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THEORY AND TESTS OF THE EFFECT OF FINANCIAL LEVERAGE ON VALUATION OF THE BANKING FIRM

The Louisiana State University and Agricultural and Mechanical Col.

University Microfilms International 300 N. Zeeb Road, Ann Arbor, MI 48106

PH.D. 1980
THEORY AND TESTS OF THE EFFECT OF FINANCIAL LEVERAGE ON VALUATION OF THE BANKING FIRM

A Dissertation

Submitted to the Graduate Faculty of the Louisiana State University and Agricultural and Mechanical College in partial fulfillment of the requirements for the degree of Doctor of Philosophy

in

The Department of Finance

by

Donald Malcolm Chance
B.S., University of Montevallo, 1972
M.B.A., University of Mississippi, 1973
August, 1980
ACKNOWLEDGEMENTS

This dissertation could not have been completed without the assistance of numerous individuals. I would like to thank Dr. Charles G. Martin, Associate Professor of Finance, who served as my committee chairman and whose guidance and criticisms were an integral part of not only this project, but my entire doctoral program. My gratitude also goes out to the other members of my committee: Dr. William R. Lane, Assistant Professor of Finance; Dr. William F. Staats, Louisiana Bankers Association Professor of Banking; Dr. David T. Crary, Professor of Finance; and Dr. Donald L. Marx, Assistant Professor of Quantitative Methods. I also wish to thank the finance faculty and the Graduate School for offering me a graduate assistantship which was held during the past three years.

I also benefitted greatly from having the opportunity to present parts of this research in seminars at Texas A&M University, Virginia Polytechnic Institute and State University, and Texas Tech University. The comments and suggestions of the finance faculties of those institutions were most helpful. I would also like to thank Dr. John D. Martin, currently of the University of Texas at Austin, who read a rather lengthy preliminary version of the paper and provided many valuable comments and criticisms.

The assistance of my family was especially important throughout the duration of the project and the entire program. My wife, Jan, provided patience and understanding and typed much of the preliminary and final drafts. My daughter, Kim, was an inspiration and a joy who made the
dissertation experience a little more tolerable. My gratitude to them comes from the heart.
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ABSTRACT

The effect of financial leverage on valuation and shareholder wealth of the banking firm was examined both theoretically and empirically. It was assumed that market imperfections made possible the creation of a bank which would operate in capital, loan, and deposit markets. The valuation of equity shares was assumed to be described by Black's zero-beta version of the Capital Asset Pricing Model. Although the Black model is a perfect market model, it served as a framework within which imperfections could be introduced.

A firm operating in a market without an intermediary was converted to a bank, charged with the responsibility of providing banking services, and allowed to issue demand deposits. The deposits were of the form of an initial inflow followed by outflows which equal inflows so that a constant level of deposit financing was maintained. A perpetuity model was assumed in the text although a single-period version was presented in an appendix. No taxes were assumed. Deposits were initially considered to be costless, riskless, non-interest bearing, and requiring no reserves. It was shown that the value of the bank and the wealth of its shareholders could be increased by using deposit leverage in lieu of equity. It was later verified that the presence of costly deposits, interest on deposits, and reserve requirements would reduce the benefits offered by deposit leverage but would not likely eliminate them. Required rate of return and cost of capital formulas were derived and reflected the advantage of deposits as a source of financing.
Next, the bank was assumed to issue risk-free interest-bearing liabilities. It was shown that the use of this form of leverage was also advantageous to banks and their owners but less so than were deposits. An incentive for banks to maximize their use of such financing was shown to exist. Required rate of return and cost of capital formulas were presented and they also reflected the advantage of this source of financing.

Empirical tests examined the effect of financial leverage on the systematic risk of banks. It was proven that if banks possess an advantage over non-banks in their financing operations, then that advantage would result in smaller increases in systematic risk as units of financial leverage are added.

A sample of banks and two samples of non-banks were collected. Time series estimates of systematic risk were calculated and regressed on the debt/equity ratio. It was found that the model worked reasonably well although the presence of outlying observations and errors in the measurement of beta made it somewhat difficult to explain a large percentage of variance.

A test was derived to measure the statistical differences between banks and non-banks in the effects of increases in financial leverage on systematic risk while taking into account differences in the underlying business risk of the samples. The results showed that an increase in leverage apparently does not produce as large of an increase in systematic risk for banks as it does for non-banks.

The implication of this finding is that investors appear to recognize that for banks benefits are associated with debt financing
which do not accrue to non-banks; thus, the well-known Modigliani
and Miller theory which states that in the absence of taxes the
amount of leverage is irrelevant does not apply to banks. The
results have important implications for regulatory issues and in
explaining bank financial management behavior.
Chapter 1

INTRODUCTION

Theories of financial structure have provided a useful analytic framework for determining the effect of financing decisions on shareholder wealth. Presently these theories are strictly applicable to the non-financial enterprise leaving us with no clear explanation of whether the issuance of debt claims, a primary function of banks, offers any benefits to their shareholders.

Banks are said to operate in imperfect markets.\(^1\) Provided that they are able to exploit imperfections in these markets, it would seem that shareholder wealth might be enhanced by establishing and following a well defined criterion for optimal financing decisions. This notion, however, is only intuitive and not well supported in the literature. Previous theoretical papers by Pringle\(^2\) and Taggart and Greenbaum\(^3\) have addressed the question among others. Their models, however, seem impossible to empirically test; and we are simply left with no acceptable and verified theory of bank financing decisions.

The need for theoretical and empirical evidence on this topic is underscored by the emergence in recent years of two significant

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practices of banks. One is the tendency for banks to undercapitalize themselves, leading to the well-known "capital adequacy" issue. A suggested approach to the problem is to allow the capital markets to regulate bank capital. Much research has been conducted into the question of whether the market can regulate bank capital and the outcome is still in doubt. Part of the difficulty seems to lie in an improper specification of the relationship between leverage and either the required equity return or the cost of capital. Most of the models tested are ad hoc formulations reflecting, as previously indicated, the lack of a well-defined theory depicting the effects of bank financing decisions.

The other practice that has come into vogue is that of "liability management" and its concomitant "spread management banking." In the early 1970's it became apparent that loan demand was outstripping deposit growth. Banks then began to turn increasingly to debt markets for their financing needs, while concurrently attempting to maintain a satisfactory "spread" between borrowing and lending rates. It is not at all clear how banks determine the spread, but for reasons that will

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subsequently be revealed, this practice is not well supported in financial theory.

Assume a very simple financial structure in which a bank's assets are financed by 80 percent debt costing 6 percent and 20 percent equity costing 12 percent. The weighted average cost of capital is, therefore, 7.2 percent. If the bank does not charge at least 7.2 percent on loans, it will not earn its cost of capital. In practice the rate it charges is frequently pegged to the cost of borrowed funds rather than the overall cost of capital. It is no surprise that this decision rule has been labeled "the Banker Theory of business expansion."

The problem with the "Banker Theory" is that it ignores the effect of marginal units of debt on the riskiness of the stream of cash flow available to equity holders. The real thorn in reconciling this issue, however, may be a result of applying an inappropriate theory of financial structure to banks.

The theory of financial structure alluded to is the well-known Modigliani-Miller (MM) theory. It is tempting to simply apply the MM theory to a bank and consequently to draw similar conclusions to those one might draw for firms. It is certainly questionable, however, whether the MM theory is directly applicable to banks. For example, the MM theory assumes that the owners of firms and the firms themselves

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borrow and lend at the same rate of interest. It also assumes perfect liquidity of assets, no transactions costs, and costless information among other assumptions. In short the assumptions which combine to produce the overall assumption of a perfect market are those which must be violated in order for banks to exist. Furthermore, when the MM theory is combined with the Capital Asset Pricing Model of Sharpe, Lintner, and Mossin \(^\text{10}\) and all investors and firms are assumed to be borrowing and lending at a risk free rate of interest, it becomes especially apparent that banks would serve no useful purpose in this market. Thus, in order to accommodate banks it become necessary to diverge from the traditional perfect market theory of finance.

The purpose of this research is to develop a theory of bank financial structure. This objective will be pursued by setting up a model which is capable of accommodating the imperfections consistent with the existence of banks and then using the model to examine the effects of leverage on valuation and shareholder wealth of the banking firm. The bank will be viewed as a wealth maximizing firm which is shown to have a competitive advantage over non-banking firms in both the risk and cost of claims issued against them.\(^\text{11}\)

Two types of claims will be examined. One is the demand deposit, here assumed to be costless, riskless, non-interest bearing, and


\(^{11}\)In Chapter 3 the question of whether wealth maximization is an appropriate objective for banks will be considered.
requiring no reserves. Although these assumptions and some others which are invoked are not necessarily realistic, they serve a useful purpose in facilitating an initial and relatively simple view of the model. Later the assumptions are dropped. It will be shown that the model's essential findings are maintained even when relaxing those assumptions.

A second form of debt issued is an interest bearing liability which will be identified as simply "credit market financing." Such financing is empirically observed in the form of federal funds, certificates of deposit, and Eurodollars. The role of this form of financing is to support asset expansion when deposit growth is inadequate.

An important feature of the model is the fact that a testable implication can be derived. It will be shown that the model implies that a specific functional relationship will exist between a measure of equity risk and financial leverage for banks that will be different from that of firms. Some preliminary evidence will be presented that is shown to provide support for the model.

Chapter 2 will present an overview of the literature to include issues such as (1) corporate financial structure theory and its empirical evidence and (2) the state-of-the-art in bank financial structure theory and the evidence on the effects of financial leverage on valuation and equity returns of the banking firm. Chapter 3 will provide the theoretical development of the bank financial structure model that forms the nucleus of this research. Also covered in this chapter will be the formulas for the bank's required rate of return and cost of capital and the model's implications under relaxed assumptions. Chapter 4 will present the derivation of a testable statement plus a
general overview of the test procedures, relevant econometric issues, and answers to anticipated criticisms of the testing process. Chapter 5 will report the empirical evidence. In Chapter 6 the results of the research will be summarized and conclusions and implications will be presented.
Chapter 2

SURVEY OF THE LITERATURE

The purpose of this research is to integrate fundamental concepts from the theory of corporate financial structure with conditions consistent with the existence and managerial objectives of a banking firm. The literature survey will, therefore, benefit from a brief review of the current state of financial structure theory as it is applied to non-banking firms. Accordingly this chapter proceeds with a review of such theory and the empirical studies that have purported to test the theory followed by the rather limited theory of bank financial structure and its empirical evidence.

The theory of bank financial structure bears little resemblance to the theory of corporate financial structure. The reason is due to the fact that no previous study has ever attempted to provide a theoretical link between firm and bank financial structure principles. The author would be remiss, however, to imply that such a link has not evolved from previous papers on the subjects. Nonetheless, it is felt that the present research may provide even further clues as to the mystery surrounding bank financial structure decisions.

One problem that quickly arises in examining separate but related areas of study is that terminology appearing in the literature is not necessarily consistent from one study to the next. The problem is most evident in the use of the term "capital." In corporate financial or "capital" structure theory, "capital" refers to debt and equity with no specific distinction being made between short and long term debt.
Nonetheless, equity is often referred to as "capital," i.e., equity capital, and debt is occasionally referred to as debt capital. In banking theory the term "capital" is somewhat more confusing primarily because the Comptroller of the Currency, the regulator of the national banks, allows banks to count a portion of their long term senior debt as capital when computing "capital adequacy" ratios such as capital to total assets. Thus, the Comptroller and also other regulators, desirous of banks meeting certain minimum ratios of "capital adequacy," are labeling equity as the primary definition of "capital," with the Comptroller allowing some debt to also count.

It is the intention of this writer to avoid any confusion over terminology. In this chapter, "financial structure" will, henceforth, refer to the relative proportions of debt and equity in the financing of a firm's assets. "Capital," used singularly will refer to equity. The expression "cost of capital" will indicate the weighted average cost of debt and equity. Unfortunately, there will be a few minor abrogations to the general rule, but these will be clearly noted, kept to a minimum, and should cause no undue bewilderment.

