid dividends nor issued new equity during the period.[6] Although this variable is not precisely equivalent to the *unanticipated* innovations in c, it is a reasonable proxy. It is largely dominated by the capital gains term which for the most part may be considered unanticipated. (See Pesando [25] and Phillips and Pippenger [26].)

Exogenous Variables

The desired capital-asset ratio is assumed to depend first on the market *interest rate* which is taken as the rate on a 3- to 5-year U.S. government bonds. The coefficient on this variable is expected to be negative since, as discussed in Section I, a rise in the interest rate causes the present value of regulatory costs to fall.

The *tax advantage of deposit relative to equity finance* is measured by the ratio

$$\frac{1 - \text{personal tax rate}}{(1 - \text{corporate tax rate})(1 - \text{capital gains rate})}$$

This ratio has been used by Miller [19, p. 267] to analyze potential gains from leverage. The personal tax rate is taken from the series computed by Brinner and Brooks [3] as the weighted average of the marginal tax rates of all investors reporting dividends in a given year, with weights equal to dividends received.[7] Although the personal tax rate on interest might have been more appropriate for

[5] One also might like to exclude short term U.S. Treasury bills. However, Compustat does not give holdings of government securities by maturity class.

[6] The calculations of capital gains and market values of various assets are described in the Appendix. Net income as used here is defined as current operating revenue less current operating expenses, taxes, interest payments on subordinated debt, and preferred dividends. Dividends on preferred stock are included with expenses because they represent cash outflows that are not quite discretionary.

[7] The data were kindly provided to me by Larry Summers. Although the personal tax rate on the marginal investor only is relevant in the Miller model, Brennan [1] and Modigliani [21] show that under uncertainty the weighted average of tax rates on all investors is the relevant variable.

this paper, such a series was not available. The capital gains tax is taken as one-half the dividend rate.

A direct measure of *regulatory pressure* is difficult to devise because the Compustat data set is missing many of the variables presumably used by regulators to determine appropriate capital. Further, a regulatory trend away from mechanical application of these measures in favor of peer group comparisons and qualitative factors has been documented by Crosse and Hempel [6].

The first proxy for regulatory pressure is the number of *cease-and-desist orders* (in hundreds) issued by the FDIC in each year. (The number of U.S. commercial banks during the sample was virtually constant.) A problem with using cease-and-desist orders is that they may be correlated with the disturbance term in (4). If the banking system suffers a negative shock to capital (for example, caused by an increase in interest rates), and the fall in capital ratios induces regulatory review, then cease-and-desist orders will be negatively correlated with the error term. Although this problem potentially can be treated by using instrumental variables, the cease-and-desist proxy is still problematic in that it is not bank specific and cannot capture the dependence of regulatory behavior on peer group standards.

An alternative measure of regulatory pressure is $f(\bar{c}_t - c_{it})$ where f is an increasing, convex function, and $\bar{c}_t$ is the mean capital ratio for all banks in year t. Because it is not clear whether regulatory pressure is primarily determined by book or market values of capital, such a variable is constructed below using both measures. This variable captures the peer group aspects of regulation. However, it introduces a difficult problem in estimation because it is a function of the dependent variable.

Because $f(\cdot)$ is a nonlinear function, one might use nonlinear functions of the exogenous right-hand side variables to serve as instruments for the regulatory pressure variable. However, without knowledge of the true functional form of the estimated equation, it is difficult to justify the exclusion of a particular function of an exogenous variable from the right-hand side and its consequent use as an instrument.

Notwithstanding these difficulties, I constructed the following *regulatory pressure variable* to capture the peer group standard.

$$\mathrm{REG}_{it} = \begin{cases} (\bar{c}_t - c_{it})^2; & c_{it} < \bar{c}_t \\ 0; & c_{it} \geqslant \bar{c}_t \end{cases}$$

The squared term captures the nonlinearities in the regulatory pressure function. Regulators are assumed not to apply pressure to banks with higher than average capital ratios. REG is constructed using both market and book values of capital.

Squared values of the exogenous right-hand side variables were included as instruments for REG. However, because identification in this specification depends upon restrictions on functional form, the parameter estimates of this equation should be interpreted with caution.

A dummy variable for *national banks* (1 = national, 0 = state) is included as a regulatory pressure variable since Mayne's [17] survey suggested that national banks might be subject to greater pressure than state banks.

