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Bank Risk, Capitalization and Inefficiency

by
Simon Kwan
Robert A. Eisenbeis

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Bank Risk, Capitalization and Inefficiency [1]

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Abstract: Abstract: This paper employs a simultaneous equations approach to measuring the tradeoffs between risk, capitalization and measured inefficiencies in a sample of 254 large bank holding companies over the period 1986 through 1991. The results confirm the belief that these three variables are simultaneously determined. Furthermore, asymmetries were identified in the relationship between risk and inefficiencies. Support was found in the asset risk equations for the hypothesis that less efficient institutions took on more risk to off set this inefficiency, thereby transferring risk to the deposit insurance finds. Similarly, less efficient institutions tended to be less well capitalized, a result that may also be associated with differences in management quality. Finally, evidence is provided that risk averse managers tend to expend real resources to reduce asset risk, which makes them appear to be inefficient, when compared to efficiency measures derived under the assumption of risk neutrality.

Simon Kwan is at the Federal Reserve Bank of San Francisco. Robert A. Eisenbeis is at the Kenan-Flagler Business School, University of North Carolina at Chapel Hill.

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I. Introduction

Recent work by Shrieves and Dahl (1992) and Jacques and Nigro (1995) suggest that changes in bank capital and risk positioning by bank management are simultaneously determined and are affected by both exogenous and endogenous factors. In general, management tends to offset increases in capital with increases in risk, but also these tradeoffs are significantly affected by regulatory pressure.[1] In particular, regulatory pressure, as reflected in the new risk-based bank capital requirements seems to have been effective in offsetting tendencies for banks with low capital to increase their risk taking and to engage in moral hazard behavior.

In separate work, Kwan and Eisenbeis(1996) indicate that there are also tradeoffs between inefficiencies and bank risk taking and that the market prices both bank risk and inefficiencies. These two streams of research suggest that it may be important to investigate further how management reacts to the market pricing of efficiencies and bank risk, and how this affects bank capital decisions as compared with incentives to engage in excessive perquisite consumption and/or increased risk taking. In particular, Jensen(1986) and Stultz(1990) imply that there are theoretical reasons to believe that agency costs and information asymmetries may significantly impact these tradeoffs and may explain why some institutions react to increased costs of capital by taking on more risk, why some may consume perquisites and why others may reduce risk.

We draw upon agency theory to specify a simultaneous equations system which attempts to disentangle the differing incentives for management in managing risk, producing intermediation services and leveraging the organization, and how these incentives may be affected by regulatory

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[1] See Jacques and Nigro(1995).

actions. The remainder of this paper first reviews the theoretical considerations and models of bank leverage, risk taking and inefficiencies. We then present the model and data. These are followed by a discussion of the empirical results. The last section presents the Summary and Conclusion.

II. Tradeoffs Between Risk Taking, Leverage and Risk

The interplay among leverage, risk and investment incentives and the effects on firm value have received attention in the corporate finance literature with the development of theories of asymmetric information and agency. It clearly suggests that the direction of causation may be two-way.

Jensen(l986), for example, argues that the role of managers as agents for stockholders, is fraught with conflicts of interest which can affect asset selection, firm behavior, efficiency and performance. Managers, especially if they are risk averse, seek to maximize their own explicit and implicit compensation at the expense of shareholders.[2] Since both managerial compensation and power are typically linked to firm growth and larger firm size, management is may be incented to maximize firm growth beyond efficient size. This, of course, decreases operational efficiency, lowers returns and works against the interests of shareholders.

Theory also suggests that agency problems will induce managers to avoid monitoring by the capital markets by relying upon internal as opposed to external financing of investments. In fact, they will tend to over-invest in projects, including investing in negative net present value

[2] Differences in risk aversion between owners and managers may bean important source of this conflict. We know that less risk averse institutions will choose higher leverage and risk With risk neutral shareholder, only returns matter. If managers are risk averse and shareholders are risk neutral, then conflicts over portfolio selection will result.

projects, and/or engage in inefficient behavior whenever there is free cash available.[3] This problem of investment and its financing becomes more acute when there is asymmetric information on the quality of investment projects between management and the shareholders. In the case of banks, it is generally thought that their assets are opaque, and hence, this asymmetric information problem may be particularly acute with respect to their asset choice.

