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COMPARING MARKET AND REGULATORY ASSESSMENTS OF BANK SOUNDNESS

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of Bank Soundness

by

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I. INTRODUCTION AND MOTIVATION

Public regulation of business enterprise is widely recognized as a justified means of dealing with certain types of market breakdown. The presence of economies of scale throughout the relevant range of production and the existence of substantial externalities are two well-known features that can cause the market mechanism to malfunction. In the banking industry, the existence of externalities, primarily those resulting from bank failures and their attendant effects on the money supply, has been used to justify regulation.

The form that regulation has taken however, differs sharply from the experience of other regulated industries. In banking, one of the major purposes of regulation is to ensure that firms are financially sound. This goal is pursued by means of frequent on-site evaluations of operating procedures and asset quality. In addition, the composition of bank liability portfolios comes under close scrutiny, especially the capital account.

Considerable attention has been given lately to alternative means of monitoring bank soundness. Two distinct approaches have been followed, the first being early warning models using accounting reports and the second being studies designed to evaluate the responsiveness of money and capital markets to differences in bank soundness. Because the present study combines aspects of both approaches, brief reviews of each branch of the literature are presented below.

The present study, by contrast, aims at a direct comparison of bank examination ratings with market evaluations of bank soundness. The methodology employed is a hybrid of a valuation model and a classification model. The first step is to construct and estimate a model of yield to maturity on long-term bank and bank holding company debt.¹ The model is grounded in widely accepted theoretical principles and can be evaluated on its own merits as an explanatory device. After establishing the integrity and suitability of the model, the independent variables from the debt model are then used to classify the sample banks according to their bank examination ratings. The critical point of this methodology is that no attempt is made to discover that set of variables best able to classify banks according to examination ratings. Rather, we seek to determine the extent to which those variables that are important to investors are also able to explain examiners' evaluations of bank soundness. To the extent that investor variables are successful, the implication is that the divergence between private and social costs of bank failures might not be so wide as regulators seem to think.²

Besides indicating what this paper attempts to accomplish, it may perhaps be well to indicate what it does not intend to do. In particular, this study should not be viewed as a contribution to the early warning literature but rather to the market efficiency literature. That investors view bank risk differently at different points in time, and consequently that different variables appear in valuation models for different years, is not a problem for this study, since bank examiners doubtless are also more sensitive to different aspects of risk in different periods. The question under investigation here is the consistency of market judgments with those of regulators.

The rest of the paper is organized as follows. Section II reviews some relevant literature. Section III presents the debt valuation model for this study and results of the empirical estimation. Section IV discusses alternative classification techniques and gives results of a logit analysis. Section V concludes the paper.

II. REVIEW OF THE LITERATURE

Early Warning Models

The early warning studies began as attempts to simulate examination ratings ex post, using logit, probit, or discriminant analysis, in the belief that resources could be conserved by substituting data processing equipment for bank examiners in the field. These early studies implicitly assumed that bank examiner ratings were correct; that is, that banks rated less sound by examiners actually were less sound. It proved relatively simple to simulate examiner ratings (see Stuhr and Van Wicklen 1974; Dince and Fortson 1972), but research also showed that examiner ratings were not very sophisticated and in particular could be quite well represented by a univariate index of asset quality (Sinkey 1978). Later studies focused more on predicting vulnerability to future events than on classifying banks ex post (Korobow and Stuhr 1975; Korobow, Stuhr and Martin 1976). The major difficulty with all models of this type is that they are not stationary, in the sense that both the specific variables discriminating among banks and their relative effects change over time. For example, despite knowing that bank profitability is important in predicting future vulnerability to deteriorating macro-economic conditions, one would not necessarily know if return on assets or on capital were the better predictor. An excellent review of this literature is contained in Daniel Martin (1977).

Financial Market Models

Research on capital markets has been conducted both for equity capital and for long-term debt. Essentially, these studies construct valuation models for the security under consideration and estimate the models using regression analysis. Independent variables are included to measure bank riskiness from an investor viewpoint, typically some aspect of leverage or a measure of asset quality such as loss rate on loans. Depending upon whether these risk variables are statistically significant and of the expected sign, one infers that financial markets do or do not respond to measurable differences in bank soundness.

Debt Valuation Models. The models employed in previous empirical research on long-term debt have been essentially reduced form equations in which the dependent variable is the arithmetic difference between yield to maturity on the risky debt and yield to maturity on default-free debt, or what is usually called a risk premium. The general form of such regression models can be written:

$$(1) \quad RR = \alpha RF + \beta MC + \gamma IC,$$

where RR = yield to maturity on risky debt, RF = yield to maturity on risk-free debt, MC is a vector of variables describing conditions in capital markets generally, and IC is a vector of variables describing characteristics of firms issuing debt securities. Expressing (1) in risk premium format ($Premium = RR - RF$) constrains the coefficient of RF to be unity.

