Capital shocks and bank growth—1973 to 1991

Herbert L. Baer and
John N. McElravey

For over a decade the U.S. depository system has been characterized by increasingly stringent regulatory capital requirements for banks, increasingly volatile earnings, and rising failure rates. However, the impact of these developments on the behavior of financial institutions is a subject of considerable debate. Some observers point to the contraction in lending by domestically chartered banks and thrifts during 1991 and wonder if overly rigid capital requirements are to blame (Martin Feldstein, 1992; Richard Breeden and William Isaac, 1992; and Michael Keran, 1992). Others have argued that losses suffered by depository institutions have been to blame. A third group argues that neither of these developments has had a significant impact on bank behavior or the economy.

This article develops testable hypotheses about the growth of financial intermediaries under the assumption that issuing new equity is a costly way for banks to smooth shocks to their equity position. We draw heavily on previous attempts to confirm the hypothesis that nonfinancial firms are forced to rely strongly on internal financing because of capital market imperfections. The article has three goals. First, we ask whether most banks manage their total assets as if it is costly to raise additional equity from external sources. Second, we examine how past changes in capital requirements have affected bank behavior. Finally, we explore the role that various shocks to the depository system have played in the recent slowdown in bank lending and the monetary aggregates. To address these issues we study to the behavior of publicly traded bank holding companies. In June of 1991 these holding companies accounted of two thirds of the total assets held by U.S. based holding companies and independent banks.

We report the following findings:

1) Banks manage their asset growth as if there are significant costs associated with issuing new equity and selling existing assets. This is consistent with the research of others who find that issuing new equity dilutes the wealth of existing shareholders.

2) Following the implementation of explicit minimum capital requirements, the proportion of variation in asset growth explained by regulatory capital ratios jumped dramatically.

3) As the regulatory capital requirement has increased, so has the level of capital at which banks begin shrinking their assets.

4) Between June 1989 and June 1991, the proportion of banks whose growth was constrained by capital requirements reached a twenty-year high. Capital-constrained banks controlled two-thirds of the assets in our sample.

Herbert L. Baer, formerly an Assistant Vice President at the Federal Reserve Bank of Chicago, is currently a Financial Economist with the World Bank. John N. McElravey is an Associate Economist at the Federal Reserve Bank of Chicago. They wish to thank Charles Calomiris, George Kaufman, Robert Laurent, Patrick McAllister, Larry Mote, Steve Strongin, Larry Wall, and Paula Worthington for helpful comments.

5) Of those banks that were constrained during the 1989-91 period, two-thirds were capital-deficient because of losses incurred during the period, while one-third were constrained because of low levels of capital at the beginning of the period.

6) The increase in regulatory capital requirements for banks can explain only about one-third of the recent slowdown in the growth of bank assets and liabilities. Other factors such as beginning-of-period capital deficiencies, losses, and asset recycling played a larger role in that slowdown.

Our findings indicate that in order to realize their full profit potential through growth, banks must now maintain significantly higher capital ratios than they did a decade ago. Banks that do not maintain these higher capital ratios are forced to shrink. This has three implications. First, with the penalties for capital deficiency rising, losses to the Bank Insurance Fund (BIF) should moderate in the near future. Second, given the increases in bank equity requirements and the quantity of assets and liabilities from failed and undercapitalized institutions which need to be recycled to healthy institutions, the depository system was unable to grow at previous rates without issuing significant (and potentially costly) amounts of new capital. According to our estimates, the banking system would have had to issue new shares equal to 28 percent of existing regulatory equity in order to absorb these new assets. Finally, since increased capital requirements accounted for only one-third of the disruption to bank capital positions, policymakers should view with great skepticism proposals to weaken bank capital requirements.

In order to understand how capital regulations have affected bank behavior in the recent past, we will first take a broad look at the relationship between firm capital and firm growth, and then proceed to a specific analysis of how changing regulations affected bank asset growth in the 1980s and early 1990s.

The cost of raising new capital and asset growth

During the 1980s, bank regulators adopted increasingly stringent capital requirements. Leverage constraints were progressively tightened and risk-based capital requirements were introduced. Table 1 presents a chronology of these changes. (A detailed discussion of the changes appears in Box 1.) While the recently implemented risk-based capital requirements have received the most publicity, Baer and McElravey (1993) show that until the passage of the FDIC Improvement Act (FDICIA), the leverage restrictions remained the binding constraint for most banks.

TABLE 1

Major changes in regulatory capital requirements

1981	Introduction of primary capital requirements—5 percent of balance sheet assets for regional banks and 6 percent for community banks.
1983	Primary capital requirements for regional banks extended to so-called multinational banks.
1985	Primary capital requirements set equal to 5.5 percent for all banking organizations.
1986	Federal Reserve announces its intention to develop a risk-based capital requirement.
1989	The tier 1 and total risk-based capital requirements (4 and 8 percent of risk-based assets) are adopted with phase-in scheduled to begin at year-end 1990. Loan-loss reserves are excluded from tier 1 capital.
1990	Regulators adopt a new tier 1 leverage limit. Published regulations indicate that most banks will be required to maintain a ratio of at least 4 to 5 percent of assets.
1991	FDICIA requires closure when the tier 1 leverage ratio falls below 2 percent and mandates the inclusion of interest rate risk in risk-based capital.
1992	Regulators require banks to maintain a tier1 risk-based capital ratio of 6 percent to be considered well-capitalized.

With the greater regulatory emphasis on bank capital have come increased penalties for banks that maintain inadequate capital levels. To adjust to a shortfall, a bank may take one or more of the following actions: retain more of its earnings, shrink its assets, reduce its portfolio risk, or issue new equity. A bank will choose among these actions on the basis of their relative costs. While these costs can be difficult to measure, the theory and reality of corporate finance suggest that it is often more costly to issue equity than to increase retained earnings or to sell assets.

Whether firms decide to issue new shares depends on the degree of information asymmetry and the value of options embedded in the debt contracts. The dilution associated with new share issuance can be quite large relative to the amounts issued. For example, a study of 121 industrial firms found that on average, every dollar of new equity issued caused a 28 cent reduction in the market value of existing shares—a marginal dilution rate of 28 percent (Asquith and Mullins, 1986).[1] Obviously, these firms would have been willing to incur substantial costs rather than issue new shares. Share issuance by banks also results in dilution, but the available studies do not directly calculate the marginal dilution rate.[2] The wealth transfer from existing shareholders that occurs when new shares are issued can be thought of as a lemons

BOX 1

The changing nature of capital requirements

Capital regulation of banks in the United States changed dramatically during the 1980s. Prior to 1981, federal banking regulators did not enforce specific uniform guidelines for capital adequacy.[1] Rather, they imposed capital requirements subjectively, taking into account the results of examinations of individual banks as well as capital levels at other banks with similar characteristics. Regulators persuaded a bank with capital below its peers to increase its capital. Since bank assets were not becoming any less risky, the relatively steady decline of the industry's capital cushion during the 1960s and 1970s suggests that this system of peer-based capital requirements was not particularly effective as implemented (Peltzman, 1970).

As the 1970s drew to a close, regulators became increasingly concerned that banks were holding inadequate capital given the riskiness of their assets. In response, the three federal banking regulators announced minimum "primary capital ratios" for banks and bank holding companies in December 1981. Primary capital included common and preferred equity, mandatory convertible debt instruments, perpetual debt instruments, and loan-loss reserves. After a phase-in period, the minimum primary capital ratio was set at 5.5 percent of total assets. In addition to raising the amount of capital held by banks, the explicit capital requirement also linked the total asset size of the banking system to the system's total primary capital.