The Theory of Corporate Financial Structure

The theory of corporate financial structure has been a focal point of financial research for many years. Its origins are generally traced to the seminal work of Modigliani and Miller (MM).¹ MM postulated that in a no tax world, the value of the firm and shareholder

wealth could not be enhanced by the use of financial leverage. They argued that investors capitalize a firm's net operating income, or cash flow from operations, which is determined solely by the probability distribution of the returns on the firm's investment activities. Their proof rested on the individual being able to engage in arbitrage operations that effectively substitute personal leverage for corporate leverage. The firm can do nothing for the individual that he cannot already do for himself, implying that financial leverage and, thus, financial structure is irrelevant. The introduction of a corporate income tax would, however, modify this conclusion. The tax deductibility of interest payments would augment the stream of earnings available to the equityholders so that it would be larger than that of an unlevered firm of equivalent business or operating risk. The value of the firm and shareholder wealth would then increase. Under these assumptions the firm should use as much debt as it could obtain in its financial structure.

The MM theory was the first counterargument to a traditional view of firm financial structure as set forth in Solomon.² Rebuttals of MM were published by Solomon and Baumol and Malkiel.³ They argued that even in a no tax world, the moderate use of debt would provide benefits that would more than offset any additional risk. Up to a certain point, equityholders would not increase their required rates of return by enough to completely offset the use of low cost debt.

The MM theory was examined further in two papers by Stiglitz. In the 1969 paper he developed the theory in a state preference framework assuming margin restrictions and differential personal and corporate borrowing rates. He found that if the individual investor were able to recreate corporate leverage on a personal basis by selling short, the MM results could be upheld. He also derived the theory using the Sharpe-Lintner-Mossin (SLM) Capital Asset Pricing Model (CAPM) of market equilibrium. At approximately the same time, Mossin and Hamada derived the MM propositions using the SLM model, but Stiglitz's proof as well as that of Rubinstein were more general as they incorporated risky debt whereas Hamada and Mossin had assumed riskless debt.

In the 1974 paper Stiglitz extended the MM theory to the question of whether the debt/equity decision for firms in aggregate were relevant to the economic welfare of society. Under very general conditions he proved that it was indeed irrelevant. A similar conclusion was reached

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by Miller\textsuperscript{8} but discussion of that paper will deferred to a later paragraph. Stiglitz also provided an insight into the existence of financial intermediaries. He argued that if levered firms were overvalued relative to unlevered firms of equivalent business risk, and if for some reason individuals were unable to engage in the arbitraging operations necessary to eliminate disequilibria, then financial intermediaries would be created. The intermediaries would then undertake the buying and selling of financial securities that would restore equilibrium. It should be noted that this argument rests on the assumption of \textit{costless} creation of intermediaries.

Setting aside the no tax case, academics have found themselves unable to reconcile the MM recommendations that firms should seek maximal use of debt with the empirical observation that excepting financial intermediaries, firms simply do not use ninety-nine percent debt. To hopefully resolve this conundrum, Kim\textsuperscript{9} developed a mean-variance financial structure theory in which an optimal level of debt financing was found to occur where the present value of the interest tax subsidy equals the present value of bankruptcy costs. Also Kraus and Litzenberger\textsuperscript{10} reached a similar conclusion with a state preference model where an optimal financial structure was shown to exist at the point where the firm "jumps"


from the discrete state of solvency to the state of bankruptcy. These papers, however, are subject to considerable questioning. The possibility that bankruptcy costs are sufficiently great enough to deter management from maximizing the use of debt financing has been denounced by Haugen and Senbet\textsuperscript{11} and empirical evidence that bankruptcy costs appear to be trivial relative to the value of the firm was presented by Warner\textsuperscript{12}.

Another but as yet untested possibility is the agency cost model of Jensen and Meckling.\textsuperscript{13} They suggest that the separation of ownership and control creates agency costs if owner and managerial objectives do not coincide. Managers in seeking to maximize their own welfare will trade off costs of bringing in outside financing (financial reporting, bonding costs, etc.) with returns from having outsiders share costs of perquisites. In this manner an optimal mix of debt and equity along with an optimal ratio of inside to outside financing is found.

Miller\textsuperscript{14} has extended the basic MM model with corporate taxes to include personal taxes. Because of the relatively higher tax rate on interest income than on dividends and capital gains, bondholders require compensation in the form of higher pre-tax yields. Any advantages of


\textsuperscript{14}Miller, loc. cit.
debt are erased as the progressive income tax forces firms to offer higher pre-tax yields as they sell additional debt to the marginal investor. In equilibrium no optimal financial structure exists; however, evidence given by Kim, Lewellen, and McConnell provide little support for the existence of financial leverage clienteles, an implication of Miller's model.15

Empirical Evidence on Corporate Financial Structure Theory

Attempts to verify the MM theory have concentrated on testing the relationship between leverage and the cost of equity capital, stated as MM's Proposition II

\[ K_e = K_0 + (K_0 - K_1)(D/S) \]

where \( K_e \) is the cost of equity capital for a levered firm, \( K_0 \) is the cost of equity capital for the same firm if unlevered, \( K_1 \) is the cost of debt capital, \( D \) is the market value of the debt, and \( S \) is the market value of the equity (stock).

Tests focusing on the above relationship are valid tests of the MM theory because Proposition I - the value of the firm and the cost of capital are unaffected by the use of financial leverage - and Proposition II are joint hypotheses. Such tests, however, are not easily performed. Most importantly, an accepted equity valuation model is needed and the CAPM, the most popular one to date, has not, according to Roll,16 especially stood the test of econometric rigor and may not


even be testable at all. Furthermore, firms used in a sample must be of equivalent business risk which is not, as empirically verified by Gonedes and Martin, Scott, and Vandell, necessarily equivalent to belonging to the same Standard Industrial Classification (SIC) "industry." Another problem lies in the measurement of the cost of equity capital. Neither the ratio of earnings to price nor the dividend/price ratio, often used in other studies, is necessarily a satisfactory proxy for $K_e$. Also, the use of market values as implied by the theory creates some spurious correlation if price is used to measure $K_e$. Another problem occurs in the interpretation of the tax effect. Proposition II with taxes simply contains a $(1 - \tau)$ factor multiplied by $D$ where $\tau$ is the corporate marginal income tax rate. If tests are found to uphold Proposition II some irrationality on the part of managers for not maximizing debt financing is implied. On the other hand, the traditional theory implies that there is some advantage to debt financing and it is easily seen that this advantage might be indistinguishable from the MM case with taxes. Consequently interpretation of test results must be tempered with caution.

Modigliani and Miller found results consistent with their views for samples of oil and electric utility stocks. Using the CAPM for a

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sample of firms from nine SIC "industries," Hamada found evidence that leverage was increasing the firms' beta coefficients where beta is the relevant measure of risk in the CAPM. He concluded that since the required return on equity is determined in the market by the beta coefficient, the results were consistent with MM. Joy and Jones using the CAPM also purported to have found results supporting MM; however, they erroneously attempted to satisfy the equivalent risk class assumption by holding total risk constant rather than business risk. Furthermore, they misinterpreted their results which could easily have been consistent with the traditional view.

Other evidence fully supports the traditional view. Brigham and Gordon in an equity valuation model incorporating leverage and other factors found that investors did not appear to be requiring complete compensation for marginal units of financial risk. Wippern using a modified leverage measure designed to remove the problem of heterogeneity of business risk, found leverage to have a smaller effect than predicted by MM. Sarma and Rao tested the theory on a sample of Indian firms


and found less of a leverage effect than implied by MM. Barges\textsuperscript{24} carefully reviewed the MM theory and the statistical problems involved in testing it and designed tests which supported the traditional view of no leverage effect at low levels of debt, but a rising cost of equity at higher levels of debt. A summary and critique of these and other general equity valuation models is found in Keenan.\textsuperscript{25}

The state of corporate financial structure theory is an unsettled one. To extend the uneasy case for or against an optimal financial structure to a banking firm might well be ill-advised, but the severity of contemporary problems in banking demands some form of rigorous model for which the preceding is at least better than nothing at all. The next important task, then, is to examine existing theories of financial structure of banking firms to determine the extent to which their predictions concur with or diverge from current theories of corporate financial structure.

The Theory of Financial Structure and the Banking Firm

Theories of banking firms have generally been of the microeconomic partial equilibrium nature. An exception is a paper by Santomero and Watson\textsuperscript{26} who derive a formula for a socially optimal level of bank capital; however, the approach is void of any direct practical significance as


it would require quantification of several non-measurable factors. Also, it provides no theory of bank financial decisions.

Focusing on the microeconomic models, it was found that the role of capital in models of banking firms has frequently been restricted to serving as the residual claimant of the bank's earnings stream and not playing an active role in the decision process. Such an approach provides interesting insights but undermines the importance of the financing decision. Other models though supported by rigorous economic theory have omitted equity altogether providing no answers to the questions addressed herein.

Mingo and Wolkowitz have developed a useful theory under certainty. In their model a binding regulator imposed-constraint forces the bank to hold inefficient portfolios and renders risk aversion an unnecessary requirement. The bank would simply maximize profits given the soundness constraint. Solving the constrained optimization problem, they found that a bank would respond to an increase in soundness requirements by raising new capital, improving loan quality, reducing deposits, or

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reducing loans. The choice would depend on the bank's relative advantage in the markets for capital, loans, and deposits. The financial structure decision, thus, might well be dictated by regulatory soundness requirements though it would seem likely that a bank would command more of an advantage in the loan and deposit markets and would choose not to raise additional capital.

Taggart and Greenbaum\(^\text{30}\) developed another certainty model with further significant results. They view the bank as a maximizer of net present value of equity and generating cash flows from loans and deposit service transactions. No taxes are assumed. Debt is of the form of deposits which may or may not pay interest. Under reserve requirements and interest on deposits, the bank would substitute equity for deposits which would release reserves for lending. At the same time transactions service profits from deposits would be foregone. An optimal point would be reached when the additional profits generated by the released reserves offset the foregone transaction service profits. In the absence of reserve requirements, deposits would be substituted for equity indefinitely. With reserve requirements but no transaction service profits, an all equity financial structure would be optimal. In the absence of reserve requirements and transaction service profits, no optimal financial structure would exist. Under reserve requirements and no interest on deposits, the substitution of equity for deposits would increase the safety of the bank's remaining deposits. Banks would continue to do so until no bank

in the market could gain a competitive advantage. An optimal financial structure would then exist. Under reserve requirements, no interest on deposits, and deposit insurance, the incentive to increase the safety of deposits by raising equity is missing. Deposit insurance would serve this purpose. New equity would only be issued if loan demand outstripped the bank's available sources of borrowing. This particular case is the most realistic and its predictions are consistent with the empirical observation that banks seen reluctant to raise new equity.

The model coming closest to bridging the gap between banking and corporate financial structure theory is attributed to Pringle.\(^{31}\) Pringle argues that the Sharpe-Lintner-Mossin model is insufficient in its basic form for explaining bank behavior. He suggests that the existence of banks implies that markets are imperfect whereas the SLM model assumes that markets are perfect. A modification of the SLM model to incorporate a premium in the pricing of assets due to imperfections in loan, deposit, and capital markets is made. The premiums are identified as "excess" returns and costs over equilibrium values. Banks are viewed as risk averse expected utility of terminal wealth maximizers who command certain advantages in the loan market and face frictions in the money and capital markets. Two scenarios and considered. In the first case the bank faces a single-period short run world where capital is fixed, loans are the decision variable and deposits are stochastic. The optimal level of loans would occur at the point where excess marginal

loan revenue equals excess marginal cost and would be a function of excess loan revenue, excess short term borrowing cost, the parameters of the probability distribution of deposits, the market price of risk, and the chosen level of capital. In the second case the bank faces a long run multiperiod world where capital is an active decision variable. Optimal loan volume then would occur at the point where excess marginal loan revenue equals excess marginal cost of capital; thus, the only factors affecting loan policy would be attributed to market imperfections. The optimal level of capital would depend on the extent of imperfections in the borrowing and capital markets. Capital is seen as a medium for avoiding the high excess costs of short term borrowing. If the excess cost of short term borrowing exceeds the excess cost of capital, banks would increase capital to the point where it is equal to or less than the optimal level of loans. If excess capital costs are greater than or equal to excess short term borrowing costs, capital offers no benefits and would not be used at all.

If one were willing to accept the extent of market imperfections implied by Pringle, then the above model may be accurate; but for its predictions to conform to the observed decline in bank capital ratios, the degree of imperfections in the short term money market must be overshadowed by the degree of imperfections in the capital market. Ergo, Pringle's theory depends on the relative excess costs of long versus short term borrowing and the existence of a differential between them.

The preceding survey of banking models is not exhaustive. Most of the other models, however, do not address the leverage issue whereas these models do. At this point it will be beneficial to follow this discussion with an examination of the evidence on this controversy.