An equation such as (1) is usually called an offer function. Despite the term, which connotes the supply side of a security market, (1) is a reduced form. For example, indices of the position and slope of the term structure are elements of MC , which also includes indices of the

economy's position in the business cycle. IC includes demand-side variables, such as investor perceptions of the riskiness of the issuer, as well as supply-side variables, such as the deviation of the current from the optimal capital structure of the firm.

The seminal article on the valuation of risky debt was published by Lawrence Fisher (1959). He hypothesized that risk premium is a function of the probability of default and of the marketability of the debt issue. Probability of default he took to be a function of three variables: the coefficient of variation of net income, the elapsed time since creditors were forced to realize a loss, and the ratio of the market value of equity to the par value of debt. Marketability he measured by the size of the debt issue. The regression equation estimated by Fisher was linear in the logarithms of risk premium and the four variables denoting risk.

Paying due consideration to functional form, Fisher's regression equation is readily seen to be a reduced form. Since the logarithm of a quotient of two variables is simply the difference in their logarithms, the coefficient of variation of net income can alternatively be viewed as the mean value of net income and the standard deviation of net income, where the regression coefficients of these two variables are constrained to be the same in absolute value but opposite in sign. Net income, or expected earnings on assets, is an argument in the supply of securities function, since firms whose earning rate on assets is higher will seek to expand their assets more greatly, ceteris paribus. Variability of earnings enters the demand for securities, since more widely fluctuating earnings for a given average level of earnings imply higher probability of default. Leverage, the market value of equity divided by the par

value of debt, enters the demand function, with greater leverage representing greater risk to investors. Leverage could also enter the supply side, but the model would be incomplete without specifying the optimal capital structure for the firm (if it exists).

Recent studies of bank debt, while not adhering strictly to Fisher's specification, have all followed his basic format. Pettway (1976a) examined risk premiums for a sample of newly issued debt securities of large banks and bank holding companies. His purpose was to assess whether or not financial markets responded to measurable differences in bank risk, as measured by financial leverage. The specific capitalization variables he used were the ratio of deposits and non-capital borrowed funds to total capital and total equity capital to total assets. Pettway also included total asset size of the issuing firm in his model as a third measure of default risk. He followed Fisher by measuring marketability as the size of the capital issue, but did not include period of solvency or earnings variability in his model. Pettway did include term to maturity of the capital note and a learning curve variable, since bank capital notes were relatively recent financial instruments and some learning phenomenon may have occurred in the market pricing mechanism. Finally, Pettway distinguished between banks and bank holding companies with an intercept dummy variable and used a linear functional form.

Michael Martin (1977) utilized nearly the same model as Pettway, introducing two earnings variables and measuring leverage alternatively on a consolidated basis and on a parent-only basis for bank holding companies. The two measures of earnings were growth in earnings per share over a five-year period and an earnings coverage ratio (earnings before tax to interest on long-term debt).³ Earnings coverage ratios

are commonly used to rate the quality of debt issues, but what constitute fixed-cost sources of bank funds is not a simple issue and was not discussed in Martin's study. Despite these alterations, Martin's regression model was quite similar to Pettway's, also being linear in the variables.

Beighley (1977) concentrated his attention on the effect of leverage on risk premiums and in particular on whether leverage should be measured at the parent level, on a consolidated basis, or at the issuing firm level (parent or lead bank). Besides leverage, Beighley related risk premium to size of the consolidated bank holding company (his sample contained no unaffiliated banks) and the loss rate on bank loans. Thus, Beighley included a measure of the riskiness of loans but excluded earnings, earnings variability, and marketability. His equation was also linear in the variables.

Results for the debt valuation models are mixed. Pettway (1976a) observed a statistically insignificant relationship between leverage and risk premium for his sample of bank and bank holding company capital notes, a result which was confirmed by M. Martin (1977). Beighley (1977), on the other hand, found leverage to be a significant determinant of risk premium. One should note that Beighley, Pettway, and Martin all used fairly similar models and observed much the same span of time. To what the differences in their results can be attributed has not yet been determined.

A theoretical approach to the valuation of risky debt was taken by Merton (1974) within the framework of perfect capital markets and continuous trading in securities. By assuming that the value of the firm follows a stochastic differential equation, he was able to derive

explicit expressions for the value of the firm's securities in terms of observable variables. In particular, the yield to maturity on risky debt was a function of just four variables: the risk-free rate of return, term to maturity of the debt, the volatility of the firm's operations, and the ratio of the present value of debt repayment to the market value of the firm, where debt repayment was discounted at the riskless rate of return. Since Merton's was an equilibrium model, his expression for the yield on risky debt was comparable to a reduced form equation. Merton also wrote his model explicitly in risk premium format (eq. 14). Comparing his three remaining variables with the four debt valuation studies previously described, it is interesting to note that the model bearing the most similarity to Merton's is that of Fisher.

Equity Valuation Models. Three contributions to the bank stock literature have appeared recently. The models underlying these studies have been standard stock valuation expressions, although one study (Pettway 1976a) also presents results based upon capital asset pricing ideas.