The treatment of loan-loss reserves as primary capital was significant because reserving for loan losses would not decrease a bank's regulatory capital. To illustrate, a bank first reflects prospective losses in its loan portfolio by making a provision for possible loan losses. These loan-loss provisions reduce the bank's equity and increase its loan-loss reserve. Only when a loan is actually charged off is the loan-loss reserve, and therefore primary capital, reduced. However, this treatment of loan-loss reserves as regulatory capital was questionable to the extent that it was already allocated to absorb *expected* losses in a bank's loan portfolio. If the reserve is an accurate reflection of the losses embedded in a bank's loan portfolio, then it should not be included in the measure of the bank's ability to withstand additional unexpected losses, that is, its regulatory capital ratio.[2] Because loan-loss reserves were included in the measure of capital adequacy, a bank's equity cushion could have eroded while its primary capital ratio remained unchanged. To the extent that regulatory actions were based on primary capital, banks that should have been facing pressure to raise additional equity or reduce total assets (or, at least, reduce asset risk) could argue that they had sufficient capital.[3]

In the latter half of the 1980s, in an effort to overcome some of the deficiencies in primary capital, regulators introduced a plan for risk-based capital requirements. The product of protracted international negotiations, the risk-weighted capital ratio measures a bank's capital with respect to the default risk of its on- and off-balance-sheet credit exposures. Regulators, the banking industry, and the press have discussed at great length the appropriate risk weightings for on- and off-balance-sheet activities. In addition, the types of financial instruments that qualify as capital for regulatory purposes, as well as their amounts, have been more restrictively defined. While a detailed discussion of risk-based capital requirements is beyond the scope of this paper, one feature is crucial: risk-based capital requirements may constrain total bank lending to the private sector, but they do not constrain the total assets held by the banking system. Indeed, a bank that is below the minimum risk-based capital ratio could come into compliance and still show asset growth by selling assets with higher risk weights and purchasing assets with lower risk weights. For example, commercial loans (100 percent risk weight) could be exchanged for Treasury securities (zero risk weight) so that total assets could still show growth while risk-weighted assets would decline.

premium—compensation to the purchasers of new shares for the possibility that existing shareholders are misrepresenting the firm's condition.

Many firms behave as if it is costly to raise additional debt or equity from external sources. Calomiris and Hubbard (1992) show that during the 1930s, firms willingly incurred significant tax penalties to avoid dividend payouts that would have required raising additional funds from outsiders. Studies by Fazzari, Hubbard, and Petersen (1988), Himmelberg and Petersen (1992), and Fazzari and Petersen (1990) document the extent to which the costs of external finance constrain investment by high-growth firms. A study by Hubbard and Kashyap (1992) documents the impact of collateral requirements on agricultural lending.

The internationally negotiated risk-based capital requirements do not preclude national regulators from implementing more stringent standards for the banks they supervise. Concerned that the risk-based guidelines did not properly account for interest rate risk, U.S. regulators tightened the old primary capital standard and added it to the risk-based requirements for U.S. banks. The result was the leverage ratio. Under rules effective since January 1991, banks with a CAMEL rating of 1 are required to have tier 1 capital (the sum of common equity, certain preferred stock, and minority interests in equity accounts of consolidated subsidiaries less goodwill) equal to at least 3 percent of total balance sheet assets. As of June 1991, few of the nation's banks had a CAMEL rating of 1. For all other banks, the minimum tier 1 leverage ratio is to be 3 percent plus an additional cushion of at least 100 to 200 basis points. Banks experiencing growth are expected to maintain strong capital positions above minimum regulatory levels. Bank holding companies with consolidated assets in excess of $150 million are also required to adhere to these guidelines.

Given the imprecise nature of the leverage limit rule, it is difficult for an outside observer to say with any certainty which leverage standard any particular bank was being held to.[4] However, former FDIC Chairman William Seidman estimated that most banks would face a minimum leverage ratio of 4.5 percent (Holland, 1990). Others believe that most banks and bank holding companies were in fact being subjected to a 5 percent leverage ratio. Evidence presented in this article suggests that the requirements began to affect bank behavior once the tier 1 equity ratio fell below 7.0 percent.

If, in fact, most banks were being required to maintain a tier 1 leverage ratio in excess of 4.5 percent or 5 percent, then the adoption of the leverage limit represented a significantly tighter capital requirement than the primary capital standard, because tier 1 capital excludes loan-loss reserves. Under the leverage limit, banks found it necesssary to raise additional equity or decrease total assets as soon as problem loans are identified and reserved for, rather than waiting until they were charged off. Perhaps more surprising, the leverage limit also appears to have represented a tighter capital requirement than the new risk-based capital standards (Baer and McElravey, forthcoming 1993). We believe that this occurred because banks constrained by the leverage ratio could not adopt a program of asset substitution to avoid shrinkage. Perhaps in recognition of this fact, regulators have recently advocated eliminating leverage ratio requirements.

Responding to the FDIC Improvement Act, in September 1992 regulators set new minimums for the tier 1 leverage ratios and the tier 1 and total risk-based capital ratios. In order to be considered well-capitalized, a bank must now maintain a tier 1 leverage ratio of 5 percent, a tier 1 risk-based capital ratio of 6 percent , and a total risk-based capital ratio of 10 percent. The adoption of these new rules would appear to eliminate much of the uncertainity concerning the minimum leverage ratio. However, banks must continue to manage both their leverage and their risk-based capital ratios.

[1]During the 1950s and 1960s, the Federal Reserve System calculated a type of risk-based capital standard called the "Form for analyzing bank capital," or ABC Form. However, it does not appear that any attempt was made to enforce capital requirements based on this approach. Paul M. Horvitz (1968) noted that "individual bank scores on the capital adequacy formula show a very wide dispersion which indicates that probably neither the banks nor the Federal Reserve take it very seriously."

[2]In fact, it appears that many of the larger bank holding companies were underproviding for loan losses because their market-to-book ratios were below 1 for much of the 1980s.

[3]Of course, banks could face funding pressure from concerned depositors and investors.

[4]In its 1991 annual report, Citicorp states that "Citicorp has not been advised by the Federal Reserve Board or the Federal Financial Institutions Examination Council as to a specific required leverage ratio applicable to it."

BOX 2

Some definitions

A_t	end-of-period assets
L_t	end-of-period liabilities
Regulatory growth model	
S_t	new shares issued
RE_t	retained earnings using regulatory accounting
E_t	end-of-period regulatory equity: $E_{t-1} + RE_t + S_t$
ε_t	$\frac{E_t}{A_t}$
ε_t^n	the do-nothing regulatory equity ratio: $\frac{E_{t-1}+RE_t}{A_{t-1}}$
ε^r	the level of ε_t at which regulatory intervention begins
ε^*	the bank's optimal regulatory equity-to-asset ratio
RINT	$\frac{E_{t-1} + RE_t}{E_{t-1}}$
DUM0-DUM8	dummy variables based on the bank's do-nothing capital ratio, ε_t^n
Market growth model	
r_t	the percentage change in the net market value of the existing portfolio of assets and liabilities during period t
V_t	end-of-period market value of equity: $V_{t-1}(1+r_t)+S_t$
v_t^n	the do-nothing market value equity ratio: $\frac{(1+r_t)\,V_t}{L_{t-1}}$
v^*	the uninsured bank's optimal market value of equity ratio: $\frac{V_t}{A_t}$
DMCAP	$\frac{V_t}{V_{t-1}}$
MDUM0-MDUM8	dummy variables based on the bank's do-nothing market capital ratio, v_t^n

Testing the relationship between capital and asset growth at banks

We seek to determine whether financial intermediaries, like their nonfinancial counterparts, find it costly to bridge the gap between desired and actual capital levels by adjusting their asset portfolios. This is by no means the first article to explore the response of intermediaries to disturbances in their capital positions. Wall and Peterson (1987) examine the factors influencing banks' capital ratios. Peek and Rosengren (1991) document the negative impact of declines in regulatory capital on the growth of commercial banks in New England. Bernanke and Lown (1991) study interstate variation in asset growth as well as the behavior of banks in New Jersey and report similar results. Furlong (1992) develops implicit estimates of banks' desired capital ratios and finds that they have risen during the 1980s. Finally, Hancock and Wilcox (1992) examine the impact of capital shortfalls on various aspects of bank growth. Of these papers, only Hancock-Wilcox and Furlong focus on changes in behavior of banks over time, and none examines the behavior of well-capitalized banks in any detail.