Asymmetric information, as Stultz(1990) notes, can not only lead to inefficient investment when cash flow is high, it can also inhibit efficient investment choice when free cash flow is low and the firm does have NPV investment projects. The problem is that shareholders understand management's incentives to overinvest, and hence, there is little that management can do to signal to shareholders that NPV projects are available, but sufficient investment finds are available to the firm to take advantage of these investments.

A partial solution to this problem is related to the choice of leverage. Jensen(1986) points out that not only are there agency costs to debt, debt can also seine a positive function in inducing managers to behave efficiently. While managers can promise to pay out free cash flow to shareholders through announcements of permanent changes in dividend payouts, Jensen points out that dividends can always be reduced in subsequent periods, and therefore, such announcements lack credibility. However, issuance of debt can provide a more permanent and credible way of disbursing free cash flow.[4] In effect, debt serves a bonding function and reduces

[3] Jensen(1986) defines free cash flow as "cash flow in excess of that required to fund all projects that have positive net present values when discounted at the relevant cost of capital."

[4] Jensen argues that the proceeds of the debt issue aren't retained.

the agency costs associated with free cash flow. Greater leverage also overcomes institutional resistance to entrenchment, which the free cash flow hypothesis assumes.

Counterbalancing these positive aspects of debt issuance and increased leverage are increased agency costs of debt. As leverage is increased, bankruptcy and related costs also increase which ameliorate the incentives to issue debt.

The implicit model implied by this analysis implies that inefficiency should be positively related to firm asset risk to the extent that managers are induced to take on negative net present value projects, or in the case of banks, to invest in lower quality loans. It also implies that inefficiency would be positively related to firm growth in that firms would be induced to grow beyond efficient size. Finally, inefficiency should be related to leverage, although it is not clear whether the bonding incentives or agency costs of debt would dominate.

As slightly different hypothesis concerning the relationship between inefficiency and risk taking which has the opposite sign prediction is offered by Hughes, Lang, Mester, and Moon(l994). They note that the traditional production functions and efficiency estimates are derived under the assumption of risk neutrality. However, managers may be risk averse rather than risk neutral, especially when a substantial portion of their wealth or human capital is tied to the performance of the firm. Hence, under risk aversion, managers may be willing to trade off reduced earnings for reduced risk. In doing so, they incur additional costs in initially making loans and in monitoring loan performance, which would show up as measured inefficiencies. Under the Hughes, Lang, Mester and Moon hypothesis then, one would expect to see a positive relationship between measures of asset quality and inefficiencies, with higher measures of loan quality being associated with greater inefficiencies.[5]

[5] Alternatively, higher loan quality would be associated with greater measure inefficiencies.

The literature also suggests that bank risk may not only affect leverage and inefficiencies, but also may itself be dependent upon leverage and inefficiencies. Management may be induced to offset higher capitalization by taking more risk. In banking, the leverage decision is further complicated by the existence of deposit insurance and regulation, which change some of the inferences one might draw from the corporate finance literature. Of primary concern are the effects that regulation and the structure of federal deposit insurance have on bank risk and return tradeoffs in a portfolio theoretic framework. It examines the effects that mispriced deposit insurance has had on bank incentives to take risk and to exploit the deposit insurance subsidy. This theoretical and empirical work indicates that the value of deposit insurance increases as asset risk and leverage increase.[6] In the presence of fixed rate deposit insurance and imperfect monitoring, these models would imply that the incentives to take on additional risk would be unbounded. Empirically, however, such behavior has not been observed, perhaps because of the bankruptcy costs reflected in the possible loss of a valuable bank charter and related considerations raised by Kwan(1990) and Keeley(1988).