In a monograph prepared for the Association of Reserve City Bankers, Jacobs, Beighley and Boyd (1975) discussed rather thoroughly the issues surrounding the use of leverage by bank holding companies and the relationship between market-based and regulatory evaluations of bank capital adequacy. In their empirical section, they estimated a model in which stock price is the discounted present value of future earnings per share, where the discount rate was taken to be a function of leverage and asset size. In a subsequent study (Beighley, Boyd and Jacobs 1975) they expanded their model to include the rate of loan losses as an additional

dimension of the discount rate, tested dividend as well as earnings models, and added another year's data.

Pettway (1976a) tested two valuation models for equity, the first of which used beta as the dependent variable while the second used the price/earnings ratio. (The price/earnings ratio appeared as an independent variable in the beta model and vice versa.) He experimented with a wide assortment of earnings and risk variables: current dividend yield, dividends per share, payout ratio, change in earnings per share from the previous quarter, and average growth rate of earnings over the previous eight quarters for earnings variables; total capital over risk assets, earnings growth stability, and total asset size as risk variables. Apart from testing more variables, Pettway's price/earnings model was similar to the model employed in the two studies by Jacobs, Beighley and Boyd, while his beta model simply interchanged the roles of P/E and beta.

While the empirical format for all three equity studies was thus quite similar, and although very nearly the same period of time was studied in all cases, the results were hardly conclusive. For Pettway's beta model, the only variable consistently significant was total size of the organization. Beta was significantly related to the price/earnings ratio, the payout ratio, and the ratio of capital to risk assets in 1974 but not in 1971, 1972, or 1973. In his P/E model, only the stock yield was significant in all four years. The payout ratio, earnings variables, and the ratio of capital to risk assets were sometimes significant, but not consistently. Jacobs, Beighley and Boyd found asset size, earnings, and the growth rate of earnings to be significant in explaining share price, while consolidated leverage was

insignificant in 1970 and 1971 but significant in 1972 and 1973. This they ascribed to a learning phenomenon, and their subsequent study tended to substantiate this view. Also, they found leverage to be of increasing importance until 1974, when the loss rate on loans apparently became the foremost aspect of investor risk.

Thus, these studies lend some support to the position that financial markets are sensitive to bank riskiness, but the results are not particularly robust. In particular, there is disagreement over the proper specification of the valuation model, both as regards the appropriate dependent variable--beta, P/E, or price--and the relevant aspects of investor risk--leverage, loan losses, or beta.

Regulatory Viewpoint. For public policy purposes, the major shortcoming of the valuation studies is that they adopt an investor, rather than a regulatory, point of view. Since the basic justification for bank regulation is the existence of costs that are not internalized by individual banks or by investors in banks, finding that the prices or yields of bank securities are responsive to the amount of risk they present to investors does not imply that financial markets are capable of influencing banks to accept the socially optimum quantity of risk.

In a recent paper, Pettway (1978) addresses this shortcoming in an interesting way. He estimates Sharpe's market model (1964) of the rate of return to investors for an index of large commercial banks and bank holding companies whose soundness is unquestioned. Using the beta coefficient thus obtained, he compares the time series of expected and actual rates of return to investments in banks that subsequently failed, using the methodology of Fama, Fisher, Jensen and Roll (1969). Pettway's main concern is to evaluate the efficiency of the stock market in dis-

counting new information concerning bank soundness relative to the efficiency of bank examiners. To accomplish this, he defines critical dates based on the bank examination process. The earliest critical date is that day on which the examination began that ultimately led to the bank's being classified as a problem bank. The second critical date is the day on which the bank was classified as a problem, and the third date was the date of bank failure.

Pettway's results indicate that the stock market discounts financial distress long before bank examiners have even walked in the door to begin their evaluation. He thus concludes that the market for bank equities is highly efficient and suggests that information from the stock market can be used (when available) as an early warning device to alert regulators to potential bank problems. In an even more recent paper, Pettway and Sinkey (1978) propose an integrated early warning system that uses both accounting and market information and which consistently anticipates regulatory assessments by substantial time spans.

Two problems detract from the power of Pettway's results, however. The first is that he examines only failed banks, which are highly pathological cases of financial distress. Clearly, many banks get into financial difficulties without failing, and one would wish to know whether or not markets respond to less severe difficulties also. The second problem is that the sample of failed banks was selected ex post, which might impart a bias to his results due to the fact that his sample was known beforehand to differ significantly from the rest of the universe of banks. In this connection, one should also note that Pettway requires an index of the rate of return on equities of banks whose soundness is unquestioned. Finding such an index poses difficult

philosophical and theoretical problems.