This article seeks to build on previous research in two ways. First, we wish to determine whether most banks manage their total assets as if it is costly to raise additional equity from external sources. Second, we wish to determine whether past changes in capital requirements have affected bank behavior. In order to accomplish these goals, we first examine the behavior of banks under two different scenarios:

1) banks are uninsured and face information asymmetries when selling assets or issuing equity;
2) banks have access to underpriced deposit insurance and face information asymmetries when selling assets or issuing equity.

The behavior of uninsured, unregulated intermediaries

In the absence of deposit insurance and regulation, banks would not behave differently than other firms that hold significant amounts of financial assets. Information asymmetries, moral hazard, bankruptcy costs, and taxes would jointly define the bank's optimal capital structure.

The market value of existing shares V_t is one component of a banks' capital structure.

$$V_t = (1+r_t)\,V_{t-1} + (1\text{-}\delta)\,S_t\,,$$

where r_t is the change in the net market value of the portfolio of assets and liabilities held at the end of the previous period and δ is the dilution associated with new equity S_t issued in period t. Let v_t denote the ratio of V_t to total end-of-period liabilities L_t. The bank's optimal ratio of equity to liabilities, v_t^* would of course vary with the composition of its assets and liabilities. Creditors would charge undercapitalized banks a risk premium to cover potential losses due to declining asset values and bankruptcy costs. If information asymmetries make it costly to issue new equity to existing shareholders, a key state variable for the bank is its "do-nothing" market equity ratio,

$$v_t^n = \frac{V_t(1-\delta)S_t}{L_{t-1}} = \frac{V_t^n}{L_{t-1}}\,.$$

If investors believed that changes in asset values were permanent, the growth in a bank's assets would be determined primarily by the relative magnitudes of v_t^n and v_t^*. When $v_t^n > v_t^*$, the bank will expand until $v_t^n = v_t^*$ or until profitable investment opportunities are exhausted, whichever comes first. When $v_t^n < v_t^*$, the bank will face pressure to shrink its assets until the lemons premium incurred by selling additional assets equals the risk premium charged by creditors. If at this point the risk premium on its debt exceeds the lemons premium associated with issuing additional equity, the bank will issue equity.

We would expect that

$$(1)\quad \frac{A_t}{A_{t-1}} = f\left(\frac{v_t^n}{v_t^*}, dP\right),$$

where A_t is the bank's total assets at the end of the period, and dP is a set of possibly unobserved variables which measure the profitability of a bank's future investments. The optimal ratio of market capitalization to assets, v^*, is unobservable. However, we could use V_{t-1}/L_{t-1} as a proxy v_t^* and estimate equation (1).

The behavior of insured intermediaries with asymmetric information

When underpriced 100 percent deposit insurance is available, a bank's capital structure is determined by a regulatory constraint tied to regulatory measures of bank equity rather than by creditor estimates of net worth. The bank's end-of-period regulatory equity is given by

$$E_t = E_{t-1} + RE_t + S_t\,,$$

where E_t denotes end-of-period regulatory equity, RE_t denotes retained earnings, and S_t denotes new equity issued in period t. Both E_t and RE_t are based on regulatory accounting principles.

Let ε^r denote the equity-to-asset ratio at which regulators begin constraining a bank's assets. We assume that if $E_{t-1}+RE_t < \varepsilon^r A_{t-1}$, then asset growth at a bank is subject to the constraint

$$(2)\quad A_t - A_{t-1} < \rho\left[\frac{E_{t-1} + RE_t + S_t}{\varepsilon^r} - A_t^*\right].$$

If $\rho = 0$, a capital-deficient bank is not permitted to grow. If $\rho = 1$, then a capital-deficient bank is forced to return immediately to compliance. If $0 < \rho < 1$, then the bank is permitted to return to compliance over time.

If banks find it costly to issue new equity or to sell assets in response to a shortfall in regulatory equity, their optimal regulatory capital ratio ε^* will exceed the regulatory minimum. For a given level of regulatory equity, E_t will have an optimal quantity of assets A_t^*, an optimal ratio of regulatory equity to assets of ε^*, and an adjustment function θ which describes how the bank adjusts to disturbances to its regulatory capital position.

The bank's optimal regulatory equity ratio ε^*, would of course vary with the composition of its assets and liabilities and the parameters of the regulatory constraint. If information asymmetries make the issuance of new equity costly to existing shareholders, a key state variable for the bank is its do-nothing regulatory equity ratio,

$$\varepsilon^n_t = \frac{RE_t + E_{t-1}}{A_{t-1}} .$$

When $\varepsilon^n_t > \varepsilon^*$, the bank will expand until $\varepsilon^n_t = \varepsilon^*$ or until profitable investment opportunities are exhausted, whichever comes first. When $\varepsilon^* > \varepsilon^n_t > \varepsilon^r$, the bank will face pressure to shrink its assets until the lemons premium incurred by selling an additional dollar of assets just offsets the benefits of a greater capital cushion. When $\varepsilon^r > \varepsilon^n_t$, the bank becomes subject to the regulatory constraint of equation (2). In this case, growth will depend on the ratio of ε^n_t and ε^r, although it is possible that banks with higher values of ε^* might choose to shrink more rapidly than those with lower levels of ε^*.

For a given bank, the arguments of θ are ε^n_t, ε^r, and ε^*. The following simple model reveals some of the econometric issues involved in estimating the asset growth function θ:

$$(3) \quad \frac{A_t}{A_{t-1}} = \theta\left(\frac{\varepsilon^n_{i,t}}{\varepsilon^r}, \frac{\varepsilon^n_{i,t}}{\varepsilon^*_i}, dP_i\right) \theta_1 \geq 0 \quad \theta_2 \geq 0 ,$$

where i denotes the bank and dP_i measures the marginal value added from expanding intermediation activities. The do-nothing capital ratio ε^n_t is directly observable, while the variables ε^r_t, ε^*_t, and dP_i are not. The first argument of θ reflects the regulatory constraint in equation (2). The second argument of θ represents the rate of asset growth that would permit the bank to end the period with $\varepsilon_{i,t} = \varepsilon^*_i$ without issuing additional shares.

The structure of θ will change when the regulatory constraint changes. As table 1 documents, regulatory capital requirements have been raised at several points over the last decade; thus it would be inappropriate to estimate θ in a time series format. However, $\varepsilon^n_{i,t}/\varepsilon_{i,t-1}$ can be used as a proxy for $\varepsilon^n_{i,t}/\varepsilon^*_i$ in order to estimate θ cross-sectionally. We call this proxy *RINT*.

For estimation purposes, we linearize θ in the following fashion:

$$(4) \quad \frac{A_{i,t}}{A_{i,t-1}} = \sum_j B_{j,t} DUM_{i,j,t} + \sum_j C_{j,t} DUM_{i,j,t} RINT_{i,t} + dP_i + \mu_{i,t} ,$$

where i denotes the ith bank, j denotes one of seven capital categories based on the bank's do-nothing capital ratio, t denotes time, $DUM_{i,j,t}$ is 1 if the ith firm is in capital class j and zero otherwise, $RINT_{i,t}$ is the ratio of internally generated regulatory capital in period t to total regulatory capital at the end of period t-1, and dP_i is a vector of unobserved variables measuring the ith firm's growth prospects. If external capital is costly and firms are unwilling to drive their equity ratio below ε^*, we would expect the coefficient on *RINT* to be between zero and one. Like the models specified by Bernanke and Lown (1991), Hancock and Wilcox (1992), and Peek and Rosengren (1991), this model also allows a bank's capital level to affect its growth. Unlike theirs, however, our model also allows for the possible willingness of well-capitalized banks to forego growth opportunities in order to maintain their optimal capital ratios.