None of the theories of bank financial structure previously mentioned have been directly tested. A plethora of empirical studies, however, have been concerned with the effect of leverage on the cost of equity, valuation, cost of capital, etc. of banks. Most of these tests represent examinations of ad hoc models being supported rather loosely by a minimum theoretical foundation and frequently lacking econometric rigor. Few address the question of whether the relationship, if any, between leverage and equity cost completely offsets any advantage of debt financing. Rather, the point of interest has frequently been the question of whether the market can sufficiently distinguish banks by their leverage so that it might be a surrogate for government regulation of banking organizations with publicly traded shares.

Humphrey and Talley\(^ {32} \) used a system of simultaneous equations to measure the response of the cost of equity to changes in leverage for fifty-five bank holding companies in 1973 and 1974. Cross-sectional regressions of price/earnings on dividends/earnings, growth in earnings, variation in earnings, and leverage measured as total assets/equity capital plus reserves were tested. To examine whether leverage decisions were being affected by market behavior, the leverage variable was regressed on the ratio of earnings/price to the cost of debt lagged one period, a risk asset ratio, and the yearly change in total deposits of the banking

system. In the 1974 regressions leverage was found to be related to the cost of equity, but in neither 1973 nor in 1974 was the market having any impact on the leverage decision. They concluded that the market may be recognizing but not regulating bank leverage.

Gahlon and Stover\textsuperscript{33} examined thirty-seven banks and holding companies in the periods, 1963-67 and 1972-76. Using the CAPM they first postulated that bank betas would be related to the bank's degree of operating leverage, degree of financial leverage, and the correlation of its common stock earnings with the market. Standard textbook definitions of degree of operating leverage and degree of financial leverage were used. The degree of financial leverage was found to be correlated with beta in the 1963-67 period but not in the 1972-76 period.

Pettway\textsuperscript{34} conducted several tests of the market's sensitivity to bank leverage. For a sample of thirty-eight banks and holding companies, he regressed the beta coefficient from a time series regression on dividend yield, dividends per share, dividend payout ratio, the change in earnings per share from the third to fourth quarter, earnings growth over the last eight quarters, price/earnings ratio, total capital/risk assets, stability of earnings growth, and size of the firm. It should be noted that capital included equity and long term debt. The regressions were performed for each of the years from 1971 through 1974. The leverage


ratio, capital/risk assets, was significant only in 1974. For the same sample he interchanged the price/earnings ratio and beta coefficient as the dependent and independent variables, and the leverage variable was significantly related to price/earnings in 1972 and 1974 but unrelated in 1971 and 1973.

Durand\textsuperscript{35} collected a sample of 117 banks and estimated cross-sectional regressions for six geographic groups of banks for each of the years from 1946 through 1953. He regressed the stock price on earnings, dividends, book value per share, size of the firm, assets/capital, risk assets/capital, dividend payout ratio divided by an average of past dividend payout ratios, and earnings stability. Neither assets/capital nor risk assets/capital were found to be statistically significant.

Shick and Verbrugge\textsuperscript{36} applied multiple discriminant analysis to the price/earnings ratios of fifty-four banks over the years 1963-67 to determine if forty financial statement variables would be accurate discriminators. Using a stepwise technique, leverage variables defined as capital notes plus preferred stock divided by common equity and debt plus equity capital divided by total assets less cash and government securities did not enter the model significantly. Worth noting is the fact that simply because a computer program rejects a particular independent variable does not necessarily imply that the variable is unrelated to the dependent variable.


Magen\(^{37}\) used a sample of forty-five banks and estimated cross-sectional regressions for each of the years from 1962 through 1966. The cost of capital defined as net operating earnings divided by market value was regressed on leverage measured as debt divided by debt plus equity capital, dividend payout, growth in net operating earnings, coefficient of variation of the deviation of net operating earnings from a trend line, coefficient of variation of the deviation of earnings before interest and taxes from a trend line, and the loan/deposit ratio. Several alternative measures of leverage were also tested, but no measure of leverage was found to be significantly associated with this measure of the cost of capital.

Silverberg\(^{38}\) regressed the dividend yield as a proxy for \(K_e\) on firm size, leverage, earnings, and growth for a sample of sixty holding companies for 1973 and 1974. Leverage was found to have no effect on the dividend yield. The doubtfulness of dividend yield being a proxy for the required equity return would tend to explain these results.

Fraser\(^{39}\) regressed price/earnings for fifty banking firms for the years 1974 and 1975 on variability of return on assets, earnings growth, dividend payout, equity/assets, and long term debt/total capital. Using a stepwise technique, leverage did not enter the model significantly.

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Again, the caveat is that stepwise procedures sometimes obscure relationships which are significant.

Van Horne and Helwig\textsuperscript{40} examined a sample of small Michigan banks in 1964 and found their stock prices to be unrelated to their use of financial leverage.

The following papers in contrast found a definite leverage effect. Gendreau and Humphrey\textsuperscript{41} re-examined the Humphrey-Talley model discussed earlier. They converted the model to time series form and regressed price/earnings on the same variables but added dividend growth and the Standard and Poor's 500 Stock Composite Index. For the cost of debt regressions they added the Consumer Price Index to reflect inflationary effects. The leverage regression was maintained as before. The sample consisted of fifty large banking firms over the period 1970-75. Leverage was found to be statistically related to both the price/earnings ratio and leverage decisions did seem to be affected by market activity. They then re-estimated the regressions cross-sectionally. No leverage effect was found for the entire sample although a significant leverage effect was evident for a separate regression with the highest levered banks. Then going back to a time series regression for the highest levered banks revealed no leverage effect. They concluded that the market was apparently not distinguishing banks by their degree of leverage but acknowledged

\textsuperscript{40}James C. Van Horne and Raymond C. Helwig, The Valuation of Small Bank Stocks (East Lansing, Michigan: Michigan State University Graduate School of Business Administration, 1966).

possible misspecification and a sample range of leverage that was fairly limited. Nonetheless, they had found some evidence that variations in bank leverage ratios were being detected by the market.

Beighley, Boyd, and Jacobs\textsuperscript{42} found no relationship between leverage and stock price in 1970 and 1971 but did find a significant relationship in 1972 and 1973 for a sample of ninety banking firms. They subsequently extended the study to a sample of 113 holding companies and banks for the years 1970-74.\textsuperscript{43} They regressed price on net operating earnings, dividends per share, total cash dividends, a four year geometric mean growth rate in net operating earnings, total holding company consolidated assets, the ratio of loan charge-offs net of recoveries to total loans, the ratio of total deposits and other liabilities to the book value of common stock, common shares outstanding, and a dummy variable for whether net operating earnings had increased each of the last few years. Leverage was found to be statistically significant for each of the years increasing in significance in 1972 and 1973 over 1970 and 1971 but decreasing in significance in 1974. When the sample was partitioned by size, leverage had an even greater effect on large banks' equity prices.

Graddy and Karna\textsuperscript{44} collected a sample of forty large bank holding companies over the period 1969-76. They regressed price/earnings on

\textsuperscript{42}Donald P. Jacobs, H. Prescott Beighley, and John H. Boyd, "The Financial Structure of Bank Holding Companies" (Chicago: Association of Reserve City Bankers, 1975).


\textsuperscript{44}Duane B. Graddy and Adi S. Karna, "Bank Holding Company Leverage and the Cost of Capital" (paper presented at the meeting of the Financial Management Association, Boston, Massachusetts, October, 1979).
various combinations of debt/equity, dividend yield, risk assets/debt plus equity capital, accounting income/assets, growth rate of earnings, demand deposits/total deposits, and loan losses/operating income. Linear and non-linear models were tested. A positive significant leverage effect was found; however, when net income/book value of equity, a proxy for equity return, was used as the dependent variable, the relationship was significantly negative. When average cost of capital, defined as earnings before interest and taxes/market value of the firm, was regressed on the above variables, the relationship was significantly negative and a quadratic model implying a U-shaped curve provided the best fit. Diametrically opposite results were found when the value of the firm was the dependent variable.

The conclusions drawn from these studies would leave us with no solid ideas one way or the other on whether the financing decision affects valuation and equity cost for banking firms. Beyond the conflicting results, it is apparent that measurement errors, heteroskedasticity, and multicollinearity were certainly present in at least some of the studies; in most cases, the authors failed to address these possibilities. Furthermore, leverage was defined in a variety of manners further confounding the possible functional relationships between leverage, valuation, and equity cost. Accordingly, further research is warranted and the model that will be developed in Chapter 3 will hopefully turn over another stone in the mystery surrounding the relevance of bank financing decisions.
Chapter 3

A THEORY OF BANK FINANCIAL STRUCTURE

The approach to financial structure theory used here will be that of mean-variance analysis. Mean-variance analysis has perhaps been the most widely used framework for financial theory for many years but is not without its drawbacks. The most critical problem is that it is best applied to the case where investors have quadratic utility functions. The quadratic utility function has the inherent weakness of assuming that investor risk aversion increases with wealth. The interpretation is that as an investor becomes wealthier, he is less tolerant of a given amount of risk, a characteristic that seems inconsistent with rational behavior. Also, the quadratic utility function reaches a maximum at a given level of wealth beyond which utility and wealth are negatively related, an implausible assumption; therefore, the function is only valid up to a specific level of wealth. Furthermore, the function ignores skewness and other higher order moments of the probability distribution of returns. All of these criticisms are more thoroughly explored in Mossin¹ and the problems of applying mean-variance analysis to financial structure models are discussed by Gonzales, Litzenberger, and Rolfo.²


Nonetheless, mean-variance analysis retains many desirable properties, primarily its inherent simplicity, and serves well as a useful approximating framework. For this reason it has been selected for use in this model.

Fundamental to any analysis is the question of which objective firms and banks are interested in meeting. It would seem likely that banks, like many other firms, maximize multiple goals; however, the goal of shareholder wealth maximization provides the most tractable framework for mean-variance analysis. As a positive model of bank (and corporate) financial management theory, shareholder wealth maximization may be inappropriate. As a normative model, however, it is especially useful but is more applicable to the case of large banks. For that reason the model will be restricted to the group of largest banks in the economy.

Also necessary to an analysis such as this one is the assumption that bank shares are traded in a relatively efficient market. Few studies have addressed this question but Hagerman has reported finding some evidence of market efficiency among bank shares. Following the suggestions of Mason, this model's applicability is restricted to that class of large banks with publicly traded shares, thus, assuring the existence of a reasonably efficient market.

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5Mason, op. cit., pp. 208-10, 222-3.
Before proceeding to the development of the model, it will first be necessary to review some fundamental concepts of capital asset pricing theory and the equilibrium model that will be used for this analysis.

Equilibrium Models of Equity Returns

The Sharpe-Lintner-Mossin model of capital market equilibrium is given as

$$E(R_i) = R_f + \frac{E(R_m) - R_f}{\text{var}(R_m)} \beta_i$$  \hspace{1cm} (3-1)

where $E(R_i)$ is the equilibrium expected return on the $i^{th}$ security held in an efficiently diversified portfolio, $R_f$ is the risk-free borrowing and lending rate, $E(R_m)$ is the expected return on the market portfolio of all risky assets, $\beta_i$ is $\text{cov}(R_i, R_m)/\text{var}(R_m)$ and is the systematic or non-diversifiable risk measure of the $i^{th}$ security which represents that security's contribution to the risk of an efficient portfolio. The tilde ($\tilde{\cdot}$) denotes a random variable. The model is often alternatively written as

$$E(R_i) = R_f + \lambda \text{cov}(R_i, R_m)$$  \hspace{1cm} (3-2)

where $\lambda = \frac{E(R_m) - R_f}{\text{var}(R_m)}$. Assumptions of the model are risk averse investors who maximize expected utility of terminal wealth in a single-period world, investors are price takers and have homogeneous expectations about the joint multivariate distribution of security returns which is assumed to be of the normal or Gaussian type, all investors may borrow and lend in unlimited quantities at a risk-free rate, the supply of assets is fixed, all assets are marketable and infinitely divisible, markets are perfect and efficient, information is costless, and there are no taxes, transactions costs, or other frictions inhibiting trading.
The essential implication of the model is that in equilibrium all investors hold only two assets. One is the risk-free security either held long (lending) or sold short (borrowing). The other is the market portfolio. Each security's weight in the risky portfolio of an individual investor is the ratio of the market value of the security to the market value of all risky securities.