III. THE DEBT VALUATION MODEL

Theory

The present study adheres closely to the tradition initiated by Fisher (1959), specifying a risk premium model as an econometric reduced form. The dependent variable should properly be the expected rate of return in excess of the expected risk-free rate of return. On the assumption that Treasury securities are indeed free of default risk, yield to maturity is their expected rate of return to maturity. Yield to maturity is also used as the market-clearing rate on risky debt because expected rates of return are not observable.⁴

Referring to the general regression model (1), the variables of interest are those in the vector IC, which denote relative riskiness of banks issuing debt securities. The coefficients of these variables will indicate the extent to which investors are sensitive to measurable difference in bank risk. The variables in vector MC must be specified, however, so that parameter estimates for IC are not biased through variable omissions. As noted above, variables in MC describe conditions in financial markets, meaning the economy's position in the business cycle and investor attitudes towards features of securities that are not related to specific issuers. Most prominent among such features are marketability of the security and various indenture provisions, such as callability, convertibility, sinking fund or other retirement features, and term to maturity. These features will vary among specific debt issues and must be included in the regression model. Economic conditions in financial markets, however, are a given for all securities at any specific point in time. To focus attention on the variables in

IC, economic and business cycle factors can be suppressed by examining a cross-section of bank debt securities that trade in secondary markets.⁵

Following Fisher, marketability of the debt is measured by the amount of the issue outstanding (ISSUE). In addition, a dummy variable for those securities that trade over the counter, rather than on the New York or American exchanges, is included (OTC). This variable can be viewed as a crude index of market imperfections. Bid-asked spreads tend to be much larger in over-the-counter markets, which means higher transactions costs for buyers and sellers. Thus the expected sign of OTC is positive, while the expected sign of ISSUE is negative.

Indenture characteristics that are observed accurately enough to warrant inclusion are term to maturity (TERM), restrictions on dividend payments (DIV RESTR), and requirements that the debt be paid back in instalments (INSTAL) or that a reserve be set aside for retirement of the issue (RESERVE).^{6,7} One expects that longer terms to maturity require higher risk premiums, ceteris paribus, since probabilities of default are usually taken to increase with longer horizons (Cohan 1974). Restrictions on the payment of dividends are not usually imposed unless lenders have strong reservations concerning the adequacy of the bank's capital and can thus be expected to imply higher risk premiums. Provisions for retiring debt prior to maturity avoid large balloon payments and the "crisis at maturity," implying negative coefficients in the risk premium model.

Firm-specific variables in Fisher's model are variability of earnings, which he measured by the coefficient of variation, and the debt-equity ratio. Similarly, the driving variables in Merton's model are the instantaneous variance of the rate of return on the firm and a debt-

equity ratio. For the present study, financial leverage is measured by the ratio of debt capital to equity, valued at book (DEBT/EQ). The expected rate of return on the bank is measured by the gross rate of return on income-producing assets⁸ (GROSS EARN). Measuring the variability of earnings poses problems. Because banking has changed greatly over the last few years, mostly due to the substantial diversification via bank holding companies, it was considered inappropriate to use a long time series of earnings figures for each bank in the sample. Rather, we rely on Merton's result (1974, p. 451, eq. 3.b) that the variance of returns on the firm as a whole is functionally related to the variance of returns on a security issued by the firm. Variability of the firm's earnings is thus proxied by the variance of the rate of return on the risky bond, computed from the most recent 12 monthly observations, and scaled by the mean rate of return on the bond (VARIANCE).

Consistent with results reported by Beighley, Boyd and Jacobs (1975) and by Pettway (1976a), two additional dimensions of investor risk are included in the risk premium model, the loss rate on loans (LOSS RATE) and the overall size of the bank (ASSETS). The loss rate on loans, actual loan losses as a percentage of total loans, probably reflects more accurately management's taste for risk than does the variance of the rate of return on the bank. Fluctuations in the rate of return on the investment portfolio are related to unexpected movements of interest rates or shifts in the term structure (i.e., to poor forecasting) rather than to the riskiness of assets, since commercial banks are forbidden by law from investing in fixed-income securities of low quality. Loan losses, on the other hand, reflect the credit-worthiness of the customers with whom the bank has chosen to cultivate long-term relationships and

consequently indicate management risk preferences directly.

The overall size of the bank has been used in previous studies to denote a dimension of default probability. One should probably view the influence of size on default as a market imperfection, possibly induced by regulation (i.e., larger banks are less likely to fail because regulators are less likely to allow them to fail). By most conventional measures of risk, large banks present considerably more risk to investors--lower capital/asset ratios, for example--and it is not clear how much of this risk can be overcome through greater geographical diversification of the portfolio.

Writing out the variables in MC and IC, the regression equation to be estimated is the following, with expected signs as shown:

$$(2) \quad \text{Premium} = b_0 + b_1 \text{TERM} - b_2 \text{ISSUE} + b_3 \text{OTC} - b_4 \text{RESERVE} - b_5 \text{INSTAL} \\ + b_6 \text{DIV RESTR} + b_7 \text{LOSS RATE} + b_8 \text{DEBT/EQ} - b_9 \text{GROSS EARN} \\ - b_{10} \text{ASSETS} + b_{11} \text{VARIANCE.}$$

The model will be estimated with ordinary least squares.

Sample and Data

The sample is drawn from the Bank and Quotation Record and consists of all listed debt securities that are the obligations of banks or bank holding companies. Holding company securities must be included to achieve sufficient degrees of freedom. Financial data are taken from the Report of Income and the Report of Condition when banks are obligors. When the bank holding company is the issuer, Income and Condition data for the lead bank are used. This procedure is evidently less objectionable for lead banks that constitute a large proportion of total holding company assets. This is the case for most holding companies in the sample. An

analysis of covariance indicated that, even for holding companies whose lead banks constituted less than 90% of total assets, one could not reject the null hypothesis that all observations were drawn from a homogenous population.