The estimates of the coefficient on *RINT* may be subject to omitted variables bias. In particular, dP_i may be positively correlated with *RINT*. This may lead us to infer a significant link between growth in regulatory capital and asset growth, when in reality the relationship is between profit opportunities and asset growth. There are, however, many reasons to believe that a positive coefficient on *RINT* would not result solely from omitted variable bias. First of all, many of the reasons why banks make or lose money have nothing to do with the profitability of their future lending opportunities. For example, duration mismatches and ceilings on deposit interest rates can explain a significant amount of cross-sectional variation in bank earnings, yet they have little to do with the inherent profitability of lending opportunities. In addition, since there was frequently a long lag between the deterioration of a bank's loan portfolio and increases in its loan-loss reserves, changes in asset growth due to changes in lending environment should have been incorporated in bank behavior before they were reflected in earnings. Even more fundamentally, losses on the existing portfolio need not have any significant implications for the profitability of future lending opportunities. Losses are merely evidence of a change in environment or an inappropriate risk assessment by the lender. They do not imply that lending will not be profitable once the bank adjusts to the new environment or employs an improved risk-assessment procedure.

Even though there are many reasons to believe that cross-sectional variation in *RINT* is not simply proxying for the profitability of lending opportunities, it would be foolish to dismiss concerns about omitted variables bias. Instead, we will seek to ensure that our results are robust. First, we will present two estimates of θ, one using the levels of variables in equation (4), the other using changes in the variables in equation (4). Second, we present estimates of equation (4) which also include changes in the bank's share price. This should capture changes in banks' future expected profitability.[3]

When estimating θ, it may also be possible to identify the regulatory constraint. If a bank is operating on the regulatory constraint, only the do-nothing capital ratio ε^n and the regulatory minimum capital ratio ε^r will be important in explaining a bank's growth rate; variation in other variables should not be associated with differences in asset growth. Even if the coefficient on *RINT* is nonzero because of omitted variable bias, a positive coefficient would indicate that factors other than regulatory capital levels are driving bank behavior.

The sample

To test for the changing impact of regulatory capital requirements on the growth of U.S. banking institutions, we studied the behavior of U.S. bank holding companies included on the current Compustat data base, as well as those carried in the Compustat research file.[4] Share price data as well as certain balance sheet and income statement items came from the Compustat data base. Table 2 provides descriptive statistics for the sample for the time periods under study.

We present the results obtained by estimating equation (4) on cross sections for four different two-year periods, December 1973 to December 1975, December 1979 to December 1981, December 1984 to December 1986, and June 1989 to June 1991. We estimated similar models for other time periods. The results were consistent with those reported here. In a given cross section, each bank holding company is represented by a single observation. The key independent variables for estimating equation (4) are the level of the do-nothing capital ratio, ε^n_t, and the growth in the capital base of the bank holding company (BHC) that was due to retained earnings, *RINT*. These variables are calculated over two-year intervals, for example, year-end 1984 to year-end 1986.

TABLE 2

Sample characteristics[a]
(billions of dollars)

	Do-nothing book equity ratio[b]	N	1973-75 assets	N	1979-81 assets	N	1984-86 assets	N	1989-91 assets
*DUM*0	0-3	2	$ 4	3	$ 13	4	$ 10	7	$ 39
*DUM*3	3-4	11	124	6	259	4	160	7	272
*DUM*4	4-5	22	162	12	297	4	106	12	612
*DUM*5	5-6	27	131	21	162	19	631	15	363
*DUM*6	6-7	29	79	47	184	38	275	17	286
*DUM*7	7-8	19	40	42	127	45	241	33	336
*DUM*8	>8	25	34	40	72	47	185	41	264
Sample total		135	574	171	1,114	161	1,608	132	2,172

[a]The period 1989-91 is June 1989 to June 1991. All other periods are December to December.
[b]$\frac{\text{(beginning-of-period equity + earnings retained during period)}}{\text{(beginning-of-period assets)}}$

We use the ratio of equity to total assets to measure the adequacy of capital for regulatory purposes. Previous work by Baer and McElravey (1993) showed that risk-based capital requirements did not have a significant impact on bank growth over the period covered by this study. Each BHC was assigned to one of seven categories depending on its end-of-period equity-to-asset ratio. Using this classification, we then generated a set of dummy variables with the prefix *DUM*, based on the leverage ratio (ratio of book value of equity to assets). For instance, *DUM3* takes on the value 1 if the bank's do-nothing capital ratio is between 3 and 4 percent; otherwise it takes on the value 0. The definition of the categories, the corresponding dummy variables, and the distribution of the banks for each two-year sample period are given in table 2. That table suggests that it was not unusual for banks in our sample to have inadequate regulatory capital. During the period 1989-91, for example, twenty-six BHCs with 41.5 percent of the assets in the sample had do-nothing capital ratios below 5 percent. In the earlier period 1984-86, fifteen BHCs with 19.6 percent of the assets in the sample had do-nothing primary capital ratios below the crucial 5 percent level. Table 3 presents values of *RINT* and asset growth for each time period for banks in the lowest and highest capital categories.

TABLE 3

Sample characteristics

Period[a]	*RINT* *DUM0*	*RINT* *DUM8*	Asset growth *DUM0*	Asset growth *DUM8*
			(---annual rate---)	
1973-75	90	118	0	9
1979-81	56	121	−15	14
1984-86	7	130	−9	35
1989-91	46	121	−13	10

[a]The period 1989-91 is June 1989 to June 1991. All other periods are December to December.

Determinants of asset growth

One of the central propositions of this paper is that banks manage their assets as if they find it costly to issue new equity. This implies that growth in assets will be closely linked to the rate of internal capital generation, *RINT*. Table 4 presents two tests of this hypothesis. The estimation results presented in table 4 ignore the possible impact of regulatory constraints on asset growth. Model I includes only one variable, *RINT*. In every case, the coefficients on *RINT* lie between 0 and 1, as predicted by the theory. Depending on the time period, variation in *RINT* across BHCs explains 30 to 40 percent of the variation in firms' asset growth rates. The values of the intercepts indicate that banks with no retained earnings experience no asset growth. Moreover, banks appear to respond similarly to positive and negative earnings. When the coefficient on *RINT* is allowed to take on different values for $RINT > 100$ and $RINT < 100$, the coefficients are similar in value.

These results remain robust even when we reestimate Model I in first differences to eliminate possible biases caused by omitted firm-specific differences in long-run profitability. In first differences form, there is a positive, statistically significant relationship between *RINT* and asset growth. Moreover, the coefficient estimates for *RINT* and $\Delta RINT$ are generally close to one another. This suggests that the high correlation between *RINT* and asset growth is not being driven primarily by omitted, firm-specific differences in long-run profitability. To determine whether these results merely reflect the behavior of poorly-capitalized banks or also reflect the behavior of well-capitalized banks, we reestimated Model II using data for banking organizations with do-nothing capital ratios above 7 percent (results not shown). We find that for these well-capitalized banks, the coefficient on $\Delta RINT$ continued to be positive and significantly different from zero at the .01 level.

These results leave open the possibility that cross-sectional variation in *RINT* is correlated with unanticipated cross-sectional changes in (rather than levels of) in long-term profitability. One measure of the unanticipated change in long-term opportunities is the rate of change in the value of a bank's existing equity claims, *DMCAP*. The last panel of table 5 uses both *RINT* and *DMCAP* to explain asset growth.[5] In all cases, *RINT* continues to be significant.