Empirical verification of the model has proven to be difficult indeed. Tests by Black, Jensen, and Scholes, Fama and MacBeth, and Miller and Scholes\(^6\) have been questioned by Roll.\(^7\) Roll argues that the only true test of capital asset pricing theory is a test to determine whether the market portfolio is efficient. Since the exact composition of the market portfolio cannot be specified, the model cannot be tested. He proves that results which support the model can be found by selecting an efficient proxy for the market portfolio even though the true market portfolio may not be efficient. Conversely, results which reject the model may be found by simply selecting an inefficient proxy for the market portfolio which may itself be efficient.

Bearing Roll's criticism in mind, it is, nonetheless, worthwhile to consider one essential implication from the Black, Jensen and


Scholes tests. They suggest that a second term, called a "beta factor," should be incorporated into the model. The "beta factor" is a second portfolio which has the property of positive variance but zero covariance with the market portfolio. Instead of combining the market portfolio with the risk-free asset as in the SLM model, investors are assumed to combine the market portfolio with the zero-beta portfolio. The equilibrium relationship between expected return and risk for securities is given as:

\[ E(R_i) = E(R_z) + [E(R_m) - E(R_z)] \beta_i \]  

(3-3)

where \( E(R_z) \) is the expected return on the zero-beta portfolio and all other terms retain the same definitions as in the Sharpe-Lintner-Mossin model. Black, Jensen, and Scholes have stated that

It seems to us that we have established the presence and significance of the beta factor in explaining security returns but, as mentioned earlier, we have not provided any direct tests aimed at explaining the existence of the beta factor. We have, however, suggested an economic rationale for why capital market equilibrium is consistent with the finding of this second factor.8

The "economic rationale" was to be found more precisely in Black.9

In this paper Black examines the equilibrium conditions of a capital market in which no riskless borrowing or lending exists.

8Black, Jensen, and Scholes, op. cit., p. 115.

9Fisher Black, "Capital Market Equilibrium with Restricted Borrowing," Journal of Business, 45: 446-52, July, 1972. It should be noted that the zero beta model is the more general version of the capital asset pricing model. The Sharpe-Lintner-Mossin model simply incorporates a risk-free asset even though the existence of such an asset is not a necessary condition for equilibrium so long as efficient portfolios have inefficient orthogonal portfolios and the market portfolio is efficient. The first condition has been proven among other places in Roll's critique. The second condition, as mentioned earlier, remains untestable according to Roll.
Consider Figure 1 in which the opportunity set of available securities and portfolios is plotted in $E(\tilde{R}_p), \sigma(\tilde{R}_p)$ space. The only additional assumption needed over the Sharpe-Lintner-Mossin model is that of unrestricted short selling of positive variance securities. The set of minimum variance portfolios is given by the parabola beginning at the lower right hand corner. All portfolios on this curve are minimum variance portfolios because they have the lowest possible variance for any given expected return. It is evident, however, that investors would only choose portfolios on the positively sloped segment of the minimum variance set because those portfolios offer higher returns for the same level of risk as corresponding portfolios on the negatively sloped segment of the minimum variance set. Such portfolios are called efficient portfolios. The equilibrium conditions of both the SLM and Black models require that $M$, the market portfolio of all risky assets, be efficient. The efficiency of $M$ can be proven by showing that a portfolio consisting of two efficient portfolios each with positive proportions of wealth invested is efficient. Since investors hold only efficient portfolios, and because the relative weight of each security in $M$ is the ratio of the market value of that security to the market value of all securities which is positive, then the market portfolio must be efficient. The model further requires that in equilibrium, all investors hold portfolios which are combinations of the zero-beta portfolio and the market portfolio. That this property holds is verified by the fact that all minimum variance portfolios can be generated as combinations of any two minimum variance
Figure 1
Market Equilibrium in Black's
Capital Asset Pricing Model
(No Riskless Borrowing or Lending)
portfolios. The two portfolios chosen may simply be the zero-beta portfolio and the market portfolio. Investors hold only efficient portfolios and all efficient portfolios are minimum variance portfolios.\textsuperscript{10}

An extended version of the basic Black model is also given by Black.\textsuperscript{11} In this version riskless lending opportunities exist, but no riskless borrowing is available. The model is depicted in Figure 2. The minimum variance set of risky portfolios is the same as in the basic Black model, but the efficient set is different. Here investors who are the most risk averse, i.e., desire low expected return-low risk portfolios, choose portfolios along the segment from $R_f$ to C. These investors are combining risk-free lending with risky portfolio C. Note that C like other minimum variance portfolios will also be a combination of the market portfolio, M, and the zero-beta portfolio, Z. Investors who are less risk averse, i.e., desiring returns greater than would be expected by investing one hundred percent of their wealth in C, will select portfolios of both Z and M that lie on the solid line extending from C to the upper right corner of the figure. The efficient set, hence, runs from $R_f$ to C infinitely upward and to the right along the curved line of minimum variance portfolios. Black has shown that the equilibrium asset pricing equation is the same as in the no riskless borrowing or lending case (Equation 3-3) and that the only difference is in the location of the set of efficient portfolios.


\textsuperscript{11}Black, op. cit., pp. 452-454.
Figure 2
Market Equilibrium in Black's Capital Asset Pricing Model
(Riskless Lending, No Riskless Borrowing)
Two final points should be noted about the Black model. One is that Black proved that $R_f$ must be less than $E(R_Z)$ and that this relationship is a necessary condition for market equilibrium. The fact that $R_f$ is less than $E(R_Z)$ will take on a very important role in the model developed here. The other point is that investors are able to borrow at the rate of $E(R_Z)$. They do so by selling short the zero-beta portfolio. In fact this is how investors obtain portfolios which are on the efficient set but to the right of $M$.

A third variation of the model given by Brennan\textsuperscript{12} involves borrowing and lending at risk free but different rates. The asset pricing equation is again given by Equation (3-3). The Brennan model will not be pursued here because it would not be useful in analyzing the effects of bank leverage since it would require that banks act as pure intermediaries pricing their loans so as to extract only a fee for their services rather than a risk premium.

The assumption of risk-free borrowing and lending in the SLM world is inconsistent with the existence of financial intermediaries. Banks would serve no useful purpose if liquidity needs could be met by the costless issuance of riskless claims. Some degree of market imperfection must create the need for intermediation. Several justifications have been proposed. Benston and Smith\textsuperscript{13} have argued that the existence of transactions costs impedes the free function of the


market and that intermediaries can reduce these costs by consolidation of surplus funds and issuance of their own claims. Intermediaries, they suggest, have economies of scale, are able to achieve a degree of diversification that individuals might not be able to attain, and offer a package of financial commodities that is more desirable to investors than the services they would receive without intermediation. Leland and Pyle\textsuperscript{14} believe that the transaction cost argument is insufficient and that the existence of asymmetries in the market for information is the motivating factor. Intermediaries collect and consolidate information and sell it to the market. Their competitive advantage in information collection and processing creates profit opportunities which they are motivated to exploit. Klein\textsuperscript{15} argues that imperfect divisibility of securities creates the need for intermediaries which can issue claims which are more perfectly divisible. Stiglitz\textsuperscript{16} has added that financial intermediaries may exist to exploit disequilibria in the valuation of firms, and Pyle\textsuperscript{17} developed a theory where intermediaries exist to exploit differences in maturity structures of financial assets and liabilities. For whatever justification for the existence of intermediaries, the Black model will be shown to provide a convenient mechanism for accommodating them. The model acknowledges


the existence of another market participant and does not allow
investors to issue riskless securities on themselves other than by
shorting the zero-beta portfolio. Although Black's model is an
equilibrium model and the introduction of imperfections must result
in disequilibrium, the model, nonetheless, creates a setting within
which to analyze the leverage activities of a bank. The next section,
therefore, proceeds with the creation of a bank by the issuance of
demand deposits.

The Analysis of Bank Leverage: Demand Deposit Financing

Assume that a capital market such as the one described by the
Black model exists. No riskless borrowing or lending opportunities
are available. Taxes are assumed to be non-existent, not because they
are irrelevant, but because the tax effects of debt financing remain
the same whether the borrower is a bank or non-bank. Also, the
interest tax subsidy is not sufficient to explain why banks use large
amounts of debt since it cannot explain why firms do not maximize
debt financing.

Although the CAPM is a single period model, it is usually applied
to the perpetuity case when analyzing the effects of financial leverage.
The model, however, does not strictly hold in the multi-period world.
The problem has been addressed in the literature dealing with the use of
the CAPM in the general multi-period capital budgeting problem and its
solution is a complex one involving dynamic programming. Nonetheless,

18 Marcus C. Bogue and Richard Roll, "Capital Budgeting of Risky
Projects with 'Imperfect' Markets for Physical Capital," Journal of
Finance, 29: 601-13, May, 1974; Eugene F. Fama, "Risk-Adjusted
Discount Rates and Capital Budgeting Under Uncertainty," Journal of
the perpetuity assumption is used here as it is frequently elsewhere for its inherent simplicity and for testing purposes. It will be shown later in Appendix B that the essential implications of the model can be confirmed in the single-period case.

Given reasons previously cited plus needs of liquidity and a payments mechanism, a financial intermediary, henceforth referred to as a bank, is found to be needed. Let a firm currently engaged in some other, though probably related, line of commerce be granted a charter to become a bank. Its responsibilities are to accept demand deposits and extend credit. It is initially assumed that reserve requirements are not imposed and that fixed and variable costs of providing demand deposit services are fully recovered through the collection of service charges. These assumptions are relaxed in a later section. It should be noted that recovery of the initial investment in demand deposit service facilities would not likely be possible from service charge revenue alone. By assuming that the firm granted the charter has some excess capacity plus the technology and know-how to provide deposit services, this factor can be overlooked. Assume further that the firm is unlevered prior to engaging in intermediation services. Otherwise, the effects of pre-existing leverage would be com mingled with the incremental deposit leverage.

The expected return on the unlevered firm's equity is given from the Black model as

\[ E(R_y) = E(R_z) + \lambda \text{cov}(R_y, R_m) \]  (3-4)

where \( E(R_y) \) is the expected return on the unlevered firm, \( E(R_z) \) is the expected return on the minimum variance zero-beta portfolio, \( \lambda = \frac{[E(R_m) - E(R_z)]}{\text{var}(R_m)} \) and is called the market price of risk, and
cov(\tilde{R}_y, \tilde{R}_m) is the covariance between the unlevered firm's equity return and the return on the market portfolio.

Assume that the firm accepts $D_d$ dollars of deposits paying no interest and being fully insured so that they are considered riskless. In order to analyze the effects of deposit leverage in isolation, the firm will use the proceeds to repurchase shares of its stock, thus maintaining the exact asset portfolio composition as before the deposits were accepted. To do otherwise could alter the stream of operating earnings, inject growth or decline into the model, and allow valuation to be affected by the net present values of investments the firm undertakes with the proceeds; thus, isolating the effects of leverage would be difficult.

Following the assumption of a perpetuity, the deposit dollars, $D_d$, must be assumed to represent an immediate flow into the bank which is maintained throughout $n$ periods where $n=1,2,\ldots,\infty$. No intermediate cash flows are associated with the deposits and only a final principle repayment at infinity is made. Although in reality deposits do fluctuate from period to period and repayments are made when customers withdraw funds, the bank is assumed to continually refinance by issuing new deposits. At the end of each period a certain percentage of deposits are withdrawn but a like amount are newly deposited. The assumption is somewhat simplifying and is done so to bypass the problems associated with identifying the stochastic nature of deposits. It is not an

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especially critical assumption, however. As previously mentioned, a derivation of the model in Appendix B will verify the validity of its primary implications in a single-period world.

Two points are worth noting before determining how leverage affects valuation. It is assumed that second order effects on $\lambda$, the market price of risk, are insignificant. Some controversy has appeared in the literature over this issue, but it would serve no purpose to address this debate here. Also, the assumption that the issuance of debt by firms with no pre-existing debt produces the same result as the issuance of debt by firms which already have some debt depends on the existence and enforceability of "me-first" rules. Such rules protect existing debt suppliers from erosion of their claims caused by a firm's stock-piling of additional debt possessing equal or greater claims to the firm's assets. With respect to this model, it is assumed that all depositors are equally insured and protected.