Certain other data requirements had to be met for inclusion in the sample, foremost among which were relatively frequent trading activity, so that variances of rates of return on the securities could be computed, and the requirement that the lead or issuing bank be a member of the Federal Reserve System, to assure availability of examination ratings. In all, 72 securities met the data requirements.

Price quotations are as of March 31, 1976, while income and balance sheet data are for year-end 1975. Ideally, a date should be found on which the most recent Income and Condition Reports have been fully discounted by the market but the next Condition Report has not yet become available. This, unfortunately, cannot be achieved since approximately six months' time is required to process the reports into publicly available form. Compounding the problem is the fact that holding companies frequently release earnings reports within one week of the close of a fiscal quarter. This means that by the first week in April many large holding companies have announced first-quarter earnings, while the balance sheet for the entire previous year is not yet available to the public. The solution adopted here is to assume that by March 31 of the year, the Reports of Income and Condition for the previous year-end, had they been available, would have contained no surprises, or in other words that the informational content of these reports has been discounted by the end of March. While this procedure is admittedly arbitrary, one should recognize that blindly using contemporaneous

market and accounting data entails implicit assumptions that are equally arbitrary.

Results

Table 1 presents ordinary least squares regression results for the risk premium model developed above. The regression model is linear in the variables. Additional experimentation was conducted with a model linear in the logarithms of the variables, Fisher's original usage. The results of those estimations were considerably poorer overall fits to the data (adjusted R-squares lower by more than 10 percentage points) and elasticities too small to be economically sensible. Accordingly, only results using untransformed variables are shown.

Column (1) of the table gives result using all eleven independent variables. Only the coefficient of TERM fails to have the expected sign, although it is not significant by usual statistical criteria. All other coefficients exceed their standard errors and eight variables are significant at the 5% level or better. The adjusted R-square shows that the model achieves an impressively high explanatory power relative to most cross-sectional studies.

Column (2) deletes TERM because its coefficient's sign was counter to expectations. Other parameter estimates are almost totally unaffected by this change, indicating that TERM was not collinear with the remaining ten variables. Column (3) further deletes ISSUE and VARIANCE since their coefficients are not significant by usual statistical criteria. One will note that only the coefficients of GROSS EARN and ASSETS change appreciably by this further deletion. With very little distinguishing the three versions of the model in terms of overall goodness-of-fit, column

(3) is selected as the most appropriate specification on grounds of simplicity.

The coefficient of OTC indicates that over-the-counter issues on average yield nearly 47 basis points more than issues trading on one of the major exchanges. Taken purely as an index of relative transactions costs this estimate seems too high. Probably some effect of the size of the issuing institution remains impounded in OTC.

The coefficients of RESERVE and INSTAL are definitely much too large in absolute value to be economically sensible, both indicating that provisions for early retirement can save a full percentage point in yield. To what these anomalous results can be attributed is not clear. The effect of indenture provisions such as these has not received much attention in the theoretical or practical literature.

The coefficient of DIV RESTR is also quite large but perhaps more sensible in economic terms, since imposing restrictions on the payment of dividends is an infrequently used sanction against banks. In any event, the statistical significance of these indenture provisions indicates that previous studies which omitted them have probably produced biased results for the risk characteristics of issuing banks.

Results for the financial variables measuring the riskiness of issuing banks and holding companies are on the whole economically sensible. A one percentage point increase in the rate of losses on loans would require nearly 40 basis points greater yield for investors. This effect, while very large, makes good sense when put into perspective with sample values of LOSS RATE. The mean rate of loss on loans is just under one percent and the standard deviation is about .5 percent. Thus an increase in the rate of loan losses to one standard deviation above

the mean would raise risk premium by about 20 basis points. As an additional benchmark, the difference between the sample maximum and minimum values for LOSS RATE is 2.762. The difference in risk premium attributable to this difference is about 110 basis points. These numerical examples of the effect of loan losses accord with economic common sense.

The coefficient of the debt/equity ratio seems quite small, although it is highly significant statistically. The sample mean value for DEBT/EQ is about 22.5 percent. If one were to increase leverage in the sample "average" bank to the maximum under current regulatory guidelines, namely long-term debt amounting to 50 percent of the book value of equity, the effect on risk premium would be an increase of about 22 basis points. Economically this effect is substantial although clearly not enormous. No doubt the fact that debt/equity ratios are circumscribed by regulation contributes to the effect being no larger than it is.

A bank able to increase the gross rate of return on its income-producing assets by a full percentage point would be able to issue debt at a 25 basis point lower cost. Given a sample mean value for GROSS EARN of 9.44 percent, this effect seems sensible. Similarly, a \$10 billion dollar increase in total size would allow nearly the same decrease in borrowing costs. For anyone persuaded that the effect of size is truly an imperfection created by regulation, this comparison gives an indication of the competitive advantage afforded big money market banks in raising funds relative to their larger regional competitors.