Debt as a fraction of noncash assets is included because regulators should prefer equity to debt finance. The debt ultimately must be paid back and imposes fixed interest costs that increase the chances of financial difficulty. Therefore, capital (which includes debt) should rise by some fraction of a dollar for each dollar of debt included in capital.

Both regulators and bankers are concerned with the variance in the returns of the bank's asset portfolio. Maisel [16] documents the importance of *interest rate volatility* as a dominant source of variability in bank performance. Therefore, the variance of the level of the Treasury bill rate for the twelve monthly observations in each year is included as an explanatory variable. Interest rate risk should increase equilibrium capital ratios because it increases probability of insolvency for any given capital ratio.

Bank size is another determinant of portfolio risk because larger banks can more easily diversify their asset portfolios. Thus, the coefficient of bank assets should be negative. Although Mayne [17] finds econometric support for this hypothesis, the banks included in the sample are all quite large[8] and might all be well diversified.

Government bonds as a fraction of assets are included as a final proxy for the riskiness of the asset portfolio. It is not clear, however, whether long term government bonds are more or less risky than loans since the latter are subject to business cycle risk, while the former are subject to interest rate risk.

Finally, as an econometric point, it seems desirable to allow for banks to adjust capital at different speeds in response to innovations in income, capital gains, and deposit growth. Therefore, the ratio of income to assets and the percentage change in deposits were included as explanatory variables to eliminate the constraints on adjustment speeds that would be implicitly imposed by treating the total innovation to capital alone as the explanatory variable.

C. Results

Equation (4) is estimated in a time series-cross section framework. One hundred and fifteen banks were selected at random from the 1978 Bank Compustat tape[9] which includes data for 20 years through the end of 1977. Data going back at least 15 years were available for 44 of these banks. Lost observations due to lags resulted in a sample of 44 banks for the 13 year period 1965–77, a total of 572 observations.

[8] The smallest bank in the sample had assets of $857 million in 1977. The average of assets for all banks in the sample in 1977 was $7.7 billion. See footnote 9 for a discussion of the sample.

[9] This tape is the latest version available at M.I.T. The Compustat tape includes only banks that are traded in equity markets. These tend to be large banks; although the sample contains relatively few banks, those included comprise a significant fraction of the total banking system. In 1977, for example, the book value of assets of the 44 banks totaled $340 billion, which represented almost 30 percent of assets of all U.S. commercial banks. However, the sample obviously is not representative of a "typical" bank. National banks are overrepresented (27 out of 44 of the banks in the sample), as are large banks. Every firm in the sample is organized as a bank holding company. Unfortunately, market values of equity are observable only for publicly traded banks. Thus, the sample necessarily must be selective.

Table I

Dependent Variable: Capital/Noncash Assets

Independent Variable	Total Period Results					
	(1) FE	(2) RE	(3) FE	(4) RE	(5) FE	(6) RE
c_{-1}	.761	.756	.800	.777	.792	.778
	(.053)	(.053)	(.053)	(.050)	(.050)	(.050)
Assets	.105	.097	.054	.039	.033	−.002
	(.127)	(.123)	(.131)	(.119)	(.139)	(.134)
Debt/Assets	.389	.389	.475	.416	.412	.393
	(.069)	(.069)	(.092)	(.085)	(.079)	(.080)
Innovation	.817	.814	.798	.781	.790	.783
	(.039)	(.039)	(.039)	(.037)	(.036)	(.037)
Government Bonds/ Assets	.043	.042	.022	.023	.023	.022
	(.016)	(.016)	(.017)	(.016)	(.016)	(.016)
Interest Rate	−.595	−.598	−.520	−.558	−.543	−.563
	(.074)	(.074)	(.079)	(.077)	(.073)	(.074)
Variance of Interest Rate*	.220	.219	.180	.187	.178	.187
	(.019)	(.019)	(.020)	(.019)	(.019)	(.019)
Cease and Desist Orders	−.0021	−.0021				
	(.0005)	(.0005)				
REG (Market)			2.089	−.153		
			(2.038)	(1.832)		
REG (Book)					.763	4.355
					(6.023)	(6.288)
Tax Disadvantage	−.056	−.056	−.022	−.026	−.024	−.027
	(.015)	(.015)	(.014)	(.013)	(.013)	(.013)
National Bank		.0005		.0006		.0006
		(.0008)		(.0008)		(.0008)
Income/Assets	.060	.116	.466	.770	.568	.748
	(.563)	(.565)	(.559)	(.529)	(.526)	(.530)
Percent Change in Deposits	−.015	−.014	−.053	−.044	−.046	−.044
	(.011)	(.011)	(.015)	(.014)	(.014)	(.013)
ρ	−.012	−.010	.002	−.018	−.023	.020
Standard Error of Regression	.00942	.00960	.00990	.00955	.00946	.00960
R-Square (adjusted)	.944	.943	.938	.944	.944	.943

Note: Standard errors of parameter estimates are in parentheses.
* Variance of interest rate was multiplied by 1000 in all regressions in order to scale units for convenient presentation.