The unlevered firm now having added deposit leverage, and henceforth, being referred to as a bank, has an expected equity return given as

$$E(R_L) = E(R_Z) + \lambda \text{cov}(R_L, R_m)$$

(3-5)

where $E(R_L)$ is the expected return on the levered bank's shares, $E(R_Z)$ and $\lambda$ are as before, and $\text{cov}(R_L, R_m)$ is the covariance between the return on the levered bank's shares and the market portfolio. The expected returns on the unlevered and levered bank's shares may also be defined

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in the perpetuity case as

\[ E(\tilde{R}_U) = \frac{E(\tilde{\text{NOI}})}{S_U} \]  

(3-6)

and

\[ E(\tilde{R}_L) = \frac{E(\tilde{\text{NOI}})}{S_L} \]  

(3-7)

where \( E(\tilde{\text{NOI}}) \) is the expected value of the net operating income, \( S_U \) is the market value of the equity of the unlevered bank, and \( S_L \) is the market value of the equity of the levered bank. Equating (3-4) with (3-6) and (3-5) with (3-7) and multiplying through by \( S_U \) and \( S_L \), respectively, leaves

\[ E(\tilde{\text{NOI}}) = S_U[E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{R}_U, \tilde{R}_m)] \]  

(3-8)

and

\[ E(\tilde{\text{NOI}}) = S_L[E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{R}_L, \tilde{R}_m)] \]  

(3-9)

The covariance terms can be restated by noting that \( \text{cov}(\tilde{R}_U, \tilde{R}_m) = \text{cov}(\tilde{\text{NOI}}/S_U, \tilde{R}_m) \) which simplifies to \( \text{cov}(\tilde{\text{NOI}}, \tilde{R}_m)/S_U \). Likewise, \( \text{cov}(\tilde{\text{NOI}}/S_L, \tilde{R}_m) \) can be stated as \( \text{cov}(\tilde{\text{NOI}}, \tilde{R}_m)/S_L \). Substituting these results and equating (3-8) with (3-9) gives

\[ S_U[E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{\text{NOI}}, \tilde{R}_m)/S_U] = S_L[E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{\text{NOI}}, \tilde{R}_m)/S_L]. \]

Removing brackets leaves

\[ S_U E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{\text{NOI}}, \tilde{R}_m) = S_L E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{\text{NOI}}, \tilde{R}_m). \]

It follows that

\[ S_U = S_L. \]  

(3-10)

Now define \( V_U \), the value of the unlevered bank and \( V_L \), the value of the levered bank as follows:

\[ V_U \equiv S_U \]  

(3-11)
and

\[ V_L = S_L + D_d \]  \hspace{1cm} (3-12)

Rearranging (3-12) to obtain \( S_L = V_L - D_d \) and substituting this result and (3-11) into (3-10) leaves \( V_U = V_L - D_d \) or more appropriately,

\[ V_L = V_U + D_d. \] \hspace{1cm} (3-13)

The value of the bank increases dollar for dollar with the amount of deposit financing added, a statement which is this model's counterpart to MM's Proposition I.

The reader might note that holding an asset which returns no intermediate interest payments but only a principle repayment at infinity seems to be an irrational act on the part of depositors. Depositors would appear to simply abnegate a portion of their wealth to the bank. Recall, however, that depositors receive the services provided by the bank (liquidity, payments mechanism, safety, etc.) although they pay a fee for them. Also, the wealth transfer is not a transfer from any single depositor but from depositors as a group. Any depositor can withdraw his money on demand but the existence of deposit insurance precludes a run on the bank. All depositors' funds are, therefore, safe and available and all withdrawals are assumed to be offset by deposits. In short the resulting effect is that depositors freely leave a portion of their wealth with the bank. No interest is paid and any depositor will be paid off on demand but the depositor group as a whole is not repaid until infinity. The present value of the principle repayment is, thus, zero. In the interim the bank converts the proceeds into gains for its stockholders. The advantage to the bank from deposit financing will be reduced somewhat when reserve requirements, interest, and
non-recovered costs are later introduced but only in extreme cases is the gain eliminated.

Although it might not be readily apparent, the increase in the value of the bank implies that there is an increase in shareholder wealth which is reflected in the equity market by an increase in the price of the stock. A simple numerical example will be useful to visualize this effect. Let the unlevered bank consist of 50 shares of stock priced at $20 per share. Hence, $V_U = S_U = $1000. Issue $D_d = $200 and repurchase $200/20 = 10$ shares leaving 40 shares of stock outstanding. Since $S_L = S_U$, then $(50)(20) = (40)(P_L)$ and $P_L$, the new price per (levered) share, is $25. Shareholder wealth was initially the $1000 equity in the bank. After the repurchase, shareholders have the $200 received from the sale of 10 shares, plus an equity portfolio valued at $S_L = $1000. Their wealth has grown by $200, the amount of $D_d$. A more general proof of these effects is found in Appendix A. It should be noted that the share repurchase itself is simply a mechanical procedure for distributing the proceeds to stockholders. In the absence of taxes and transactions costs, a simple dividend payment would have accomplished the same effect.

Another means of considering how the effects are empirically observed is to imagine the case where investors wish to obtain a charter for a new bank. When the charter is granted, the doors are opened, and deposits are received. A type of "windfall" gain then accrues to the owners. Each time deposits increase to a sustainable level (i.e., where subsequent inflows equal outflows), additional gains are made. It is not surprising then that a bank charter is such a highly prized possession. 22

22 Other reasons may exist for desiring a bank charter. The above mentioned one is only a possibility.
It should be apparent that with the introduction of deposits the Black CAPM would no longer satisfy equilibrium conditions. Indeed it should not as the existence of banking firms would be an unlikely characteristic of an equilibrium market. Nonetheless, market equilibrium is still a satisfactory framework for this analysis since all markets must evolve toward equilibrium.

Returning to the analysis it is easily seen that the bank's required equity return does not change by adding deposits. If \( E(\tilde{\text{NOI}}) \) is constant and \( S_U = S_L \), then (3-6) equals (3-7) and \( E(\tilde{R}_U) = E(\tilde{R}_L) \). This result follows from the fact that fully insured, costless, and non-interest bearing deposits do not alter the stream of earnings available to the bank's stockholders. Deposits are a form of "riskless" leverage and it is to the bank's advantage to obtain as many dollars of deposits as possible. Furthermore, the inclusion of deposits in traditional measures of bank leverage would seem to overstate the bank's risk.

Having established these propositions it will now be possible to derive formulas for the cost of capital for the bank. The approach taken here will be to derive the cost of capital for projects of any risk, called here the generalized cost of capital, and then to determine from that result the more traditional weighted average cost of capital for projects of homogeneous risk.

The Generalized and Weighted Average Costs of Capital:

Deposit Financing

The concept of a generalized cost of capital refers simply to the required rate of return on the firm and in a mean-variance world will be determined by the riskless rate, the market price of risk, and the
firm's covariance risk. Any specific project the firm is considering accepting will have its own required rate of return based on the project's covariance risk. Projects which are of equivalent risk to the firm's existing projects will require a rate of return equal to that required on those projects. This particular rate has a special identity in the finance literature; it is known as the cost of capital. The cost of capital then is a special case of the required rate of return or generalized cost of capital.

The generalized cost of capital (and the more specific case) may be derived from conditions consistent with the maximization of firm value. The theorems are presented among other places in Hamada.23 Now they are developed for the banking firm using deposit financing. Again the perpetuity model is assumed.

From Equation (3-12) it is true that \( S_U = \frac{E(\tilde{NOI})}{E(\tilde{R}_U)} \). Using \( E(\tilde{R}_U) \) as defined by Equation (3-5) and substituting into this definition of \( S_U \) gives

\[
S_U = \frac{E(\tilde{NOI})}{E(\tilde{R}_U) + \lambda \text{cov}(\tilde{R}_U, \tilde{R}_m)}.
\]

This risk adjusted discount rate formula is then converted to the certainty equivalent formula

\[
S_U = \frac{E(\tilde{NOI}) - \lambda \text{cov}(\tilde{NOI}, \tilde{R}_m)}{E(\tilde{R}_U)}.
\]

Since \( S_U = S_L \), substitute (3-15) into (3-12) to obtain

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\[
V_L = \frac{E(\tilde{\text{NOI}}) - \lambda \text{cov}(\tilde{\text{NOI}}, \tilde{\text{R}}_m)}{E(\tilde{\text{R}}_z)} + D_d.
\] (3-16)

The bank would want to identify the rate of return on an investment of I dollars that would assure it of an increase in value; therefore, it should be true that \( \frac{\partial V_L}{\partial I} \geq 1 \). Differentiating and forming this inequality gives

\[
\frac{\partial V_L}{\partial I} = \frac{1}{E(\tilde{\text{R}}_z)} \left[ E(\tilde{\text{NOI}}) - \lambda \frac{\partial \text{cov}(\tilde{\text{NOI}}, \tilde{\text{R}}_m)}{\partial I} \right] + \frac{\partial D_d}{\partial I} \geq 1. \quad (3-17)
\]

Since \( \frac{\partial E(\tilde{\text{NOI}})}{\partial I} \) is the generalized cost of capital, solving (3-17) to isolate this term gives

\[
\frac{\partial E(\tilde{\text{NOI}})}{\partial I} \geq E(\tilde{\text{R}}_z) \left[ 1 - \frac{\partial D_d}{\partial I} \right] + \lambda \frac{\partial \text{cov}(\tilde{\text{NOI}}, \tilde{\text{R}}_m)}{\partial I}. \quad (3-18)
\]

Equation (3-18) merits some discussion. The bracketed term, \( 1 - \frac{\partial D_d}{\partial I} \), represents the proportion of the project financed by new equity. Since the second term on the right hand side of (3-18) is obviously a factor reflecting the project's risk and is, for a specific project, uncontrollable, the bank can minimize the project's required rate of return by financing it with all deposit debt. In such a case \( 1 - \frac{\partial D_d}{\partial I} \) approaches zero and the entire first term vanishes. This result is of course consistent with the previous finding that the bank should maximize its use of deposit financing. Again, value maximization and (generalized) cost of capital minimization are seen as two sides of the same coin.

Note that the second term, \( \lambda \frac{\partial \text{cov}(\tilde{\text{NOI}}, \tilde{\text{R}}_m)}{\partial I} \) is a project risk-capturing factor. It reflects the market price of risk times the incremental covariance risk per dollar of incremental investment. Should the firm select a zero risk project, this term would disappear; but,
again note that the riskless project's required rate of return would be lower than the rate at which the market prices riskless claims, $E(R_Z)$, provided that it is at least partially financed with deposits. Bank shareholders are, thus, recognizing that the bank can do something for them that they cannot do for themselves. If the bank's owners (and all other investors) desire to issue riskless claims on themselves, they can sell short the zero-beta portfolio. They are in effect borrowing at the risk-free rate, $E(R_Z)$. The bank, however, issues deposits at a zero rate and with the assumption of fully recoverable costs via service charges, provides a unique benefit to its shareholders. With this advantage projects which would otherwise be unacceptable become acceptable. For example, a riskless project should by market standards earn $E(R_Z)$, but the bank requires that it earn only $E(R_Z)[1 - \frac{\alpha D_d}{\alpha I}]$. Riskless projects may exist which are not expected to earn as much as $E(R_Z)$ but might be expected to earn $E(R_Z)[1 - \frac{\alpha D_d}{\alpha I}]$. These principles clearly will hold also when projects are risky and $\lambda \text{cov}(\text{NOI, } R_Z)/\alpha I$ is added to the required return.