These regression results have been discussed in detail because the value of the classification analysis, which is the crux of this study, depends fundamentally on the integrity of the risk premium model. It seems fair to conclude that the risk premium results presented in this section are considerably superior to any previously reported results for banks and furthermore that the parameter estimates are generally economically sensible in magnitude. The following section discusses how these results are used to compare market evaluations of bank soundness with regulatory judgments.

IV. THE CLASSIFICATION ANALYSIS

In fulfilling their statutory responsibilities, federal bank regulators conduct on-site examinations of nearly every commercial bank at regular intervals. At the time this study was undertaken, banks were evaluated on three bases, quality of their assets, adequacy of their capital, and quality of their management, which were then consolidated into a single overall ranking of soundness.⁹ The overall ranking is thus the regulator's summary judgment concerning the soundness of the bank and can appropriately be compared with risk premium, the summary market evaluation of the riskiness of the bank's security. Since data on risk premiums contain considerable noise, summary bank examination ratings are correlated with variables explaining risk premium rather than with the risk premiums directly.

It is well known in the econometrics literature that ordinary least squares is inappropriate when the dependent variable takes on relatively few discrete values (see Goldberger 1964, for example). To deal with this problem, classification techniques have been developed, foremost

among which are discriminant analysis and logit regression analysis. Although discriminant analysis has been used frequently in the past (Dince and Fortson 1972 and Stuhr and Van Wicklen 1974 are two examples), strong requirements concerning the distribution of the variables are needed for its proper application. In particular, the data must be distributed multivariate normal; in addition, linear discriminant analysis is then appropriate only if the variance-covariance, or dispersion, matrix of the data is statistically equal across all classes. If the dispersion matrices are not equal, quadratic discriminant analysis must be used.¹⁰ For the set of variables under consideration, it is evident that the assumption of multivariate normality is not met, since several of the variables are dichotomous while others have truncated distributions.

Logit analysis is considerably more flexible than discriminant analysis and is the method applied to the present case. A derivation of the logistic functional form will not be presented here since these results are readily available elsewhere. See especially Daniel Martin (1977), who appears to be the first to apply logit regression to banking, and McFadden (1974), who derives the logistic form from an axiomatic treatment of qualitative choice. Reduced to the barest essentials, logit analysis assumes that the probability of an observation's belonging to class i , or P_i , can be written as

$$(3) \quad P_i = \exp[b_i'X] / \sum \exp[b_m'X].$$

where the summation runs over all classes $m = 1, \dots, M$ and X is the set of explanatory variables.¹¹ Multiplying (3) by $\exp[b_M'X] / \exp[b_M'X]$ gives

$$(4) \quad P_i = \exp[(b_i - b_M)'X] / (1 + \sum \exp[(b_m - b_M)'X]),$$

where the summation in the denominator now runs over $m = 1, \dots, M-1$.

Some restriction is necessary in order to identify unique values for the b_i and not just relative values. The convention used in TROLL's logit program, which was used for this study, is to set $b_M = 0$.

The parameters b_i are estimated by the method of maximum likelihood. McFadden (1974) proves that parameter estimates are asymptotically normally distributed and efficient, which further implies a test of the goodness of fit of the overall logit model is available from a comparison of the value of the maximized log likelihood function with the value of the log likelihood under the null hypothesis that $b_i = 0$ for all i . Let $L(b^N)$ be the value of the log likelihood under the null hypothesis and $L(b^*)$ be the unconstrained maximum value of the log likelihood. Then $-2[L(b^N) - L(b^*)]$ is approximately chi-square distributed with degrees of freedom equal to the number of parameters estimated. McFadden also discusses the use of $1 - [L(b^*)/L(b^N)]$, sometimes called the "likelihood ratio," as an analogy to the R-square of regression analysis.

Table 2 presents classification results for the logit analysis based upon the variables in column 3 of Table 1.¹² For the sample as a whole, 60 out of 72, or 83.3 percent, of all observations are correctly classified. The chi-square test value for goodness of fit, 92.094, can be compared with the critical value of 21.666 for nine degrees of freedom at the 1 percent level of type I error. The value of the likelihood ratio test is 0.582. The only previous logit analysis of banks (Daniel Martin 1977) reported values of the likelihood ratio test in the range of 0.40 to 0.50 for 1974 data and 0.05 to 0.20 for 1970 data. Thus, on overall fit criteria the logit model in this study performs admirably.

One should also note that the logit model classifies best for banks rated 1, those which are unquestionably sound, and worst for banks rated 2, those midway between sound and unsound. That banks rated 2 are most poorly classified is not surprising. Research conducted at the Federal Reserve Bank of New York (Stuhr and Van Wicklen 1974) has shown that banks rated 2 are typically in transition between ratings of 1 and ratings of 3. That is, there may be a relatively stable number of banks rated 2, but individual banks tend not to remain in that class for long periods of time. It is natural that any static classification technique would thus do poorest on this set of banks.