The persistent importance of *RINT* in explaining asset growth and changes in asset growth suggests that well-capitalized and poorly-capitalized BHCs in our sample find external sources of regulatory capital to be significantly more expensive than internal sources. This relationship does not appear to be merely a result of a correlation between *RINT* and long-run or short-run differences in profit opportunities.

TABLE 4

Relationship between internally generated equity and bank holding company asset growth[a]

Model I
Dependent variable: asset growth rate
Variables in levels

	1973-75		1979-81		1984-86		1989-91	
	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$
INTERCEPT	–29.83	4.64	–42.60	5.40	–32.30	5.14	-17.47	3.19
RINT[b]	.31***	.04	.45***	.04	.42***	.04	.22***	.03
N	132		170		160		126	
$\bar{R}^2$	.30		.37		.38		.30	
RMSE	5.39		6.82		13.11		8.03	

Model II
Dependent variable: change in asset growth rate

	1979-81		1984-86		1989-91	
	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$
INTERCEPT	–1.48	.57	.01	1.60	–1.00	1.16
Δ*RINT*[c]	.27***	.06	.40***	.04	.26***	.04
N	145		161		128	
$\bar{R}^2$	.12		.32		.24	
RMSE	6.89		20.43		12.07	

[a]The period 1989-91 is June 1989 to June 1991. All other periods are December to December.
[b]*RINT* = (beginning-of-period equity + retained earnings)/(beginning-of-period equity).
[c]$\Delta RINT = RINT_t - RINT_{t-2}$
*, **, *** significant at the .10, .05, and .01 levels respectively.

This is consistent with the basic findings for nonfinancial firms (for instance, Fazzari, Hubbard, and Peterson, 1988).

The preceding analysis sheds little light on the impact of capital requirements on bank growth. In Model III, asset growth is influenced by *DUM0-DUM8*, dummy variables tied both to ε_i^n, the bank's do-nothing capital ratio, as well as to the bank's internal capital generation rate, *RINT*. The estimation results for Model III are presented in table 6. Taking account of banks' regulatory capital significantly increases the ability to explain differences in bank asset growth in all time periods studied. In the 1973-75 period and the 1979-81 period, $\bar{R}^2$ increases by .07 and .09 respectively. Results for 1984-86 and 1989-91 are more dramatic; $\bar{R}^2$ increases by .19 for 1984-86 and by .15 for 1989-91. This suggests that capital levels have become more important in determining bank growth. This conclusion is backed up by the variation in coefficients on *RINT* across different capital categories. Low-capital banks have smaller coefficients on *RINT* which are generally not significantly different from zero. High-capital banks have larger, statistically significant coefficients on *RINT*. The continued significance of *RINT*, even after accounting for differences in the level of capital, is further evidence that its significance is not simply due to differences in long-run profitability.

Previous discussion indicated that we could consider bank behavior to be driven primarily by regulatory pressures at levels of capital for which the coefficient on *RINT* becomes zero. In each two-year period, the coefficient on *RINT* becomes insignificantly different from zero once the do-nothing capital ratio falls below a critical level. The results presented in table 6 suggest that the regulatory capital constraint has become binding at higher and higher capital ratios. For the 1973-75 period, variation in *RINT* began to matter once a BHC's capital ratio rose above 4 percent. For the 1979-81 period, the cutoff point

TABLE 5

Relationship between changes in market capitalization and asset growth[a]

Dependent variable: asset growth rate

Variables in levels

	1973-75		1979-81		1984-86		1989-91	
	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$
Market model								
INTERCEPT	7.96	.90	7.56	.75	6.48	1.55	4.82	.94
DMCAP	.16	.04	.22	.03	.32	.03	.10	.03
$\bar{R}^2$	.09		.29		.38		.07	
RMSE	6.19		7.23		13.01		10.31	
Regulatory model								
INTERCEPT	−30.18	4.68	−42.36	5.39	−32.2	5.2	−26.6	3.86
RINT	.31	.04	.45	.04	.42	.04	.30	.03
$\bar{R}^2$	.30		.37		.37		.36	
RMSE	5.42		6.79		13.12		8.53	
Joint model								
INTERCEPT	−26.35	5.38	−30.09	6.55	−17.54	5.22	−27.17	4.37
RINT	.28	.04	.33	.05	.24	.06	.30	.04
DMCAP	.06	.04	.10	.03	.19	.04	−.01	.03
$\bar{R}^2$	.30		.41		.44		.37	
RMSE	5.40		6.62		12.35		8.56	
N	130		169		158		122	

[a]The period 1989-91 is June 1989 to June 1991. All other periods are December to December.

was a capital ratio of 5 percent. For the 1984-86 period, the cutoff point was an equity-to-asset ratio of 6 percent. For the 1989-91 period, *RINT* began to matter only when the equity-to-asset ratio exceeded 7 percent. The regulatory constraint first appeared to slow growth rather than halt it. It is also interesting that regulatory pressures appeared to influence banks well before their do-nothing capital ratio fell to the ostensible regulatory minimum. For example, the 1991 regulatory minimum equity-to-asset ratio was ostensibly in the 4 to 5 percent range. However, regulatory pressures appeared to become operative once the equity ratio fell below 7 percent. A similar phenomenon appeared to be at work in the 1984-86 period.

Table 7 presents data on the shape of the regulatory constraint. The asset growth rates of banks with do-nothing equity ratios below 3 percent have declined steadily over the last two decades.

The 1989-91 period is distinguished from previous periods by more than the apparent tightness of the regulatory constraint. The link between changes in regulatory capital and asset growth as reflected by the coefficients on *RINT* is much weaker than in any previous period. The coefficients on *RINT* during the most recent period were roughly half those of the previous period. These differences are statistically significant for BHCs with do-nothing capital ratios over 6 percent.[6] There are two possible explanations for this. First, it may reflect tight monetary policy by the Federal Reserve. This tightening made further growth by well-capitalized banks unattractive. However, two interest rate indicators of policy tightness—the term spread and the change in rates—indicated a relatively loose policy stance, suggesting that the Federal Reserve did not dramatically tighten its monetary policy. A second possible explanation for the small coefficients is that a tightening of the regulatory constraint drove every bank's optimal equity ratio above the current level. With their equity ratios well below optimal, these banks

TABLE 6

Relationship between regulatory equity ratios, internally generated equity, and bank holding company asset growth[a]

Model III
Dependent variable: asset growth
Variables in levels[b]

	1973-75[c]		1979-81[d]		1984-86[e]		1989-91[f]	
	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$	$\hat{\beta}$	$\hat{\sigma}$
INTERCEPT	9.13***	1.26	15.35***	1.24	28.16***	2.03	10.93***	1.24
DUM0	−10.62**	4.56	−22.91***	4.72	−38.52***	7.26	−23.39***	3.49
DUM3	−6.17***	2.33	−8.27**	3.45	−34.95***	7.26	−15.80***	3.26
DUM4	−5.92***	1.83	−8.70***	2.59	−27.66***	7.26	−12.38***	2.62
DUM5	−5.09***	1.73	−6.72***	2.12	−19.66***	3.79	−15.97***	2.40
DUM6	−3.53**	1.71	−3.17*	1.69	−14.18***	3.04	−7.06***	2.30
DUM7	−3.84**	1.90	−1.70	1.74	−6.47**	2.90	−0.64	1.86
*RINT*DUM0*	.066	.122	.138	.164	.139	.082	−.061	.142
*RINT*DUM3*	.164	.122	−.332	.629	.194	.712	−.008	.191
*RINT*DUM4*	.465***	.098	.062	.143	−.004	.349	.092	.154
*RINT*DUM5*	.307**	.119	.474***	.177	.182	.252	.018	.257
*RINT*DUM6*	.113	.139	.583***	.125	.646***	.197	.081	.175
*RINT*DUM7*	.635***	.179	.207	.158	.759***	.181	.305**	.147
*RINT*DUM8*	.589***	.121	.713***	.087	.987***	.117	.217*	.118
$\bar{R}^2$	.37		.46		.57		.45	
$\Delta\bar{R}^2$ vs. Model I	.07		.09		.19		.15	
N	134		170		160		131	

[a]The period 1989-91 is June 1989 to June 1991. All other periods are December to December.