Theory also demonstrates that there is an isomorphism between risk related premiums to control moral hazard behavior and capital standards designed to limit risk taking. Once this correspondence between risk-based premiums and bank capital requirements became understood, concern began to be expressed that increases in regulatory capital requirements may have the perverse effect of inducing institutions to take on more risk to offset higher capital requirements rather than to induce institutions to operate in a more safe and sound manner. Others turned to better understanding the role of monitoring and attempts to offset the incentives of institutions to

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[6] There is no consideration in the banking literature of the benefits that leverage may have in affecting firm efficiency or investment policy.

modify their portfolios, once capital decisions had been made, or risk-related premiums established, to rebalance portfolios to take on more risk. In particular, both Koehn and Santomero(l980) and Kim and Santomero(1988) suggest that increases in bank capital requirements would induce bank risk taking and have perverse effects on bank safety. Furlong and Keeley(1990) and Keeley and Furlong(1989), however, demonstrate that this conclusion depends upon the assumption of a constant cost of funds, and therefore, it ignores the impacts that increased capital would have on reducing the risk exposure of debtholders who would accept lower returns. Hence overall bank returns would be enhanced by increased capital requirements,' The positive correlation between returns and capital has been demonstrated by Berger(1994).

Shrieves and Dahl argue that the theoretical models suggest that whether there is a negative or positive relationship between bank risk and leverage depends upon the marginal benefits and costs of leverage and asset risk, which is strongly impacted by the size of the deposit insurance subsidy. Furthermore, this relationship changes as leverage and risk vary, since the option value of the deposit insurance subsidy has been shown to be nonlinear in both risk and leverage. They posit a partial adjustment simultaneous equation system which models the interactions between changes in risk, measured on an overall basis, changes in non performing loans, and changes in capital. Shrieves and Dahl find evidence that, even for banks that are not constrained by regulation, changes in capital and risk are positively related. Jacques and Nigro(l995) extend the work of Shrieves and Dahl in a simultaneous equations model to capture the relationship between changes in bank capital, portfolio risk and risk-based capital standards.

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[7] Given that monitoring was not perfect and that most banks' debt was not freely traded, the question arose as to why banks did not appear to pursue corner solutions and take on greater and greater risk, especially as capital ratios declined. One possible explanation was the existence of valuable charters which would be lost if management adopted portfolio strategies that would be optimal in a single period decision making world.

Their empirical work suggests that the new risk-based capital standards brought about increased in bank capital and reductions in risk, even for those institutions that were not capital-constrained.

This banking work has not considered the implications that Jensen's analysis suggests about the linkage between bank leverage, risk taking and investment decisions and inefficiencies. In particular, this work implies that, for certain institutions (those with free cash flow), reduced leverage - higher capital - may intent managers to consume more perquisites, operate more inefficiently and over invest. For other institutions, however, greater inefficiencies would be associated with poorer operating performance, and when coupled with greater leverage, would be associated with higher risks of bankruptcy. With mispriced deposit insurance, higher risk and greater leverage would imply stronger incentives to engage in moral hazard behavior since the option value of shifting risk to the FDIC would be greater. Finally, examiners have long observed that firms with rapid rates of growth tend to also take on more risk. Counterbalancing these incentives to take on unlimited risk would be the potential loss of valuable charter values, lost of firm specific human capital on the part of management, and increased incentives for regulatory oversight and intervention.