The results of the regression analysis are reported in Table I. The first pair of estimates uses cease-and-desist orders as the regulatory pressure variable; the second pair uses REG evaluated with market values of capital; the third pair uses REG evaluated with book data. Estimates for both fixed and random effects specifications are presented. In the fixed effect (FE) specification, equation (4) is estimated treating α_i as a dummy variable or separate intercept term for each bank.[10] In the random effect (RE) specification, the α_i are incorporated into the

[10] Computationally, it is quite difficult to estimate so many parameters. An equivalent technique which does not require explicit estimation of the intercept terms is to perform the regressions on

disturbance term and therefore are not estimated.[11] The Hausman [12] specification test for consistency of the RE estimates is unable to reject that specification at five or ten percent confidence levels.

Instrumental variables are used for both the lagged dependent variable and the regulatory pressure variables in all regressions.[12] Because the regression coefficients are consistent, one may test for serial correlation using the regression residuals. However, the reported Durbin-Watson statistic is inappropriate because of the transitions of the ordered sample across banks. Instead, the serial correlation coefficient (ρ) is computed directly using the regression residuals and imposing equality of ρ across banks. The values for ρ reported in Table I offer no evidence of serial correlation so that reported standard errors of the coefficient estimates can be used for hypothesis testing.

D. Interpretation

The three pairs of estimates in Table I are fairly similar. The coefficients on the lagged capital ratio range from .761 to .800. The implied adjustment coefficients of .200 to .239 are fairly low for annual data. The coefficients on the innovation to capital are insignificantly different (at the 5 percent level) from those on lagged capital,[13] implying equal speeds of adjustment. However, the coefficient of the percentage change in deposits was slightly negative and generally significant. Thus, it appears that banks adjust capital ratios to deposit growth at a slightly lower rate than to capital gains or income.

The coefficients on the interest rate are negative, as expected, large enough to account for significant change in the capital ratio, and significant at the one

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deviations from group means, i.e., the deviation of each observation on bank i from its mean computed over the 13 year period. This procedure forces each α_i to fall through the origin.

[11] Mundlak [23] discusses the relationship between FE and RE regression. The GLS transformation required for the RE specification is presented in Hausman ([12], p. 1262). The formula requires two variance estimates. Consistent estimators for these are presented in Wallace and Hussein ([31], p. 65). The national bank dummy is excluded from the FE regression because its deviation from group mean is identically zero for all banks and consequently has an indeterminate coefficient. Essentially, in the FE specification, the national bank effect is impounded into the dummy term, α_i, for each bank.

[12] The instruments used in the column 1 and 2 regressions were current and lagged values of exogenous right-hand-side variables as well as lagged values of the return on the Standard and Poor's 500 Stock Price Index and the percentage of deposits of all commercial banks insured by the FDIC. Percentage of deposits insured were unavailable for individual banks. In the column 3 through 6 regressions, squared values of the exogenous right-hand-side variables were added to the instrument list. In the FE regressions, instruments were expressed as deviations from group mean; this procedure is equivalent to including individual bank dummy variables in the instrument list. In the RE regressions, the GLS transformation was applied to the instruments as well as the variables.

[13] When $\o_1 = \o_2$, the terms in c_{-1} and I can be combined. The resultant sum then equals the value which the capital ratio would take on were the bank not to respond to exogenous changes in capital. Although this value will be numerically close to the actual capital ratio, c, it does differ from c to the extent that banks issue equity or pay dividends. Thus, the estimates of the coefficients of the X matrix should indicate the impact of those variables on the perceived optimal capital ratio. I estimated the model constraining $\o_1 = \o_2$ and found that the constraint had virtually no effect on the estimates of the other coefficients. However, it should be acknowledged that the estimates for the $\o_1$, which are approximately 0.8, are uncomfortably high, especially given the closeness of c to the sum of c_{-1} and I.

percent level in all regressions. A one percent increase in the interest rate lowers the capital ratio by approximately 2.5 percent in the long run. The increase in the interest rate from a level of 4.2 percent in 1965 to 6.9 percent in 1977 should have caused a long-run decline in the capital ratio of almost seven percentage points. The mean capital ratio of the banks in the sample fell from 13.7 percent in 1965 to 5.4 percent in 1977. Further, as hypothesized, the coefficients of the variance of the interest rate are all positive and all significant at better than the one percent level.