[b]Deviations from mean value of *RINT* for each capital category. *RINT* = (beginning-of-period equity + retained earnings)/(beginning-of-period equity).

[c]When the constraint $\beta_0 = \beta_3$ is imposed, $\hat{\beta}_{0\text{-}3}$ is not significantly different from 0 at the .10 level.

[d]When the constraint $\beta_0 = \beta_3 = \beta_4$ is imposed, $\hat{\beta}_{0\text{-}4}$ is not significantly different from 0 at the .10 level.

[e]When the constraint $\beta_0 = \beta_3 = \beta_4 = \beta_5$ is imposed, $\hat{\beta}_{0\text{-}5}$ = .137 and $\hat{\sigma}_{\beta 0\text{-}5}$ = .075. $\hat{\beta}_{0\text{-}5}$ is significantly different from 0 at the .10 level.

[f]When the constraint $\beta_0 = \beta_3 = \beta_4 = \beta_5 = \beta_6$ is imposed, $\hat{\beta}_{0\text{-}6}$ is not significantly different from 0 at the.10 level.

*, **, *** significant at the .10, .05, and .01 levels respectively.

chose to devote a large portion of their retained earnings to rebuilding capital.

Regulation or the market?

The preceding results suggest that BHCs are behaving as if it is costly to adjust to disturbances in regulatory capital. However, these changes may reflect creditor discipline not regulatory discipline. If it is costly to issue new shares and market discipline is driving bank growth decisions, we would expect that changes in the market value of a bank's capital would be positively correlated to its asset growth. As was the case with the regulatory model, we allow both the do-nothing market capital ratio and the percentage change in market capitalization *DMCAP* to affect asset growth. We define do-nothing market capital as the sum of the end-of-period market value of common equity plus the beginning-of-period book value of preferred shares. As in the regulatory model, BHCs are then classified by their do-nothing capital ratios, the ratio of do-nothing market capital to beginning-of-period assets. Using this classification, we then generated a set of dummy variables *MDUM2-MDUM7*.

In order to assess the relative importance of market forces and regulatory forces, we then compared the performance of various versions of the regulatory model specified in equation (4)

$$\frac{A_{i,t}}{A_{i,t-1}} = \sum_j B_{j,t} DUM_{i,j,t} + \sum_j C_{j,t} DUM_{i,j,t} RINT_{i,t},$$

and a comparable market model

$$(5)\quad \frac{A_{i,t}}{A_{i,t-1}} = \sum_j a_{j,t} MDUM_{i,j,t} + \sum_j \beta_{j,t} MDUM_{i,j,t} DMCAP_{i,t}.$$

If *RINT* is merely proxying for changes in market value, we would expect regression estimates of (5) to have greater explanatory power than equations using *RINT*. Table 5 presents results including only *RINT* and *DMCAP* models. In no case do market-based measures of changes in capital adequacy do a better job of explaining cross-sectional variation in asset growth. In three of the four time periods studied, regulatory measures of changes in capital adequacy are clearly superior. When *RINT* and *DMCAP* are included in the same equation, *RINT* is always highly significant, while *DMCAP* is insignificant during both the 1973-75 period and the 1989-91 period.

Table 8 compares the $\bar{R}^2$s for models which include do-nothing capital ratios (*DUM* or *MDUM*) and the internal rate of capital generation (*RINT* or *DMCAP*). In the 1973-75 period and the 1989-91 period, the regulatory model significantly outperformed the market model. In no case did the market model outperform the regulatory model. The results presented in tables 5 and 8 support our contention that BHC behavior between June 1989 and June 1991 was driven not only by declines in asset values, but also by shocks to regulatory capital. The fact that regulatory variables continue to be significant even after inclusion of market variables reinforces our contention that *RINT* is capturing regulatory effects rather than differences in long run profitability.

TABLE 7

Estimates of the regulatory constraint[a]

Do-nothing equity ratio	Asset growth rate 1973-75	1979-81	1984-86	1989-91
< 3	−1.5	−7.6**	−10.4*	−12.5***
3 - 4	3.0	7.0***	−6.9	−4.8
4 - 5		6.6***	.5	−1.5
5 - 6			8.5***	−5.0*
6 - 7				3.8**

[a]The period 1989-91 is June 1989 to June 1991. All other periods are December to December.

*, **, *** significant at the .10, .05, and .01 levels respectively.

The equivalence of asset recycling and capital shocks

The dependence of banks on retained earnings to fund growth raises the possibility that the resolution of bank failures may have implications for the behavior of the entire depository system. When an institution fails, the Resolution Trust Corporation (RTC) or the BIF generally sells its assets and liabilities to a well-capitalized survivor. Undercapitalized but solvent institutions may also initiate the recycling of assets when they attempt to shrink their existing assets and liabilities. We call this transfer of assets and liabilities *recycling*.

When assets are recycled to a well-capitalized institution, its regulatory equity requirement increases. This occurs even though aggregate assets and liabilities of the depository system remain unchanged. If well-capitalized institutions engaged in recycling either choose or are required to maintain a capital ratio at or above the regulatory minimum, they may slow or even reduce lending to other customers in order to avoid additional costly equity issues. Under these circumstances, policies governing the sale and liquidation of failed institutions will affect real economic activity through precisely the same channels as innovations in capital requirements or earnings.

For simplicity, consider an institution which before the purchase had a capital ratio at the regulatory minimum and then purchases assets from the RTC. To remain in compliance, the institution must either raise new equity or reduce its assets and liabilities. Our results suggest that institutions generally did the latter. In order to reduce its assets and liabilities to the desired level, the purchaser will in the first instance respond by raising the price of credit and reducing the return on deposits. The distribution of the adjustment between the cost of credit and the return on deposits will depend of course on their relative interest elasticities. As the spread between loans and deposits rises, both old and new borrow-

TABLE 8

Explanatory power of regulatory measures of capital and market-based measures of capital[a]

	1973-75	1979-81	1984-86	1989-91
Regulatory model[b]	.45	.50	.59	.53
Market capitalization model[c]	.35	.50	.58	.33
N	130	169	158	122

[a]The period 1989-91 is June 1989 to June 1991. All other periods are December to December.

[b] $$\frac{A_{i,t}}{A_{i,t-1}} = \sum_j B_{j,t} DUM_{i,j,t} + \sum_j C_{j,t} DUM_{i,j,t} RINT_{i,t}$$

[c] $$\frac{A_{i,t}}{A_{i,t-1}} = \sum_j a_{j,t} MDUM_{i,j,t} + \sum_j \beta_{j,t} MDUM_{i,j,t} DMCAP_{i,t}$$

ers will seek alternative sources of credit. If loans from other intermediaries are an imperfect substitute or other well-capitalized institutions are also loaned up, borrowers and depositors will be crowded out of the depository system and the depository system as a whole will shrink.

Why would a well-capitalized institution willingly purchase a failed institution knowing that it will need to shrink or issue new equity? Because the transaction is priced to offset any costs of adjustment incurred by the purchaser, including the costs of running off assets and liabilities. These costs are ultimately borne not by the purchaser but by the seller in the form of lower bids on the failed institution.