For purposes of evaluating the market's ability to monitor bank soundness, however, the results for banks rated 3 are the most important. These banks are considered unsound by regulators, but not sufficiently unsound that insolvency is imminent. Regulators devote considerable attention and resources to these banks, hopefully assisting them to regain financial integrity, and take considerable pains to insure that the public does not discover which banks are being closely monitored. That over 86 percent of these banks are correctly classified, using only publicly available information, lends strong support to the contention that regulators ought to make more use of the normal functions of financial markets.

While it is not the purpose of this paper to delineate how market information could be explicitly incorporated into the examination process, one obvious possibility is to schedule examinations based upon classification results such as those presented in this section. That is, banks which the market rated as being less sound could be examined first, with relatively more sound banks left for later examination.

A simple extension of this method would be to design examinations of increasing thoroughness. Banks rated wholly sound by the market would receive only the most cursory examination, while banks rated unsound by the market would receive extensive examinations. In this connection, the results shown in Table 2 indicate that more banks are "downrated" by the market than are "uprated." Should regulators decide to devote an intensive examination effort to all banks rated 3 by the market, 39 of the present sample of banks would undergo this type of examination, a number which is slightly larger than the actual number of banks examiners thought deserved 3 ratings. Considerable examination resources could be saved by not examining banks rated 1 by the market and by performing a less extensive examination of banks rated 2 by the market, except in cases that presented some anomaly indicating that the market's assessment might be "wrong."

V. SUMMARY AND CONCLUSIONS

This paper is an addition to the growing literature on the efficiency of markets for bank securities and the possibility of using market-based information to supplement or supplant the bank examination process. The major difficulty with most previous studies, from a public policy point of view, is that they adopted an investor's perspective only and failed to consider the regulatory position that bank examiners have access to information not available to the public. This study overcomes that problem by directly comparing market evaluations of the soundness of banks with regulatory evaluations.

The methodology used is to specify and estimate a model of risk premium on long-term bank debt. Risk premium incorporates all avail-

able information on the financial condition of the issuing bank and its future prospects and can be considered the market's summary evaluation of the bank's soundness. The independent variables from the risk premium model are then entered into a classification analysis in the attempt to replicate bank examiners' summary evaluations of bank soundness. The classification analysis is highly successful, over 83 percent of all banks being correctly classified and a slightly higher percentage of those regulators believed to be unsound.

The policy implications of this study are straightforward. First, markets for bank securities, even debt markets, are relatively efficient in the sense that they seem to have available much the same set of information that regulators have. Second, because the market's evaluations are quite similar to regulators', one can infer that the divergence between the social and private costs of bank failures is not so great as regulators seem to believe. And third, the bank examination process seems to a large extent to be duplicative of functions carried out by securities markets on a day to day basis. A considerable economy in the use of society's resources could thus be achieved by delegating more responsibility to financial markets for monitoring risk-taking by commercial banks.

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FOOTNOTES

Economist, Federal Reserve Bank of Chicago. The views expressed in this paper are solely those of the author and do not necessarily represent the views of the Federal Reserve Bank of Chicago or the Federal Reserve System. Earlier versions of this paper were presented at the Conference on Bank Structure and Competition, sponsored by the Federal Reserve Bank of Chicago, and the 1977 Annual Meetings of the Southern Finance Association. The author wishes to thank his discussants, Donald R. Fraser and Joseph F. Sinkey, Jr., for helpful comments.

¹Whether banks and bank holding companies obey the same risk premium model for long-term debt was investigated by Weaver and Herzig-Marx (1978) using a similar model but a different sample of securities (new debt issues rather than secondary market observations as used in the present study). An analysis of covariance indicated no significant difference in slopes or intercepts between the banks and the bank holding companies in that sample.

²The supposed gulf between private and social costs of bank failures is usually thought to arise from the existence of deposit insurance, which eliminates risk of wealth losses for most depositors, and from improved macroeconomic management, which reduces the severity of the business cycle and thus also the number of banks that fail. One must, therefore, view the divergence between private and social costs of bank failures as largely an attendant result of regulation. Should this divergence turn out not to be too great, as indeed the empirical results presented below will indicate, such a finding would provide rather strong

evidence that financial markets can be relied upon to monitor bank soundness. One should also note that debt capital must be expressly subordinated to all depositors' claims in order to be exempt from the provisions of Regulation Q (ceilings on interest rates) and D (reserve requirements). Thus, the gulf between private and social costs might be expected to be smaller for debtholders than for depositors.

³Why the growth of earnings was related to number of shares outstanding is not discussed in Martin's paper, this type of variable being more customarily found in equity valuation studies.

⁴This study assumes that the investment horizon is identical to the maturity of the debt security. Since these securities do trade in secondary markets the assumption is perforce violated, which may account for the anomalous empirical results for the maturity variable.

⁵Several previous studies have used observations on bank debt securities from differing points in time yet did not control for varying economic conditions (Fraser and McCormack 1978; Pettway 1976a). How this omission altered regression results is difficult to say. Suffice it to note that the results of the present study are far more satisfactory than previous efforts.