Taken together, the analysis implies that bank leverage, asset risk and inefficiencies are simultaneously determined and can be expressed in general terms as follows:

Inefficiencies = f(leverage, asset quality, growth) (1)

Asset risk = g(inefficiencies, asset composition, and asset growth) (2)

Leverage = h(inefficiencies, Regulatory Capital Constraints, Asset Returns) (3)

Following Jensen's arguments, the first equation suggests that agency problems will lead risk averse managers to opt for higher growth, higher leverage and lower asset quality, which will maximize their own welfare at the expense of share holders and will lead to inefficiencies and excess perquisite consumption. The second equation captures the belief that agency costs and risk neutrality will lead managers to select risky assets, invest free cash flow in negative net present value projects, consume excess perquisites and grow the firm to maximize their own welfare at the expense of shareholders. It also reflects the observation by bank examiners that firms pursuing excessive growth strategies may be engaging in moral hazard behavior and taking on too much risk. Finally, equation (3) captures the relationship between leverage and measures of risk, asset returns, and regulatory constraints identified in the previous literature. It also reflects the hypothesis that inefficiencies should be related to capitalization, although it remains an empirical question whether the bonding incentives of debt, the agency costs of debt or the moral hazard incentives that inefficient firms would be induced to pursue higher leverage strategies to shift risk to the deposit insurance funds will dominate.

The next section discusses the data used to estimate the model and the proxy variables used to capture the general relationships specified in equations (1)-(3).

III. Data

The data employed in this study are from the semiannual Federal Reserve bank holding company data from 1986 through 1991 obtained from the Y-9 Reports. Since only bank holding companies with total consolidated assets of $150 million or more, or with more than one subsidiary bank are required to file the long form of the Y-9 Reports, the sample consists of larger banking organizations.

A total of 254 bank holding companies were available for estimating the inefficiency estimates which employed pooled time series-cross section estimation of a stochastic frontier cost function described fully in the Appendix. 174 companies had complete time-series data for the entire sample period. The average total assets of the 174 sample firms with non-missing observations are used to sort these firms into size-based quartiles, since previous work (see Kwan and Eisenbeis(l995)) suggests that production technologies and outputs varied across banks of different sizes. The remaining 80 sample firms with missing observations are then classified into respective size classes using the quartile break points established by the 174 firms at matching time periods. This classification method ensures that the sample firms stay in the same size class throughout the study period.

Proxy variables are employed to represent the independent and dependent variables in equations (1)-(3). The specific equations estimated were:

$$INEFF = f(BADLOAN, BVCAPITAL, M\_LOAN, M\_LOAN^2) \quad (1a)$$

$$BADLOAN = g(INEFF, RE, CI, CS, M\_LOAN, M\_LOAN^2) \quad (2a)$$

$$CAP = h(INEFF, BASLE, ROA) \quad (3a)$$

Where

INEFF = stochastic inefficiency score described in Appendix
BADLOAN = (past due loans+ non accruals)/total loans
CAP = book value capital/total assets
M_LOAN = arithmetic average loan growth over past 5 years
M_LOAN^2 = M_LOAN squared

RE = real estate loans to total loans
CI = commercial and industrial loans to total loans
CS = consumer loans to total loans
BASLE = a dummy variable equal to 1 after the risk-based capital requirements were imposed in 1989 and zero elsewhere
ROA = return on assets,

The principal variables needing explanation in equations (1a)-(3a) are the proxies for asset risk capital, loan growth, asset composition, regulatory capital constraints and asset returns. Since the main determinant of asset quality is loan quality, the sum of past due and non accrual loans were used as a proxy for asset quality. Because the regulatory agencies and prompt corrective action provisions of the Federal Deposit Insurance Corporation Improvement Act employ book value capital ratios, the ratio of equity to assets was used to capture institution capitalization. Loan growth over the past 5 years proxies for asset growth. Since these are the most labor intensive components of bank assets, it should be most closely related to firm inefficiency. Loan growth squared was used to reflect any non-linearities that may be implied by the moral hazard hypothesis. The proportions of real estate loans, commercial and industrial and consumer loans were used to represent asset category and risk choices. The banking agencies generally assign real estate loans to lower risk classes in the risk-based capital standards, and it is generally conceded that consumer loans have different risk characteristics than commercial and industrial loans. In this case, foreign loans are the omitted category and hence their effects are impounded in the constant term. To reflect the effects of any regulatory constraints on capital, a dummy variable was specified to capture when the Basle risk-based capital requirements were imposed. Finally, return on assets (ROA) is employed to measure asset returns which is assumed to affect leverage through retained earnings.