Relatively little crowding out would be observed if the transfer of assets and liabilities by the BIF, the RTC, and undercapitalized institutions is price-sensitive. However, the RTC and the FDIC generally sell assets and liabilities at auction, which suggests that the supply is very inelastic with respect to price. The other important source of recycled assets—asset sales by solvent but capital-deficient banks—is driven by efforts to avoid the high cost of issuing equity. This means that the supply curve of assets being sold by undercapitalized banks is also highly inelastic until the discount exceeds the lemons premium on new equity issues. If the dilution experienced by shareholders of industrial companies is any indication, shareholders would be willing to incur discounts up to 3.5 percent on the value of assets sold to avoid issuing new equity.[7]

Assessing the financial shocks of the 1989-91 period

The preceding analysis suggests that increased capital requirements, reduced earnings, and the recycling of assets and liabilities from poorly-capitalized or insolvent institutions to well-capitalized institutions can affect the supply of intermediated credit and the size of the depository system. Table 9 presents estimates of these shocks for the time periods covered by our study.

We estimate that ε^r, the equity ratio at which banks become capital-hungry, was one percentage point higher for the period June 1989 to June 1991 than it was in the preceding two year period. As a result of higher capital requirements and weaker earnings, the proportion of banks that behaved as if they were capital-hungry rose to a new high. Figure 1 shows the proportion of assets in our sample that were controlled by capital-hungry BHCs. As of June 1991, 66 percent of the assets in our sample were being held by BHCs with equity ratios below 7 percent—the point at which we found banks were behaving as if they were being driven by regulatory concerns.

However, to focus solely on those banks that are capital constrained understates the degree of the shock. Heavily capitalized banks will also be affected by an increase in capital requirements if they choose to maintain a buffer of excess capital. If a one percentage point increase in ε^r translates into a one percentage point increase in each banks' desired capital ratio, ε^*, the industry would have had to increase its capital base by $22 billion—9.5 percent of the industry's total equity as of June 1991—to avoid shrinking. In addition, money-losing banks experienced losses of roughly $10 billion. Finally, some banks began the period with equity ratios below the 6 percent level, creating a need for another $11 billion in equity.

Asset recycling also created major demands on the industry's supply of equity. During the 1989-91 period, capital-deficient BHCs in our sample reduced their assets and liabilities by a total of $82 billion. Insolvent banks and S&Ls with total liabilities of $235 billion were trans-

TABLE 9

Shocks to the capital of depository institutions[a]

(billions of dollars)

	(1) Minimum do-nothing capital ratio[b]	(2) Shrinkage at capital-deficient BHCs[c]	(3) Assets at failed banks	(4) Assets at failed S&Ls	(5) Total assets recycled	(6) Incremental equity required[d]	(7) Impact of increased capital requirement[e]	(8) Losses	(9) Beginning-of-period capital shortfall[f]	(10) Total new equity needed (% of equity)
1973-75	.04	$0.04	$4.2	$0.2	$4.4	$0.2	$0	$0.0	$1	1.8
1979-81	.05	3.5	5.0	1.9	10.4	0.5	11	0.2	3	12.8
1984-86	.06	20.1	15.6	18.0	53.6	3.0	18	2.3	5	14.35
1989-91	.07	82.8	58.6[g]	177.0[h]	318.4	22.0	22	10.0	11	28.7

[a]The period 1989-91 is June 1989 to June 1991. All other periods are December to December.

[b]Based on results reported in table 6.

[c]Estimated using Compustat. BHCs with do-nothing capital ratios less than column (1) are considered undercapitalized.

[d]Column (1) multiplied by column (5).

[e]Based on results reported in column (1), the minimum equity ratio is assumed to increase by .01 in the 1979-81, 1984-86, and 1989-91 period. This may overstate the extent of the increase for the 1979-81 and 1984-86 periods.

[f]Based on difference between beginning-of-period capital ratio and previous period's minimum equity ratio as reported in column (1).

[g]Estimated as one-half of the 1989 amount ($14.5 billion) plus the 1990 amount ($15.6 billion) + one-half of the 1991 amount ($28.5 billion).

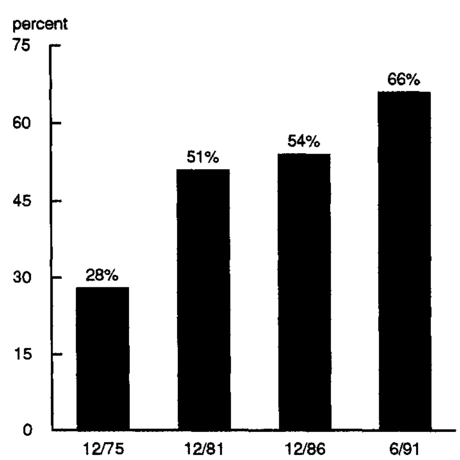
[h]Deposits transferred by the RTC through July 1991 as a result of resolution ($147 billion) and reduction in assets at S&Ls in conservatorship ($30 billion).

ferred to well-capitalized banks and thrifts. Liabilities totaling $318 billion were recycled during this period. Assuming that most well-capitalized banks in the system began the period with an equity ratio near their desired level ε^*, total equity in the banking industry would have had to be at least 9.7 percent above its June 1991 level for the banking system to reabsorb the entire $318 billion in assets and liabilities.[8]

The magnitude of these deposit transfers calls into question the assertions of some analysts, for instance, Feldstein (1992) and Keran (1992), who have argued that tighter capital standards have been the primary cause of the prolonged sluggishness in both bank lending and real GNP following the onset of the recession in July 1990. By contrast, our analysis suggests that the most recent increase in bank capital requirements can explain only a portion of the slowdown in the growth of bank assets and liabilities. If capital requirements had been kept at 1986 levels, we estimate that the equity shortfall for the banking system as a whole would have been only 33 percent less. The remainder of the equity shortfall was accounted for by the recycling of assets from failed institutions (33 percent), capital shortfalls predating the 1989-91 period (15 percent), and banks that were capital-deficient at the beginning of the period (17 percent).

FIGURE 1

Proportion of assets held by capital-deficient banks



Effects on real economic activity

Whether the resulting decrease in the supply of intermediated credit had a significant impact on real economic activity depends on two factors: the amount of earning assets transferred, and the ease with which bank borrowers can replace credit from banks with credit from other sources.

To date, there have been few attempts to estimate the extent to which the poor performance of the economy since 1989 has been due to shocks to the banking system. Seeking to assess the macroeconomic impact of bank capital deficiencies, Bernanke and Lown (1991) measured the relationship between interstate variation in bank capital ratios and interstate variations in unanticipated employment growth. They found that variation in bank capital ratios explained little of the variation in employment growth across states, and therefore concluded that the capital crunch had not had important macroeconomic consequences.

Two assumptions underlie Bernanke and Lown's interpretation of their results. One is that banks operating in states with relatively high capital ratios are freer to lend to their customers than are banks operating in low-capital states; the second is that the losses are the only shock to the banking system. However, our analysis suggests that capital deficiency as measured by Bernanke and Lown accounts for only one-third of the banking system's increased need for capital.

When banks find it costly to raise capital, higher capital requirements and asset recycling can be as disruptive to bank growth as actual declines in bank capital. Unlike earnings shocks, higher capital requirements and asset recycling tend to equalize the level of stress across the banking system. If, as our results suggest, banks willingly hold a buffer of capital, even banks with capital ratios above the regulatory minimum will choose to slow growth in the face of increased capital requirements as they seek to boost their capital positions. Heavy asset recycling will further equalize credit conditions across banks with different capital ratios. Poorly-capitalized banks will be unwilling to lend to new borrowers because they are trying to satisfy regulatory capital requirements. Well-capitalized banks will be reluctant to lend to new borrowers because they are purchasing assets and liabilities of failed institutions and trying to rebuild their buffer of regulatory capital.