The coefficients of the tax disadvantage term, as predicted, are uniformly negative and generally significant at the five percent level. The term works as predicted despite the fact that banks owned by bank-holding companies might have available tax avoidance opportunities not reflected in the measure of the tax disadvantage. (See Hanwick and Kilcollin [11] and Kimball [13] for discussions of several tax avoidance procedures available to banks.)

The coefficients on subordinated debt as a fraction of assets range from .389 to .475 and are all significant at the one percent level. Moreover, the magnitudes of the coefficients seem reasonable in that each dollar of subordinated debt increases total capital by 39 to 47 cents so that only 53 to 61 cents of equity is retired.

National banks do not appear to behave significantly differently from state banks, although the coefficient of the dummy variable is positive in all regressions. This result is similar to those of Mayne [18] who found some anecdotal but little statistical support for differential effects among the various bank regulators.

The coefficients on government bonds are slightly positive and significant at the five percent level in the column (1) and (2) regressions, which suggests that over the sample period, interest rate fluctuations made government bonds riskier investments than commercial loans, most of which are of extremely short maturity.

The coefficients on bank size are of unstable sign and generally insignificant, which might indicate that even the smaller banks in the sample are well diversified.

Contrary to expectations, cease-and-desist orders received negative coefficients. These estimates might have resulted from overfitting of the variable in the first stage regression of the instrumental variable procedure, in which case the negative coefficient would be a reflection of the simultaneity problem, i.e., that low capital can elicit regulatory pressure.

The coefficients on REG (columns 3 to 6) are positive, as expected in three of four cases, although insignificant. Because REG abstracts from the risk characteristics of each bank's asset portfolio, it is an imperfect proxy for regulatory pressure. The noise introduced into the variable by variations in risk might produce downward biased coefficients.

The adjustment speeds reported in Table I seem fairly low for annual data. To test for the stability of the estimated relationships, I split the sample into the subperiods 1965–71 and 1972–7.[14] The latter period is characterized by more

[14] Quandt [27] suggests a switching regression procedure that allows the data to determine the point at which the sample should be split. I tried splitting the sample at 1970, 1971, 1972, 1973, and

Table II

Dependent Variable: Captial/Noncash Assets

Independent Variable	1965–71	1972–7	Sub-Period Results 1965–71	1972–7	1965–71	1972–7
c_{-1}	.675	.800	.698	.873	.678	.873
	(.051)	(.088)	(.056)	(.065)	(.053)	(.068)
Assets	−.104	−.189	−.126	−.112	.064	−.255
	(.172)	(.233)	(.211)	(.197)	(.215)	(.215)
Debt/Assets	.440	.414	.576	.541	.455	.160
	(.076)	(.115)	(.112)	(.142)	(.086)	(.139)
Innovation	.676	.767	.667	.844	.594	.886
	(.060)	(.089)	(.102)	(.062)	(.093)	(.066)
Government Bonds/	.025	.050	.010	.030	.006	−.023
Assets	(.021)	(.037)	(.026)	(. 029)	(.025)	(.033)
Interest Rate	−.704	−.355	−.998	−.124	−1.067	−.468
	(.284)	(.210)	(.441)	(.285)	(.423)	(.195)
Variance of Interest	.229	−.047	.366	−.037	.391	−.029
Rate**	(.126)	(.032)	(.194)	(.029)	(.187)	(.028)
Cease and Desist Or-	.0002	−.0009				
ders	(.0017)	(.0008)				
REG (Market)			4.662	4.561		
			(2.510)	(2.913)		
REG (Book)					−3.550	−26.856
					(6.027)	(10.191)
Tax	−.074	−.046	−.101	−.014	−.119	−.0009
Disadvantage	(.036)	(.050)	(.055)	(.036)	(.053)	(.0311)
Income/Assets	2.403	2.301	2.818	1.285	2.440	−.241
	(.869)	(1.687)	(.793)	(1.227)	(.745)	(1.181)
Percent Change in	−.002	.001	−.033	−.013	−.050	.010
Deposits	(.013)	(.016)	(.041)	(.013)	(.040)	(.017)
F-Statistic*	8.359		14.361		9.123	
S.E.R.	.0080	.0096	.0089	.0086	.0085	.0091
R-Square (adjusted)	.875	.928	.847	.942	.860	.936

Note: Standard error of parameter estimates are in parentheses.
* Critical value for F at one percent level is 1.77.
** Variance of interest rate was multipled by 1000 in all regressions in order to scale units for convenient presentation.

variable interest rates and by steeply falling capital ratios. (See Figure 1.)