Now the special case of projects with risk equivalent to the risk of the bank's existing projects will be examined. First, an expression for $\alpha I$ is needed. It is assumed that $\alpha V_L = \alpha I$. Upon acceptance of a project, this statement would not necessarily be true unless the project's net present value (NPV) were zero; but if it is assumed that a project's NPV is not zero, it would not be possible to develop a meaningful cost of capital concept. The investment decision would be influencing the cost of capital, clearly impractical since the cost of capital must be known prior to making the investment decision. Using the expression $\alpha V_L = \alpha I$, it is true from Equation (3-12) that $\alpha V_L = \alpha S_L + \alpha D_d$ and from
Equation (3-10) that $\Delta V_L = \Delta S_U + \Delta D_d$; therefore, $\Delta S_U = \Delta V_L - \Delta D_d = \Delta I - \Delta D_d$ or $\Delta S_U = \Delta I(1 - \Delta D_d/\Delta I)$. From this expression, $\Delta I$ is found to be given as

$$\Delta I = \frac{\Delta S_U}{1 - \frac{\Delta D_d}{\Delta I}}$$

(3-19)

Substituting (3-19) into the second term on the right hand side of (3-18) gives

$$\frac{\Delta E(\tilde{N}I)}{\Delta I} \geq E(\tilde{R}_z)\left[1 - \frac{\Delta D_d}{\Delta I}\right] + \lambda \frac{\Delta \text{cov}(\tilde{N}I, \tilde{R}_m)}{\Delta S_U} \left[1 - \frac{\Delta D_d}{\Delta I}\right].$$

(3-20)

If the risk complexion of the bank's asset portfolio does not change from the addition of the project, the $\Delta \text{cov}(\tilde{N}I, \tilde{R}_m)/\Delta S_U = \text{cov}(\tilde{N}I, \tilde{R}_m)/S_U = \text{cov}(\tilde{R}_U, \tilde{R}_m)$; therefore,

$$\frac{\Delta E(\tilde{N}I)}{\Delta I} \geq \left[1 - \frac{\Delta D_d}{\Delta I}\right] \left[E(\tilde{R}_z) + \lambda \text{cov}(\tilde{R}_U, \tilde{R}_m)\right].$$

(3-21)

Equation (3-21) is analogous to the textbook weighted average cost of capital since the first term in brackets is the proportion of the firm financed with equity, the second term in brackets is the cost of equity, $E(\tilde{R}_U)$, and the cost of debt is zero. It is again apparent that the bank should maximize its use of debt financing since to do so would force $1 - \Delta D_d/\Delta I$ and, thus, the cost of capital toward zero.

A typical project of "equivalent risk" is the repurchase of shares. If the bank undertakes a share repurchase, it requires only the rate of return given in (3-21) whereas the shares purchased by any other investor including its current owners would require $E(\tilde{R}_U)$. So an optimal policy is to repurchase shares which naturally forces $1 - \Delta D_d/\Delta I$ toward zero. This statement should come as no surprise. The issuance of deposit debt and the repurchase of shares was earlier shown to be value maximizing.
and the bank should have continued to do this until it had as much deposit
debt as it could obtain.

In reality deposits may not be costless, reserve requirements are
a significant factor, and there remains the possibility that regulatory
reform will result in the payment of interest on demand deposits. These
factors will obviously affect the model, and they will be dealt with in
a later section of this chapter. In the interim it is worthwhile to
address the question of the assumptions concerning the supply of deposits.

Were the bank capable of following the advice suggested here of
maximizing its deposit financing until it were virtually one-hundred
percent deposit financed, deposits would have to be supplied in unlimited
quantities if there were many banks following the same policy. The
supply of deposits is influenced by numerous factors, most notably
Federal Reserve monetary policy, but is, for the most part, fixed in
the short run. Given the existence of multiple banking firms, a finite
limit exists on the supply of deposits available to a given bank.

Banks often attempt a variety of promotional devices to increase their
share of the market for deposits. A given bank's success depends on
a number of considerations, most importantly the degree of competition
in the market. These points and a model incorporating them will be
developed later. First, assume that the bank has obtained all of the
deposits it can possibly procure and is yet in need of additional
financing to support an expanding an asset base. It must then turn to
the credit markets.
The Analysis of Bank Leverage: Credit Market Financing

The increased reliance of the commercial banking system on credit market borrowing is a phenomenon of the 1970's having been noted and documented by followers of the banking industry. The expression "liability management" became synonymous with the practice whereby banks recognized that credit market borrowing was a feasible solution to the problem of insufficient deposit growth. This active participation by banks in the credit markets has no doubt contributed to the observed reduction in capital as a percentage of total financing. In this section the use of this type of financing is incorporated into the capital structure theory in a world described by Black's zero-beta asset pricing theory. The exact specification of the identity of these "credit markets" is a minor point. They could represent the federal funds, Eurodollars, CD's, or even bond markets. No long-time versus short-term distinction is made. The credit market as it will be used here will simply represent a market where the bank borrows funds and agrees to pay a stipulated rate of interest.

In the second version of Black's asset pricing model described on pages 35 through 37 investors are said to be able to lend at a risk-free rate even though they borrow at a risky rate. If investors can lend at this rate, it seems reasonable to presume that some participant is providing these lending opportunities by borrowing at a riskless rate. A reasonable assumption is that this participant is the bank.

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The assumption of banks borrowing at a risk-free rate may not be completely realistic, but the realism of a theory's assumptions is a minor point. Nonetheless, banks can be realistically said to be borrowing at what amounts to approximately a risk-free rate. First of all, large bank credit market borrowings, while not completely default-free, bear little risk since regulators seem determined to not allow such banks to fail. Although insurance is not applicable to non-deposit liabilities, the orderly takeover of a failing bank by a financially sound one eliminates the shock waves and in most cases would protect these creditors in addition to depositors. Second, bank non-deposit liabilities consist extensively of short-term borrowings which bear rates very close to the Treasury Bill rate. Third, banks also borrow, via time and savings deposits, at rates which are artificially constrained and are often far below the (riskless) Treasury Bill rate. Combining these points makes the assumption of risk-free borrowing by banks quite reasonable. Even if the rate at which banks borrow does not establish this mysterious "risk-free" rate, it is true that other market participants (individuals and firms) borrow from banks by paying the prime rate plus for most borrowers a premium. The prime rate must, therefore, exceed the rate at which banks borrow; thus, banks appear to have a definite advantage in the credit markets that individuals and firms do not possess.  

25 It is possible that many large firms possess the advantage also from their access to the commercial paper market which enables firms to often borrow at less than the prime rate.
Let the bank levered from borrowing \( D_d \) of deposits now borrow \( D_i \) of debt paying an interest rate of \( R_f \) where \( R_f < E(R_z) \). The stream of earnings available to its stockholders now becomes \( E(\text{NOI}) - D_i R_f \). The notation of \( \tilde{R}_L' \), \( E(\tilde{R}_L') \), \( S_L' \), and \( V_L' \) will be used to denote the firm now levered by borrowing in the credit market. Its required return on equity is given as

\[
E(\tilde{R}_L') = \frac{E(\text{NOI}) - R_f D_i}{S_L'} = E(\tilde{R}_z) + \lambda \text{cov}(\tilde{R}_L', \tilde{R}_m) \tag{3-22}
\]

which is rearranged to obtain

\[
E(\text{NOI}) = S_L' [E(\tilde{R}_z) + \lambda \text{cov}(\tilde{R}_L', \tilde{R}_m)] + D_i R_f \tag{3-23}
\]

Now note that \( \text{cov}(\tilde{R}_L', \tilde{R}_m) = \text{cov}(\tilde{NOI}, \tilde{R}_m)/S_L' \).

Substituting into (3-23), clearing brackets, and equating with Equation (3-9) which defines \( E(\text{NOI}) \) for the firm levered with deposit debt gives

\[
S_L = S_L' + D_i [R_f/E(\tilde{R}_z)] \tag{3-24}
\]

or equivalently,

\[
S_L' = S_L - D_i [R_f/E(\tilde{R}_z)] \tag{3-24a}
\]

Since \( S_L' + D_i + D_d = V_L' \), then \( S_L' = V_L' - D_i - D_d \) and with substitution and rearrangement (3-24a) becomes

\[
V_L' = S_L + D_i [1 - R_f/E(\tilde{R}_z)] + D_d \tag{3-24b}
\]

and since \( S_L = V_L - D_d \), (3-24b) becomes

\[
V_L' = V_L + D_i [1 - R_f/E(\tilde{R}_z)] \tag{3-25}
\]

\(^{26}\) The condition that \( R_f \) was less than \( E(\tilde{R}_z) \) is inherent in the Black model and was noted on page 37 of the text.
An alternative way of writing (3-25) is to express the bracketed term as $(E(\tilde{R}_z) - R_f)/E(\tilde{R}_z)$.

It is clear from Equation (3-25) that the bank can increase its value by further leveraging itself with dollars of $D_F$. From the proof in Appendix A, this gain is transmitted into an increase in shareholder wealth and equity price. These statements hold as long as $1 - R_F/E(\tilde{R}_z) > 0$. Such will be the case if conditions consistent with the Black model hold. Since $R_f < E(\tilde{R}_z)$, the bracketed term is greater than zero and less than one. This term reflects the advantage that banks have in the credit markets. Other participants (investors and firms) may effectively issue riskless claims on themselves by selling short the zero-beta portfolio. They are then lending at the $E(\tilde{R}_z)$ rate, but by buying the bank's equity, they can effectively lend at the lower $R_f$ rate. The closer $R_f$ is to $E(\tilde{R}_z)$, the less of an advantage the bank has and if $R_f = E(\tilde{R}_z)$, the advantage erodes completely. Of course, if $R_f = E(\tilde{R}_z)$, the Black model then becomes equivalent to the Sharpe-Lintner-Mossin model which as discussed earlier would be inconsistent with the existence of banks.  

It is not clear precisely why banks command an advantage in the credit markets. It seems likely, however, that they must do so. Otherwise, they would not exist.  

There remains, of course, the use of deposit debt, a fact still not compatible with the Sharpe-Lintner-Mossin world.  

They might, nonetheless, exist to exploit imperfections in loan markets.

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27 There remains, of course, the use of deposit debt, a fact still not compatible with the Sharpe-Lintner-Mossin world.

28 They might, nonetheless, exist to exploit imperfections in loan markets.
banks will exploit it. It is not surprising then that banks do appear to seek maximum use of both deposit and credit market leverage. Thus, society's fear that banks are overleveraged and inadequately capitalized is a product of a system which has given banks an incentive to do so. Although in practice such fears may not be totally unwarranted, they do not emanate from excessive greed but reflect simply rationale wealth maximization by private economic units.

Returning to the analysis, it is worthwhile to develop the bank's required equity return. Substituting \( \text{cov}(\tilde{N}_0I, R_m)/S_L' \) for \( \text{cov}(\tilde{R}_L', R_m) \) in (3-22) and \( \text{cov}(\tilde{N}_0I, R_m)/S_L \) for \( \text{cov}(\tilde{R}_L, R_m) \) in (3-5) and subtracting (3-5) from (3-22) leaves

\[
E(\tilde{R}'_L) - E(\tilde{R}_L) = \lambda \text{cov}(\tilde{N}0I, \tilde{R}_m)[1/S_L' - 1/S_L]. \tag{3-26}
\]

It can be shown from rearranging (3-5) that \( \lambda \text{cov}(\tilde{N}0I, \tilde{R}_m) = S_L[E(\tilde{R}_L) - E(\tilde{R}_z)] \). The bracketed term in (3-26) can be written as \( (S_L - S_L')/S_L'S_L \) which from (3-24) is equal to \( D_i(R_f/E(\tilde{R}_z))/S_L'S_L \). Substituting these results into (3-26) leaves

\[
E(\tilde{R}'_L) = E(\tilde{R}_L) + S_L[E(\tilde{R}_L) - E(\tilde{R}_z)][D_i/S_L'S_L][R_f/E(\tilde{R}_z)] \tag{3-26a}
\]
or alternatively

\[
E(\tilde{R}'_L) = E(\tilde{R}_L) + [E(\tilde{R}_L) - E(\tilde{R}_z)][D_i/S_L'][R_f/E(\tilde{R}_z)] \tag{3-27}
\]

This expression is the counterpart to MM's Proposition II. The required equity return begins at \( E(\tilde{R}_L) \) (which is also \( E(\tilde{R}_U) \)). As units of \( D_i \) are added, it increases but by a smaller increment than according to MM's Proposition II. The ability of the bank to command a credit market advantage, reflected in the ratio, \( R_f/E(\tilde{R}_z) \), dampens the increase in risk as additional leverage is added. The comparison to MM's Proposition II is illustrated in Figure 3.
The Required Return on Equity:

MM* Versus Bank Financial Structure Theory

*MM Theory has been restated in terms of the notation used here and the zero-beta model.
The Generalized and Weighted Average Costs of Capital:

Credit Market Financing

Given the valuation Equation (3-25), express $V_L$ as the certainty equivalent value of $S_L$ plus $D_d$ and re-write as

$$V_L' = \frac{E(\text{NOI}) - \lambda \text{cov}(\text{NOI}, \tilde{R}_m)}{E(\tilde{R}_Z)} + D_d + D_i \left[1 - \frac{R_f}{E(\tilde{R}_Z)}\right]$$  \hspace{0.5cm} (3-28)

Assuming that an amount $I$ is invested, the generalized cost of capital is derived by finding $\partial V_L'/\partial I$, setting it equal to or greater than 1, and then solving for $\partial E(\text{NOI})/\partial I$. Also let $\partial D_d/\partial I$ equal zero since it has been assumed that no additional deposit dollars are available.

$$\frac{\partial V_L'}{\partial I} = 1 \left[ \frac{\partial E(\text{NOI})}{\partial I} - \lambda \frac{\partial \text{cov}(\text{NOI}, \tilde{R}_m)}{\partial I} \right] + \frac{\partial D_i}{\partial I} \left[1 - \frac{R_f}{E(\tilde{R}_Z)}\right] \geq 1$$  \hspace{0.5cm} (3-29)

$$\frac{\partial E(\text{NOI})}{\partial I} \geq \frac{E(\tilde{R}_Z)}{\lambda} \left[1 - \frac{\partial D_i}{\partial I} \left(1 - \frac{R_f}{E(\tilde{R}_Z)}\right)\right] + \frac{\lambda \text{cov}(\text{NOI}, \tilde{R}_m)}{\partial I} \hspace{0.5cm} (3-30)$$

Once again the bank's credit market advantage appears. By comparing Equation (3-30) with Equation (3-29), it is seen that the effect on the cost of capital is less with credit market financing than with deposit financing. It is apparent, however, that their advantage still exists as long as $R_f < E(\tilde{R}_Z)$. If the bank were to maximize its use of $D_i$ financing, it could drive a project's required rate of return down to simply $\lambda \text{cov}(\text{NOI}, \tilde{R}_m)/\partial I$. In the case of a riskless project, it would be driven down to zero. Note that as long as the project is financed at least partially by credit market borrowing (and $R_f < E(\tilde{R}_Z)$), the project will require a lower return that it otherwise would for a firm or investor that did not command such an advantage or in a perfect
market world. Again, certain projects become acceptable to the bank when they otherwise would be rejected.