IV. Empirical Results

The results of the two-stage least squares estimation of equations (1a)-(3a) are contained in Table 1.8 Results are reported for the four different size category of banks with the smallest banks being in Group 1 and the largest in Group 4. In general, the coefficients are different enough to justify the estimation of different equation systems for the various size category of banks.

A. Inefficiency Equation

In the inefficiency equations, the measures of loan quality are consistently negative and statistically significant for all except the smallest size category of banks. The sign indicates that as asset quality declines (BADLOAN increases), measured inefficiencies, derived under the assumption of risk neutrality, decline. This finding is consistent with the Hughes, Lang, Mester and Moon hypothesis that bad loans are costly to reduce, because loan review and monitoring expenses are high. This result is inconsistent with Jensen's agency hypothesis that management will engage in inefficient behavior by investing in more risky assets..

Capitalization is consistently negatively related to inefficiency across all 4 size classes of banks. This indicates that as capital increases, banks become less inefficient. That is, well capitalized banks tend to be better run, and this is reflected in the efficiency measures.

Loan growth is statistically significant and non linearly related to inefficiency. For the smallest size banks, higher loan growth is related to less inefficiency, which is inconsistent with the moral hazard hypothesis.[9] However, for the larger size banks, once loan growth exceeds 16%, 18% and 13% for banks in Groups 2, 3 and 4, respectively, then moral hazard behavior

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[8] The systems of three equations represented by equations (la)-(3a) meet the usual indentifiability requirements.
[9] Similar results were found using asset growth rates.

dominates the fact that institutions with moderate growth rates tend to be more efficient than institutions with stagnant or low growth rates. That is, more rapidly growing institutions tend, ceteris paribus, beyond a certain point, appear to be more inefficient than institutions with more moderate growth rates.

B. The Asset Risk Equations

The asset risk equations examine the effects of asset choice, growth and inefficiencies on loan risk. The hypothesis is that inefficiencies would induce institutions to reach for more risk and engage in moral hazard behavior, and this appears to be the case. Institutions with greater measured inefficiencies tend to have higher risk loans. In contrast to the inefficiency equations, estimated relationships are consistent with the agency cost and moral hazard hypothesis that inefficient institutions take on more asset risk. The result also points out the asymmetry between the effects of risk on inefficiencies from the inefficiency equation and the effects of inefficiencies on asset risk from the BADLOAN equation. The ability to separate the two effects is an improvement upon the single equation results found in Kwan and Eisenbeis(1995) which emphasized only the effects of risk taking on inefficiencies.

Growth appears to bear a different relationship to risk for small institutions than for larger institutions. For small institutions, growth below 23°/0 for institutions in Group 1 and 13°/0 for institutions in Group 2 is risk increasing. For institutions with 5 year growth rates in excess of these amounts, growth is associated with reduced loan risk. Whether this is the result of a few outliers created by mergers or confirms the views of bank examiners, that institutions experiencing hyper growth tend to be very risky, remains to be determined. For institutions in Group 3 growth is statistically insignificantly related related to asset risk and for institutions in the largest size class, growth is negatively related to loan risk. Again, this result is inconsistent with the agency and information hypotheses that managers will trade off growth for risk in order to increase their own perquisite consumption and compensation.

C. Capitalization Equations

The last set of equations examine the relationships between capitalization, returns and inefficiency. The measured effects of inefficiencies are statistically negative and significant, suggesting that institutions with greater inefficiencies are less well capitalized, which is consistent with the moral hazard hypothesis and risk taking hypothesis identified in the BADLOAN equation. Except for the small size class of banks, imposition of regulatory capital requirements was insignificantly related to bank capitalization. In the case of small banks, the sign is negative and wrong, indicating that after the imposition of the Basle capital requirements, bank capital went down, rather than increased. ROA is positive and significantly related to capital, which is consistent with the results of Furlong and Keeley(1990) and Keeley and Furlong(1989).