Table II presents regression estimates for the FE model[15] for each subperiod. The regressions reveal important and statistically significant differences across the two subperiods. Table II presents Chow tests for the equality of coefficients

1974. The Quandt test indicated that either 1972 or 1973 was the best break point, depending upon the measure of regulatory pressure.

[15] Structural change is tested within the FE framework; a test for stability in the RE framework would be complicated because the parameters of the required GLS transformation would need to be simultaneously tested for structural change. This procedure would introduce difficult nonlinearities into the problem. In light of the similarity of the results in the FE and RE specifications, it seems adequate to test only the FE specification.

across the subperiods. The critical value for F(12,560)[16] at the 1 percent level is 1.77 which is far surpassed for all three specifications.

The adjustment speeds in the latter period are slower than in the early period by margins of 30 to 50 percent. Estimates of $ø_1$ for period 1 range from .302 to .325, while those for the latter period range from .137 to .200. The estimate ranges for ϕ_2 are similar: .324 to .406 versus .114 to .233.

The fall in adjustment speed is consistent with the peer group standard theory of regulatory pressure, which implies that when all banks suffer capital losses (for example, from a rise in the interest rate) the increase in regulatory costs for a particular bank is much smaller than it would be if that bank alone were to lower its capital. Drops in capital common to all banks do not induce regulatory review of any particular bank and consequently do not require banks to readjust capital. Therefore, measured adjustment speeds during a period with widespread falls in capital should be lower than in a period with no trend in capital levels.

Figure 1 demonstrates that the aggregate capital ratio was relatively stable from 1965 to 1972. Therefore, a decrease in capital by any bank would attract attention from regulators and create an incentive to reestablish the old capital ratio. In the post-1972 period, however, large drops in capital were widespread and adjustment speeds during the period fell substantially.

Moreover, the Table II regressions show that sensitivity to the interest rate decreased during the second subperiod, falling from period one estimates of −.704, −.998, and −1.067 to period two estimates of −.355, −.124, and −.468. The negative coefficients on the variance of the interest rate for the second period are puzzling. However, these are all insignificant and only one-tenth the magnitude of the period one estimates.

The only other notable fact about the split sample estimates pertains to the coefficients on assets, which were slightly positive in the full period regressions, but in the split sample regressions were generally negative. However, these coefficients are measured quite imprecisely; in all but one instance, the t-statistic is below one.

III. Conclusions

The empirical findings presented in Section II corroborate the hypothesis that capital-asset ratios respond negatively to increases in the interest rate and to the tax disadvantage of equity finance. Therefore, bank regulators should be aware that a large part of the recent decline in capital ratios might be the rational response of profit maximizing banks to a changing economic environment. Any policy response should be shaped by such a perspective.

Specifically, regulators should be aware that the incentive to decrease capital varies with the level and variability of the interest rate. Because FDIC premia are not risk-rated, regulators must rely upon capital adequacy standards as implicit risk-rated premia ([2, 4]). The level of jawboning required to maintain

[16] Twelve degrees of freedom are appropriate in the numerator despite the fact that only eleven coefficient estimates are presented, because the split sample and deviation from group mean format implicitly allows for different intercept terms across the subperiods.

adequate capital thus varies with the interest rate. Although capital adequacy standards per se serve an important role in the regulatory process ([2, 4]) it seems that the process could be improved by making explicit FDIC insurance premia at least partially risk-rated. This would provide regulators with another policy instrument and would free them to decide upon an optimal mix of implicit and explicit premia.

The evidence also suggests that the rate at which banks restored capital to accustomed levels was much lower in the latter half of the sample. This result is somewhat surprising: a typical convex cost structure for deviations of capital from its target level, together with economies of scale in raising equity (Smith [29]) should have caused the large swings of capital in the 1970s to produce faster adjustment speeds.