Now consider the case where the project's risk is equivalent to the risk of the bank's existing projects. It was previously argued (pages 49 and 50) that $\Delta V_L = \alpha I$. Here this assumption is repeated except it is stated as $\Delta V_L' = \alpha I$. From Equation (3-24b), $\Delta V_L' = \Delta S_L + \Delta D_i [1 - R_f/E(\tilde{R}_z)] - \Delta D_d$ or $\Delta S_L = \Delta V_L' - \Delta D_i [1 - R_f/E(\tilde{R}_z)] - \Delta D_d$. Substituting $\alpha I$ for $\Delta V_L'$ and restating leaves $\Delta S_L = \alpha I [1 - (\Delta D_i/\alpha I) (1 - R_f/E(\tilde{R}_z)) - \Delta D_d/\alpha I]$. It is assumed that no additional deposit financing is available so that $\Delta D_d/\alpha I = 0$. Isolating $\alpha I$ leaves

$$\alpha I = \frac{\Delta S_L}{1 - \frac{\Delta D_d}{\alpha I} (1 - R_f/E(\tilde{R}_z))}$$

(3-31)

Now substitute this expression for $\alpha I$ in the risk adjustment factor, $\lambda \text{cov}(\text{NOI,} \tilde{R}_m)/\alpha I$, and rewrite (3-30) as

$$\frac{\alpha \text{E(NOI)}}{\alpha I} \geq E(\tilde{R}_z) \left[ 1 - \frac{\alpha D_i}{\alpha I} (1 - R_f/E(\tilde{R}_z)) \right] +$$

$$\frac{\lambda \text{cov}(\text{NOI,} \tilde{R}_m)}{\alpha S_L} \left[ 1 - \frac{\alpha D_i}{\alpha I} (1 - R_f/E(\tilde{R}_z)) \right]$$

(3-32)

With no change in risk $\text{cov}(\text{NOI,} \tilde{R}_m)/\alpha S_L = \text{cov}(\text{NOI,} \tilde{R}_m)/S_L = \text{cov}(\tilde{R}_L, \tilde{R}_m)$ or $\text{cov}(\tilde{R}_U, \tilde{R}_m)$. Substituting this result and rearranging gives

$$\frac{\alpha \text{E(NOI)}}{\alpha I} \geq \left[ 1 - \frac{\alpha D_i}{\alpha I} (1 - R_f/E(\tilde{R}_z)) \right] E(\tilde{R}_z) + \lambda \text{cov}(\tilde{R}_U, \tilde{R}_m)$$

(3-33)

Equation (3-33) can be expressed as the more familiar weighted average cost of capital. Substitute $E(\tilde{R}_U)$ for $E(\tilde{R}_L)$ in (3-27); then, rearrange
(3-27) to isolate \(E(R^\prime)\). With some algebraic manipulations \(E(R^\prime)\), the second term in brackets in (3-33), is found to be equivalent to 
\[
(S_L' \cdot E(R^\prime) + R_f D_1)/(S_L' + D_1 R_f /E(R_z)).
\]
Noting that \(\Delta D_i /\Delta I\) equals \(D_i/(D_i + S_L')\) if the same relative proportions of financing are maintained, the first term in brackets in (3-33) equals 
\[
(S_L' + D_1 R_f /E(R_z))/(S_L' + D_i).
\]
Then multiplying, cancelling, and rearranging leaves
\[
\frac{\Delta E(NOI)}{\Delta I} \geq E(R^\prime) \cdot \frac{S_L'}{S_L' + D_i} + R_f \cdot \frac{D_i}{S_L' + D_i}.
\]

In Equation (3-33) the advantage of debt is reflected in the cost of equity, \(E(R^\prime)\), which by Equation (3-27) and Figure 3 is lower than it would otherwise be without such an advantage. It might seem unusual that the \(R_f /E(R_z)\) ratio does not appear in the component cost of debt. In fact it does as a detailed derivation would show. The cost of debt would be given as \(E(R_z)(R_f /E(R_z))\). With \(E(R_z)\) appearing as the cost of debt, the equation is reflecting the market's perception of the cost of issuing riskless claims, \(E(R_z)\), with this cost being multiplied by the relative advantage factor, \(R_f /E(R_z)\). The result is, of course, the bank's true cost of debt, \(R_f\).

**Final Comments on the Bank Financial Structure Theory**

It has been assumed throughout the stage of financing by credit market borrowing that the supply of funds was unlimited. The assumption is maintained here but merits some explanation. The credit market is assumed to be characterized by a less than perfectly inelastic supply curve. The quantity of dollars borrowed is directly related to the rate paid, \(R_f\). Total bank credit demand will determine the market rate
of interest. Moreover, no reason exists for limiting the number of banks to one. More appropriately then a number of banks will exist and their collective needs determine the rate of interest. As demand for credit increases, and assuming no offsetting shift in the supply curve, \( R_f \) must increase. The effect on this model is simply to shift everything in the direction imposed by a higher \( R_f \). The shift, while significant, is no less critical than a shift in \( \lambda \), \( E(R_m) \) or any other parameter of the equilibrium model. Thus, the issue concerning the supply of funds to banks, though controversial in practice and in some theories,\(^{29}\) is a trivial point here.

It is quite possible that many corporations possess similar advantages in the credit markets. The existence of a well-developed commercial paper market attests to the fact that many large credit worthy corporations are capable of circumventing the financial intermediation process to tap the low cost short term credit markets. Indeed many large corporations with their captive finance companies are almost certainly financial intermediaries themselves; thus, it is possible that the theory given here applies to many non-banking firms.

The question may arise as to whether this theory is modified by recognition of the bank holding company form of organization. Although the holding company is certainly a more complex financial institution than the simple bank, the model is in no way altered by applying it to a holding company. Since the equity market evaluates the holding company as a unit rather than as component parts, it is necessary to

consider the holding company's business risk and leverage rather than
that of its bank affiliates. The question of holding company engagement
in activities not available to individual banks is unimportant since the
specific investment activities of the bank or holding company are not
considered in this model. Moreover, the controversial "double
leveraging" concept, a significant contemporary issue, is avoided
here. "Double leveraging" refers to the practice of the holding company
issuing debt and using the proceeds to purchase newly issued equity in
its affiliate banks. This action improves the capital ratios of the
affiliate banks who may have been under some pressure from regulators
because of inadequate capital; however, the consolidated holding company
now has more debt and is, thus, more risky. The appearance is of
financially improved affiliates whereas the company as a whole is
less financially sound. In the model here, however, the market would
not be mislead by this cosmetic financing as it would evaluate the
debt/equity ratio of the holding company.

It is worth noting that the findings here do not necessarily
imply that loans will be priced according to the bank's cost of
capital. Rather, banks may be capable of extracting monopoly premiums
resulting from imperfections in loan markets; however, restricting
the model to the largest banking firms does minimize this possibility
somewhat.

The model has been derived in the rather specialized case of a
perpetuity. In Appendix B the model is derived under the conditions
of a single period would. The only essential difference, however, is
the fact that the gain to the shareholders is reduced by the present
value of the principle repayment. It is easily shown (see Appendix B) that a gain to the owners will still exist.

The model has now been fully developed and discussed under a set of specific conditions. The next section will relax some of the assumptions and examine the effects of these assumptions on the essential conclusions.

**The Model Under Relaxed Assumptions**

Until now it has been assumed that deposits are costless, non-interest bearing, and do not necessitate the holding of reserves. Also the effect of competitive conditions on the supply of deposits has been disregarded. These points are now considered separately. It is assumed that the bank is using no credit market financing and is considering only deposit financing. The perpetuity assumption is also maintained.

**Costly Deposits**

Deposits, unlike forms of debt issued by corporations and individuals, require that the bank perform specific services such as check processing and bookkeeping. These services are not without cost, and although there is considerable debate over how to measure these costs, they are almost universally considered to be not insignificant. On the other hand, banks do have the opportunity to recover some or all of these costs through service charges. Until now it has been assumed that the service charge is sufficient to recover the cost. Now assume that deposits incur a percentage cost, C, per dollar of deposits which represents either the net cost after service charge revenue has been collected or a gross cost in the absence of service charges. This
cost will act exactly like an interest rate as the stream of earnings available to stockholders will be \( E(\text{NOI}) - D_{d}C \). Having established this fact, the effect on valuation is the same as if the firm had issued debt at an interest rate of \( C \). The bank's value is found to equal

\[
V_{L} = V_{U} + D_{d}[1 - C/E(\bar{R}_{z})].
\]  

(3-35)

Deposits are, thus, seen to be less desirable than in the case where they were costless. They are still beneficial to the firm if \( C < E(\bar{R}_{z}) \). Since banks seem to desire deposits, \( C \) must be less than \( E(\bar{R}_{z}) \). If \( C \) were greater than \( E(\bar{R}_{z}) \), it would be more costly for banks to issue deposits, obligating themselves to provide costly services, than it would be for their owners to sell short the zero-beta portfolio, equivalent to borrowing at the \( E(\bar{R}_{z}) \) rate. Obviously at \( C = E(\bar{R}_{z}) \) there would be no effect one way or the other. It can easily be shown that the required equity return is the same as the case where \( D_{d} \) of debt were issued with \( C \) replacing \( R_f \) (Equation (3-27)).

**Interest-Bearing Deposits**

The payment of interest on demand deposits has been prohibited since depression-era regulation was enacted. The issue has been resurrected, nonetheless, and it now seems likely that regulatory reform will someday allow (or require) banks to pay interest on checking account balances. The effect on the model is easily seen. In fact it merits no repetition of equations. The interest factor will behave identically to the cost factor in the previous section making deposits less desirable but still advantageous if the interest rate is less than \( E(\bar{R}_{z}) \). Deposits, thus, would become very similar to credit market borrowing. One point
that is indeterminate is the exact specification of the interest rate. It would most likely be established by Federal Reserve or Congressional order and could conceivably be as high as $E(R_2)$. If that became the case, deposits would not be attractive to banks; however, it is more likely that service charges would increase or that there would be a general increase in the prices of other bank services including loans.

**Reserve Requirements**

Virtually all banks are required to maintain liquid reserves. The exact percentage requirement depends on a number of factors. Most major reserve city banks which are in the Federal Reserve System keep from twelve to twenty percent of their deposits in vault cash or deposits at the local Federal Reserve Bank. This regulation prevents banks from lending the entire amount of their deposits. The reserves also earn no interest although there have been some suggestions made to require that the Federal Reserve Banks pay interest.