V. Summary and Conclusions

In this paper a simultaneous equation approach was taken to examining the trade offs between risk, inefficiency and capitalization. The results confirm the belief that these three variables are simultaneously determined. Furthermore, asymmetries were identified in the relationship between risk and inefficiencies. Support was found in the asset risk equations for the hypothesis that less efficient institutions also took on more risk to off set this inefficiency, thereby transferring risk to the deposit insurance funds. Similarly, less efficient institutions tended to be less well capitalized, a result that may also be associated with differences in management quality. Finally, the empirical results tend to support the hypothesis of Hughes, Lang, Mester and Moon, that risk averse managers tend to expend real resources to reduce asset risk, which makes them appear to be inefficient, when compared to efficiency measures derived under the assumption of risk neutrality.

References

Berger, Allen N., "The Relationship Between Capital and Earnings in Banking," Finance and Economics Discussion Series Paper No. 94-2, Board of Governors of the Federal Reserve System, February 1994.

Dahl, Drew and Ronald E. Shrieves, "The Impact of Regulation on Bank Equity Infusions," *Journal of Banking and Finance,* 15, December 1990, pp. 1209-1228.

Furlong, Frederick T. and Michael C. Keeley, "Capital Regulation and Bank Risk-Taking: A Note," *Journal of Banking and Finance,* 13, 1989, pp. 883-891.

Hughes, Joseph P., William Lang, Lorretta J. Mester and Choon-Geol Moon, "Recovering Technologies That Account for Generalized Managerial Preferences: An Application to Non-Risk-Neutral Banks," Department of Economics, Rutgers University, 1994.

Jacques, Kevin T. and Peter J. Nigro, Office of the Comptroller of the Currency, Economic and Policy Analysis Division, Washington, DC. 1995.

Jondrow, James, C.A. Knox Lovell, I. S. Materov and Peter Schmidt, 1982, On Estimation Of Technical Inefficiency In The Stochastic Frontier Production Function Model, *Journal of Econometrics* 19, *233-238.*

Jensen, Michael, "Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers," *American Economic Review,* May 1985.

Keeley, Michael C. , "Deposit Insurance, Risk and Market Power in Banking," Working Paper, Federal Reserve Bank of San Francisco, 1988.

Keeley, Michael C. and Frederick T. Furlong, "A Reexamination of Mean-Variance Analysis of Bank Capital Regulation," *Journal of Banking and Finance,* " 12, 1990, pp. 69-84.

Kim, Daesik and Anthony M. Santomero, "Risk in Banking and Capital Regulation," *The Journal of Finance,* 43 No. 5, Dec. 1988, pp. 1219-1233.

Koehn, Michael and Anthony M. Santomero, "Regulation of Bank Capital and portfolio Risk" *Journal of Finance 35, No. 5,* December, 1980, pp 1235-1250.

Kwan, Simon and Robert A. Eisenbeis, "An Analysis of Inefficiencies in Banking: A Stochastic Frontier Approach," Federal Reserve Bank of San Francisco, 1996.

Kwan, Simon H., "Risk and Charter Value in Banking," Ph. D. Dissertation, University of North Carolina at Chapel Hill, 1990.

Shrieves, Ronald E. and Drew Dahl, "The Relationship Between Risk and Capital in Commercial Banks," *Journal of Banking and Finance,* 16, April 1992, pp. 439-457.

Stultz, Rene, "Managerial Discretion and Optimal Financing Policies," *Journal of Financial Economics, 26, 1990,* pp. 3-27.