However, the slower adjustment speeds are consistent with the notion that regulators do not judge banks by capitalization per se, but rather by capital *relative to other banks.* In that instance, the widespread fall in capital ratios in the 1970s would not have greatly increased regulatory costs for any particular bank and therefore would not have induced banks to restore capital.

The peer group hypothesis implies that regulators exert little influence on the response to economy-wide shocks to capitalization. Although regulation might induce individual banks to conform to industry standards, those standards are themselves not well defined. This topic seems worthy of further investigation; the response to interest rate fluctuations of bank capitalization and the implied safety of deposits can turn critically upon the determination of regulatory standards.

IV. Appendix: Data Sources

All data for the 44 banks were taken from the Bank Compustat tape for 1978 which contains data for the 20 years ending 31 December 1977. Data pertaining to the U.S. commercial banking system were found in *Banking and Monetary Statistics* or the *Annual Statistical Digest,* both of which use the FDIC *Assets and Liabilities of Commercial Banks* as their source and are published by the Board of Governors of the Federal Reserve System.

Equity. The market value of equity of each bank equals price per share of common stock times shares outstanding for the last trading day of each year. Compustat does not list market values of preferred stock; however, preferred stock in the banking industry is negligible.

The market value of equity for the national sample of banks is calculated by multiplying income of all commercial banks by an industry price/earnings ratio. The P/E ratio is taken from *Moody's Bank and Finance Manual* 1975, and is based on a national sample of banks. The Moody's series ends in 1974; thereafter, the banking industry P/E ratio reported in the *Value Line Investment Survey* was used. Figure 1 demonstrates that the total industry and Compustat P/E ratios track fairly closely over the sample period.

Subordinated Debt. To calculate the market value of subordinated debt, start with the pricing formula

$$P = \sum_{k=1}^{T} C/(1 + i)^k + B/(1 + i)^T$$

where P is the market price of a bond, C is its coupon payment, B is the face value, T is the time to maturity, and i is the market interest rate for a bond of maturity T. Denoting the discount factor, $1/(1 + i)$, as d, it can be shown using the pricing formula that if a bond is issued at par at time t yielding the market interest rate i_t with a maturity of T years, then at time $t + 1$, when the market rate is i_{t+1},

$$\frac{P_{t+1}}{P_t} = \frac{i_t d_{t+1}\,(1 - d_{t+1}^{T-1})}{1 - d_{t+1}} + d_{t+1}^{T-1} \tag{A.1}$$

This ratio can be used to compute the change in the market value of outstanding debt. The market value of debt in period $t + 1$, therefore, equals the market value in period t times the capital gain ratio from Equation (A.1) plus issues of new debt. If all debt is issued and retired at par, then the market value of newly issued debt equals the change in book value of outstanding debt. Thus, letting MV represent market value of outstanding debt,

$$MV_{t+1} = MV_t\,\frac{P_{t+1}}{P_t} + (B_{t+1} - B_t) \tag{A.2}$$

P_t and B_t are observable or easily constructed data. Therefore, Equation (A.2) can be used recursively to calculate a series for the market value of debt once a starting value for MV_0 is chosen.

The first year in which subordinated debt is a non-trivial fraction of bank assets is 1963. For 1963, one can set market value equal to book value since virtually all the debt then outstanding was issued in that year.

The average remaining maturity of outstanding bank debt is set at 16 years in the calculation of Equation (A.1). The geometric growth rate of the number of bonds outstanding (book value) has been 23 percent since 1963. With such rapid growth, most bonds must be of recent issue, so that a 16-year time-to-maturity seems a reasonable estimate for the typical bond.

The interest rate used in (A.1) is *Moody's* composite bond yield series. For the few years in which yields on bank debt are available, the *Moody's* rates closely approximate the bank yields.

Capital Gains on Assets. Capital gains are computed by netting out new capitalization from changes in the market value of equity. In any period, the change in the market value of equity equals capital gains on existing assets plus new issues of equity (including retained earnings) minus increases in the market value of subordinated debt. Market value of equity and subordinated debt have been computed. Issues of new equity can be computed as the change in the book value of equity. Thus, one can solve for capital gains on assets.

Market Value of Assets. From the balance sheet identity, assets equal equity plus debt plus deposits. The calculation of the market values of equity and debt already has been described. The market value of deposits may be well approximated by book value since deposits are either payable on demand or are in the form of short-term certificates on which capital gains or losses are minimal.

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