⁶Callability is a feature that has received considerable theoretical and empirical attention and should be included in any analysis of debt securities. Because nearly every security in the present sample is callable, it proved impossible to identify the effect of this provision.

⁷Nine bonds in the sample are convertible into common stock. While a considerable literature has accumulated on the pricing of convertible securities, and although that literature indicates that a convertible bond should not follow the same valuation model as straight debt, the convertibles were retained in this study. An examination of the prices at which these bonds were selling during the twelve months ending March 31, 1976, indicated that all convertibles were priced far below par. This implies that they were selling at or near the floor set by their value as straight debt. For the nine bonds, the average of their 12-month high prices was 71.6 and the highest of the nine 12-month high prices was only 84. A statistical test was also run to determine if the regression model differed significantly for convertibles. The value of the F statistic for this Chow test was 1.524, significant only at the 16 percent level of type I error.

⁸Income-producing assets are total assets less plant, equipment, and cash and due from other banks.

⁹Since the initiation of this study a fourth dimension has been added to the bank examination, a liquidity analysis. The composite rating used in this study takes on integer values from 1 to 4, with 1 denoting an institution that is sound in every respect and larger values denoting deteriorating soundness. The rating 4 is reserved for banks that are experiencing serious difficulties requiring immediate regulatory action (e.g., merger into a sound institution). A problem with the present study is that no banks in the sample are rated 4, which means that the market, should it have wished to, was not afforded the opportunity to rate a bank a 4. By the nature of the ranking

system, however, 4-rated banks tend to disappear quite quickly, either through failure, reorganization, or merger. For a more complete discussion of examination ratings, see Appendix I to the testimony of Brenton C. Leavitt at hearings before a subcommittee of the House Committee on Government Operations, entitled "Oversight Hearings into the Effectiveness of Bank Regulation (Regulation of Problem Banks)," January 20; February 3; and June 16, 1976, pp. 52-55.

¹⁰A detailed analysis of the assumptions underlying the proper application of discriminant analysis, together with a computer program that implements a variety of statistical tests, is the subject of a recent book by Eisenbeis and Avery (1972).

¹¹Equations (3) and (4) are not written in most general form but rather reflect the requirements of the present study, in which, according to McFadden's terminology, there are only individual attributes and no alternative attributes or interaction terms.

¹²A detailed table of logit regression results is not presented since the methodology of this paper dictates the logit model. One interesting feature of these results might be noted, however, namely that the most "important" variable, judged by individual statistical significance, is the loss rate on loans. This finding is strikingly similar to Sinkey's (1978) determination that examiner ratings are little more than a reflection of classified loans.

Table 1
Regression Results for Risk Premium Model

Variable	(1)	(2)	(3)
INTERCEPT	2.987*** (3.318)	2.869*** (3.358)	3.214*** (3.888)
TERM	-0.010 (0.443)		
ISSUE	-0.003 (1.250)	-0.003 (1.272)	
OTC	0.427*** (3.272)	0.431*** (3.336)	0.468*** (3.848)
RESERVE	-0.913*** (2.846)	-0.880*** (2.839)	-0.903*** (2.909)
INSTAL	-1.028** (2.063)	-1.040** (2.103)	-1.041** (2.100)
DIV RESTR	0.421*** (2.645)	0.394*** (2.697)	0.438*** (3.047)
LOSS RATE	0.405*** (3.189)	0.397*** (3.179)	0.397*** (3.203)
DEBT/EQ	0.008*** (7.270)	0.008*** (7.331)	0.008*** (7.454)
GROSS EARN	-0.210** (2.122)	-0.201** (2.089)	-0.249*** (2.737)
ASSETS	-0.018** (2.271)	-0.017** (2.276)	-0.024*** (4.678)
VARIANCE	0.001 (1.331)	0.001 (1.298)	
\bar{R}^2	0.718	0.722	0.720
SEE	0.480	0.477	0.479
F	17.443	19.424	23.839

NOTES: TERM is in units of thousands of days; ISSUE is in \$ millions; OTC, RESERVE, INSTAL, and DIV RESTR are dummy variables; LOSS RATE, DEBT/EQ, and GROSS EARN are in percentage points; ASSETS is in \$ billions; VARIANCE is in percentage points. Significance levels are for two-tailed tests, ** denoting 5% type I error and *** denoting 1% type I error.

Table 2
Classification Results for Logit Analysis
of Bank Examination Ratings

<u>Group</u>	<u>Number in Group</u>	<u>Percent Correctly Classified</u>	<u>Number of Observations Classified into Groups</u>		
			<u>1</u>	<u>2</u>	<u>3</u>
1	7	100.0	7	0	0
2	28	75.0	0	21	7
3	37	86.5	0	5	32

$$\begin{aligned}L(b^N) &= -79.100 \\L(b^*) &= -33.053 \\-2[L(b^N)-L(b^*)] &= 92.094 \\1-[L(b^*)/L(b^N)] &= 0.582\end{aligned}$$