Table 1. Simultaneous equation estimates for inefficiencies, risk and capitalization

	Group- 1 Small Banks	Group 2 (Quartile 2)	Group 3 (Quartile 3)	Group 4 (Quartile 4)
Panel A. Inefficiency Equation with INEFF as Dependent Variable				
Intercept	0.605993* (5.332)	.075828** (3.668)	2.142657** (2.676)	0.2996* (7.461)
BADLOAN	-1.644759 (-1.261394	-3.198535*** (-2.009)	-16.774373*** (-2.294)	-0.867666**** (-2.812)
CAP	-5.235761* (-4.153)	-6.940687**** (-2.993)	-22.765937*** (-2.544)	-3.180561* (-6.440)
M_LOAN	-0.163301 (-0.813)	-1.279108* -4.901	-2.628689*** (-2.15)	-0.234454*** (-3.007)
M_LOAN²	-2.39852) (-1.803)	4.111562* (4.130)	7.217702 (1.525)	0.956* 4.282
Adjusted R²	.3003	.1320	.0149	.1284
F Value	56.804*	21.568*	3.314*	24.321*
Panel B. Asset Risk Equation with BADLOAN as Dependent Variable				
Intercept	-0.18571* (-6.799)	-0.171392* (-5.863)	-0.182214* (-7.197)	-0.009374 (-0.752)
INEFF	.292459* (11.349)	.390811* (9.417)	.34120* (9.464)	.534561* (7.564)
RE	.161258* (6.623)	0.174227* (6.585)	0.188976* (8.525)	0.037664** (3.554)
CI	.199196* (6.472)	0.190844* (5.658)	0.212528* (7.971)	0.01207 (.681)
CS	.125505* (4.903)	0.041105 (1.458)	0.146253* (6.270)	-0.033958*** (-2.177)
M_LOAN	.126292** (3.056)	0.075214 (1.147)	-0.089278 (-1250)	-0.168873* (-4.624)
M_LOAN²	-0.276651 (-1.217)	-0.283817 -1.071	0.484149 (1.490)	.0178377 (1.527)
Adjusted R²	.2290	.2149	.2381	.2171
F Value	26.741*	25.687*	32.883*	30.256*
Panel C. Leverage Equation with CAP as Dependent Variable				
Intercept	0.094115* (29.228)	0.067845* (30.699)	0.067323* (30.262)	0.070286* (17.305)
INEFF	-0.13125* (-10.224)	-0.026973*** (-2.227)	-0.046424** (-3.353)	-0.177125* (-4.148)
BASLE	-0.005258** (-2.602)	0.001381 (1.22)	0.000118 (0.001102)	0.000470 (0.392)
ROA	0.695444* (7.865)	1.469183* (16.299)	1.562211* (15.062)	.820552* (8.601)
Adjusted R²	.4785	.4831	.4669	.3783
F Value	160.057*	169.569*	179.645*	129.397*

*Significant at the .01%level, ** at .1%level,*** at 5%, **** at 1%

Appendix: The Stochastic Translog Cost Function

The stochastic translog cost function employed is of the form:

$$\ln TC_n = f(\ln Q_i, \ln P_j) + \varepsilon_n \qquad (1)$$

where TC_n is total cost for firm n, Q_i are measures of banking output and P_j are input prices. ε_n is a two component disturbance term of the form:

$$\varepsilon_n = \mu_n + \delta_n \qquad (2)$$

where μ_n represents a random uncontrollable factor and δ_n is the controllable component of the error structure. μ is distributed symmetric normal N(0, μ^2) and δ is independently distributed half-normal N(0, $\sigma_\mu{}^2$) which is truncated from below at zero.

Following Jondrow, Lovell, Materov, and Schmidt [1982], the measure of controllable firm inefficiency can be expressed as:

$$c_n = [\delta\lambda / (1+\lambda^2)][\phi(\varepsilon_n\lambda / \delta) / \Phi(\varepsilon_n\lambda / \delta) + \varepsilon_n\lambda / \delta] \qquad (3)$$

where λ is the ratio of the standard deviation of δ to the standard deviation of μ (*i.e.*, $\sigma_\delta / \sigma_\mu$),

$\sigma^2 = \sigma^2_\delta + \sigma^2_\mu$, and ϕ and Φ are the cumulative and the standard normal density functions, respectively.