Under these circumstances, cross-sectional data cannot indicate the macroeconomic importance of supply-side shocks to the financial sector. However, if financial sector supply shocks are important, then we would expect the growth of depository system assets to be correlated with shocks to the system. If these are truly shocks to the supply of credit and not shocks to demand, we would also expect the price of intermediated credit to rise relative to the price of credit paid by borrowers with direct access to the capital markets.

Studies by Duca (1992) and Kasriel and Laurent (1992) report findings consistent with our contention that resolution activity slowed the growth of the depository system. Both papers find that changes in money supply growth are highly correlated with the resolution activities of the RTC.

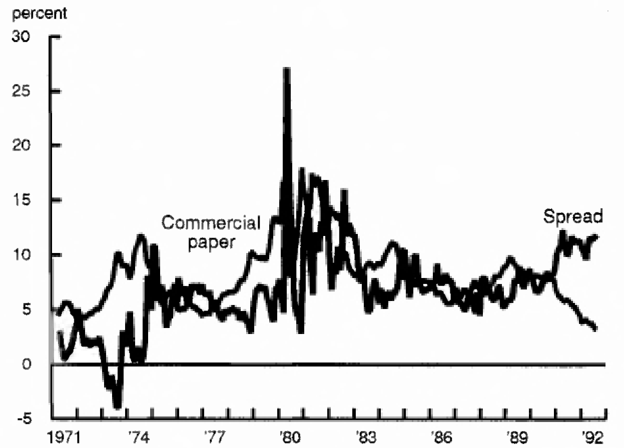
Some believe that if asset recycling caused movements in the money supply, this implies an impact on output. Others argue that unless the result is significantly more expensive credit for borrowers, the implications for output will be minimal. However, evidence on loan pricing suggests that the shocks to the capital positions of depositories have indeed made bank credit more expensive. The spread between the prime rate and the commercial paper rate provides one measure of the relative costs of bank credit. Vector autoregression analysis reported by Kuttner (1992) indicates that unanticipated changes in the prime-paper spread have persistent negative impacts on real GNP. In a related study, Corcoran (1992) reports that unanticipated changes in the spread between rates on publicly-placed and privately-placed bonds have negative impacts on real GNP.

Figure 2 shows the history of the prime-paper spread.[9] Two points are worth noting. First, it is below the peak levels of the early 1980s. However, the figure also suggests that this spread usually falls when the level of interest rates falls and rises when the level of rates rises. This is to be expected, since banks bear a disproportionately large part of the burden of any contraction in the supply of bank credit. That is because when monetary policy tightens, the cost of bank credit must rise faster than the cost of credit from other intermediaries. The previous exception to this rule was the 1973-74 period, when the prime rate was subject to price controls.

In 1990 the prime-paper spread began to rise even though interest rates were falling. Since that time it has held more or less steady despite a fairly sharp decline in rates. The initial rise in the spread despite declining rates suggests that during the last half of 1990 and the first half of 1991, the supply of bank credit was reduced by more than the demand. Since mid-1991, the prime-paper spread has remained relatively flat. The subsequent failure of the spread to decline in the face of large rate declines suggests that the sluggish growth of bank assets during the last

FIGURE 2

The behavior of the adjusted spread between the prime rate and the commercial paper rate



shock to the depository system's capital position. We find that between June 1989 and June 1991, nearly two-thirds of the assets in our sample were controlled by institutions which seemed to be responding to regulatory constraints—the highest proportion in the periods covered by our sample. Taking into account higher capital requirements, beginning-of-period capital deficiencies, losses, and asset recycling, we estimate that the depository system would have needed an additional \$65 billion in equity to remain in equilibrium. This represents 28 percent of the industry's June 1991 equity. We estimate that asset recycling and higher capital requirements each accounted for one-third of the shortfall. Finally, we note that research on the link between the behavior of the RTC and monetary aggregates is consistent with our hypothesis about asset recycling, while the behavior of the prime rate is consistent with a tightening of the supply of credit unrelated to monetary policy.

These findings suggest that policymakers should view with great skepticism proposals to weaken capital requirements. They also cast further doubt on policies like forebearance which have the effect of allowing the inventory of unresolved institutions to accumulate, thereby converting a number of relatively small capital shocks into one large capital shock. Finally, our findings suggest that when the FDIC sells off a large number of insolvent institutions in a short period of time, the result will be more expensive bank credit and slower economic growth.

two years is not merely a result of weak credit demand, but also of weak supply.

Conclusion

In this article we add several findings to the literature on bank asset growth. First, we present evidence that banks find it costly to issue new equity in response to a deterioration in their capital position. Second, we show that regulatory capital appears to play a greater role in bank growth than does stock market valuation. Third, we suggest that changes in bank capital requirements have changed bank behavior. Fourth, we argue that when it is costly for banks to issue new equity in order to maintain their regulatory equity ratios, then the recycling of assets and liabilities from insolvent to solvent institutions will have much the same effect as a capital crunch. Finally, we develop measures of the

FOOTNOTES

[1]See Paul Asquith and David W. Mullins, "Equity issues and offering dilution," *Journal of Financial Economics*, January/February 1986.

[2]See Wall and Peterson (1991), Isberg and Brown (1987), and Bishop and Lys (1992).

[3]Other papers have used measures of market attractiveness to control for cross-sectional variation in growth opportunities. There are several reasons why we do not take this approach. First, many of the banking organizations in our sample are active nationally and internationally, making it difficult to measure market attractiveness. Second, even banks operating in relatively unattractive markets may have significant growth opportunities if other competitors become acquisition targets. Several recent examples of this phenomenon include Fleet's acquisition of Bank of New England, BankAmerica's acquisition of Security Pacific, and Bank of Boston's aborted bid for Shawmut.

[4]Only those firms filing with the SEC are included in the Compustat database. Firms may cease to file with the SEC if they are acquired, are taken private, or cease operations.

[5] Barro(1990) compares this measure of future profitability to changes in Tobin's Q and finds that the former measure outperforms Q in investment equations.

[6] Equality of the coefficients on *RINT* was tested by pooling data for the 1984-86 period and the 1989-91 period. The hypothesis that the coefficients on *RINT* were indeed equal across time periods was rejected at the .03 level for banks with do-nothing capital ratios between 6 and 7 percent, .05 level for banks with do-nothing capital ratios between 7 and 8 percent, and at the .001 level for banks with do-nothing capital ratios greater than 8 percent.

[7] This assumes an offering dilution rate of 30 percent on new share issues, a marginal tax rate of 40 percent, and a desired capital ratio of 7 percent.

[8] The $318 billion reported for the thrift industry overstates the likely impact of thrift resolutions on credit markets. In contrast to usual practice with bank resolutions, the RTC has tended to transfer only a small proportion of a failed institution's noncash assets. Noncash assets have typically been sold off separately or warehoused by the RTC. To the extent they are sold off either to banks or to purchasers who rely on the banking system for funding, the effect is still the same.

[9] It is not entirely clear how best to measure the spread between the prime rate and the commercial paper rate. Macroeconomic studies of interest rate spreads typically focus on the absolute spread $r_{prime}-r_{cp}$. However, it is by no means clear that a spread of 100 basis points has the same behavioral implications when riskless rates of interest are 20 percent as when they are 4 percent. Indeed, price theory typically suggests that behavior is affected by relative prices. Discounting payment flows for a prime rate loan at the commercial paper rate r_{cp}, the price of prime rate loan maturing in *M* years is

$$\sum_{t=1}^{M} \frac{r_{prime}}{(1+r_{cp})^t} + \frac{1}{(1+r_{cp})^M}.$$

Discounting payment flows for a commercial paper transaction at the commercial paper rate yields a price of 1. The spread estimates presented in figure 2 assume a maturity of 5 years.

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