The multi product translog cost function employed to estimate ε_n is of the standard form:

$$\ln TC = \alpha_0 + \sum_i \beta_i \ln Q_i + \sum_j \beta_j \ln P_j + \frac{1}{2}\sum_i \sum_k \gamma_{ik} \ln Q_i \ln Q_k + \frac{1}{2}\sum_j \sum_h \varsigma_{jh} \ln P_j \ln P_h + \sum_i \sum_j \omega_{ij} \ln Q_i \ln P_j \quad (4)$$

where TC is total operating costs (including interest costs), Q_i are outputs, and P_j are input prices. Five measures of banking output are included. They are book value of investment securities (Q 1), book value of real estate loans (Q2), book value of commercial and industrial loans (Q3), book value of consumer loans (Q4), and off-balance sheet commitments and contingencies (Q5) (which include loan commitments, letters-of-credit (both commercial and standby), futures and forward contracts, and notional value of outstanding interest rate swaps). Three input prices are utilized. They include the unit price of capital (P1), measured as total occupancy expenses divided by fixed plant and equipment; the unit cost of funds (P2), defined as total interest expenses divided by total deposits, borrowed funds, and subordinated notes and debentures; and the unit price of labor (P3), defined as total wages and salaries divided by the number of full time equivalent employees. The linear homogeneity restrictions,

$$\sum_j \beta_j = 1, \quad \sum_h \varsigma_h = 0, \quad \sum_k \omega_k = 1$$

are imposed by normalizing total costs and input prices by the price of labor. To allow the cost function to vary across size classes, the sample banking firms are first sorted into size-based quartiles according to average total assets between 1986 and 1991. Assuming the cost function to be stationary over time, pool time-series cross-section observations are used to estimate the stochastic cost function separately for each size-based quartile by the method of maximum likelihood. The estimate of the controllable cost inefficiency, c_n, is then computed for each sample firm in each sample period to measure firm-specific X-inefficiencies.

Summary statistics on banking outputs, input prices, total assets, and total costs for the 254 sample firms are reported in Table 2. Both firm size and the cost function variables are highly skewed, indicating the desirability of grouping firms into size classes. Although not reported in Table 2, off-balance sheet activities tend to be concentrated in the larger firms in the sample. This suggests that the cost function of large banking firms may potentially be different from those of smaller firms.

Table 2
Data summary for 254 bank holding companies, based on semiannual data from 1986 to 1991.

	25th Percentile	Median	Mean	75th Percentile
Total Assets[a]	1,198,481	2,779,545	9,814,536	8,110,207
Commercial and Industrial Loans[a]	164,143	434,074	1,657,808	1,435,509
Real Estate Loans[a]	306,258	689,684	2,136,602	1,857,829
Consumer Loans[a]	139,356	345,852	1,178,900	957,541
Investment Securities[a]	266,438	613,962	1,407,576	1,480,544
Commitments & Contingencies[a,e]	71,486	307,048	17,684,563	1,984,561
Total Costs[a]	50,644	121,354	462,233	346,316
Price of Labor[b]	12.41	14.02	14.85	16.08
Price of Physical Capital[c]	0.126	0.166	0.180	0.219
Price of Funds[d]	0.025	0.027	0.028	0.030
Number of firm-year	2,733			

[a] in thousands of dollars.

[b] in thousands of dollars per full time equivalent employee.

[c] in thousands of dollars per thousands of dollars of fixed assets.

[d] in thousands of dollars per thousands of dollars of deposits and borrowed fund.

[e] include loan commitments, letters of credit, futures and forward contracts, and notional value of outstanding interest rate swaps.