Assume in this model that a reserve requirement equal to $R_r$ percent of deposits is imposed. In order to hold the bank's size constant, let the bank sell off some of its existing assets to generate the cash that will be held or deposited in the account at the Federal Reserve. The stream of earnings available to the stockholders will be reduced from $E(\tilde{\text{NOI}})$ to $E(\tilde{\text{NOI}}) - R_rD_dE(\tilde{R}_u)$. The value $R_rD_d$ is the dollar amount of reserves held, which when multiplied by $E(\tilde{R}_u)$, the return on the firm's existing assets, gives the cash flow foregone by having to sell off assets to generate cash for reserves. In practice the bank would simply lend $D_d(1 - R_r)$ and hold $D_dR_r$ in reserves, but this maneuver cannot be accommodated in the model since the bank's size and, thus,
its value would automatically change. The effect of leverage in isolation would then be difficult to identify. Working through the analysis given that \( E(R_L) = \left[ E(NOI) - R_r D_d E(R_U) \right] / S_L \) produces the valuation equation

\[
V_L = V_U + D_d [1 - R_r E(R_U)/E(R_z)]
\] (3-36)

and the required equity return of

\[
E(R_L) = E(R_U) + \left[ E(R_U) - E(R_z) \right] \left[ R_r E(R_U)/E(R_z) \right] [D_d/S_L].
\] (3-37)

The advantage of deposits remains as long as \( R_r E(R_U) < E(R_z) \). The factor \( R_r E(R_U) \) represents the true "cost" of deposits since this cost is the rate of return foregone on assets which could be earning a return in the absence of reserve requirements. As long as this "cost" of deposits is less than the rate at which the bank's owners can individually borrow, \( E(R_z) \), the bank can continue to provide them with benefits of increased wealth. Changes in reserve requirements clearly affect the valuation of bank shares and the wealth of bank investors. The effect is to make deposits become more or less expensive.

Less Than Perfectly Elastic Supply of Deposits

The nature of competition in banking markets has been a subject of much controversy in professional and academic circles. The present research will make no contributions in that area but will now incorporate the presence of competition into the model. Assume that deposits again are costless, non-interest bearing, and do not require reserves, but that they generate service charge income at a rate of \( r_s \) percent of deposits. The supply of deposits is determined by the relationship

\[
D_d = f(r_s, \pi_1, \pi_2, \ldots, \pi_n)
\]

where \( \pi_1, \pi_2, \ldots, \pi_n \) represent \( N \) other factors that influence the supply of deposits, such as monetary policy, and are assumed to be
constant. The supply curve is characterized by first- and second-order derivatives

\[ \frac{\partial D_d}{\partial r_s} < 0 \quad \text{and} \quad \frac{\partial^2 D_d}{\partial r_s^2} < 0. \]

These relationships are illustrated in Figure 4. The shape of the curve cannot be precisely specified; however, certain facts can be easily established. The curve is not vertically asymptotic but intersects the vertical axis because even at a zero service charge, only a finite quantity of deposits could be supplied. The curve should, however, be asymptotic to the \( r_s \) axis or some line above but parallel to it, because even at a very high service charge, some deposits will almost surely be supplied.

With service charge revenue being generated from deposit debt, the stream of earnings available to equityholders is equal to

\[ E(\tilde{\text{NOI}}) + r_s D_d. \]

Specifying the levered return as \( E(\tilde{R}_L) = (E(\text{NOI}) + r_s D_d)/S_L \), the analysis can proceed as illustrated in previous sections by rearranging the equation to isolate \( E(\text{NOI}) \) and equating \( E(\text{NOI}) \) to \( S_UE(\tilde{R}_U) \). The levered and unlevered equity are found to be related in the following manner:

\[ S_U = S_L - r_s D_d/E(\tilde{R}_z). \quad (3-38) \]

Recalling that \( V_L = S_L + D_d \) and \( V_U = S_U \), it can be shown that

\[ V_L = V_U + D_d[1 + r_s/E(\tilde{R}_z)]. \quad (3-39) \]

Equation (3-39) is similar to Equation (3-13) which gives the value of the bank with deposits and no service charges, costs, etc. In addition, however, a premium equal to \( D_d r_s/E(\tilde{R}_z) \) is earned. The rationale is quite obvious. Deposits not only offer the advantage of zero cost or
Figure 4

The Supply Curve of Deposits
interest but also generate a revenue that is here assumed to exceed any cost involved in providing deposit services.

The above conditions would represent an idealized world for banks except that unless the bank set its service charge at an extremely low rate, it might be unable to attract a sufficient quantity of deposits for the benefits to be significant; but if the service charge were set at an extremely low rate, the gain from service charge revenue would be very small. The bank must, therefore, find the optimal combination of deposit volume and service charge. It does so by maximizing $V_L$ with respect to $r_s$.

First find the derivative and set it equal to zero.

\[
\frac{\partial V_L}{\partial r_s} = \frac{\partial D}{\partial r_s} + \frac{D}{E(R_z)} \left( \frac{r_s}{E(R_z)} \right) \frac{\partial D}{\partial r_s} = 0. \tag{3-40}
\]

Second-order conditions assure a maximum. Rearranging (3-40) gives

\[
D_d = -\frac{\partial D}{\partial r_s} \left[ r_s + E(R_z) \right] \tag{3-41}
\]

The left-hand side represents the value of marginal units of deposit leverage. Each marginal dollar of deposit leverage increases shareholder wealth by a dollar. The right-hand side represents the "cost" of marginal units of deposit leverage. Note that this term is positive since $\frac{\partial D}{\partial r_s}$ is negative. If the bank increases the service charge, it loses deposits in an amount determined by the derivative, $\frac{\partial D}{\partial r_s}$. Each dollar of deposits foregone results in a loss of service charge revenue, $r_s$; moreover, shareholders will have to borrow on their personal accounts at a rate of $E(R_z)$ to make up for the leverage lost. At the optimum, service charge is set, deposit supply is given, and the
marginal benefits of the specified level of deposits exactly offset the marginal cost.

An element of somewhat more realism might be added if it is assumed that deposits have a cost of C percent and a service charge of \( r_s \) percent. Cost per unit is fixed and, therefore, does not influence demand. The cost, however, exceeds the service charge. The value of the bank is given as

\[
V_L = V_U + D_d \left[ 1 + \frac{r_s - C}{E(R_Z)} \right]
\]  

(3-42)

Following the same procedure as before reveals that the optimum is given where

\[
D_d - \frac{3D_d C}{3r_s} = - \frac{3D_d}{3r_s} \left[ E(R_Z) + r_s \right].
\]  

(3-43)

Equation (3-43) differs from Equation (3-41) in that the marginal benefits now include the marginal cost foregone from the loss of deposits resulting from an increase in service charges. Thus, a bank setting its service charge should consider the valuation benefits of deposit leverage, the cost of deposits, the revenue received from service charges, and the cost of additional borrowing by the bank's shareholders that would be necessary to adjust their personal leverage positions. It is also easy to visualize how reserve requirements would take effect. Reserves released from an increase in service charges would be a positive benefit. Likewise, interest payments could be incorporated into this version of the model. These factors are not specifically illustrated here but their effects are naturally recognized as empirical phenomena mandating consideration in practice.
The analysis completed here more realistically determines the quantity of deposits that the bank will want to obtain. The bank recognizes benefits to deposit leverage but realizes that to obtain these benefits it must give up something. In practice banks tend to offer free gifts, special services, and other monetary benefits in addition to lower charges on checking accounts. It is easily seen that the model presented here provides a more precise specification of the trade-off faced by the bank with respect to its effect on market valuation.

The theory of bank financial structure developed in this research has been presented in complete detail. It is now worthwhile to consider whether the theory has testable implications. This question will be the subject of Chapter 4 where the development of some empirical tests will be presented.
Chapter 4

EMPIRICAL TEST DESIGN

The model presented in Chapter 3 has the capability of producing testable statements. Although the tests are not strictly without weaknesses, they are, nonetheless, suitable as preliminary evidence which can be used to support or reject the theory. In order to derive testable statements, it will initially be necessary to extend the model to a more realistic environment which recognizes the existence of corporate income taxes. Again the perpetuity case is considered.

The Model Under Corporate Income Taxes

The effect of corporate income taxes on firm valuation is well known and was discussed in Chapter 2. It will not be necessary to repeat that discussion here nor will the implications thereof require a complete derivation of the model (as in Chapter 3) with the tax factor added. Rather, only the high points of the model and the direct effects of corporate taxes will be noted here.

In the first case where deposit financing was employed, corporate taxes have no effect at all. Since only the interest tax subsidy causes leverage to affect valuation, the issuance of non-interest bearing debt creates no tax subsidy and, hence, has no valuation effect. The implication is not that taxes have no impact on valuation. In fact they do. Obviously taxes reduce the stream of earnings available to shareholders, thus, reducing the value of the firm. Taxes, however,
have no effect on risk and newly issued non-interest bearing debt generates no advantages not already extant in the absence of taxes.

The use of interest-bearing debt in the case of credit market financing, however, is a different but familiar story. The issuance of interest-bearing debt creates a tax subsidy which is transmitted to the owners as an increase in their wealth. In this model, debt, thus, offers two advantages. One is the benefit of the bank borrowing at a rate less than the rate at which its owners can borrow. The other is the subsidy resulting from the tax deductibility of interest payments.

The model is easily derived. Set up the required equity returns of the bank levered with deposits and the bank levered with deposits plus interest-bearing debt.

\[
E(R_L) = \frac{E(\tilde{\text{NOI}})(1 - \tau)}{S_L} = E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{R}_L, \tilde{R}_m) \quad (4-1)
\]

\[
E(R_L') = \frac{(E(\tilde{\text{NOI}}) - R_f D_i)(1 - \tau)}{S_L'} = E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{R}_L', \tilde{R}_m) \quad (4-2)
\]

Rearrange (4-1) and (4-2) to isolate \(E(\tilde{\text{NOI}})(1 - \tau)\), and equate these results. Then rearrange and substitute as in the procedure outlined in Chapter 3 and the result is

\[
V_L' = V_L + D_i \left[1 - \frac{R_f (1 - \tau)}{E(\tilde{R}_Z)}\right]. \quad (4-3)
\]

Note that if \(\tau = 0\), (4-3) reduces to Equation (3-25) and that if \(R_f = E(\tilde{R}_Z)\), (4-3) reduces to the familiar \(V_L' = V_L + D_i \tau\). By following the same procedure illustrated in Chapter 3, the required equity return can be easily derived and is found to be given as
\[
E(\tilde{R}_L') = E(\tilde{R}_L) + [E(\tilde{R}_L) - E(\tilde{R}_Z)] \frac{R_f}{E(\tilde{R}_Z)} \frac{D_i}{S_L'} (1 - \tau). \quad (4-4)
\]

Note that the tax factor \((1 - \tau)\) is in the zero to one interval and, thus, forces the slope of the line to be lower than it would be in the absence of taxes. In the presence of taxes investors require even smaller financial risk premiums.

**A Testable Equation**

Equation (4-4) can be modified to produce an equation which is directly testable and somewhat easier to work with than (4-4). From Chapter 3 it is known that \(E(\tilde{R}_L) = E(\tilde{R}_U)\). Substituting this result and the CAPM definition for \(E(\tilde{R}_U)\) (Equation (3-4)) into (4-4) and rearranging gives

\[
E(\tilde{R}_L') = E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{R}_U, \tilde{R}_m) \left[ 1 + \frac{R_f}{E(\tilde{R}_Z)} \frac{D_i}{S_L'} (1 - \tau) \right]. \quad (4-5)
\]

From the theory of capital asset pricing, it is known that \(\lambda \text{cov}(\tilde{R}_U, \tilde{R}_m) = [E(\tilde{R}_m) - E(\tilde{R}_Z)] \beta_U\) where \(\beta_U\) is the beta if the firm were unlevered.\(^1\)

Substituting this result for \(\lambda \text{cov}(\tilde{R}_U, \tilde{R}_m)\) in (4-5) leaves

\[
E(\tilde{R}_L') = E(\tilde{R}_Z) + [E(\tilde{R}_m) - E(\tilde{R}_Z)] \beta_U \left[ 1 + \frac{R_f}{E(\tilde{R}_Z)} \frac{D_i}{S_L'} (1 - \tau) \right]. \quad (4-6)
\]

Recalling that the equity return \(E(\tilde{R}_L')\) can be written in CAPM form (Equation (3-22)) and that \(\lambda \text{cov}(\tilde{R}_L', \tilde{R}_m)\) is equivalent to

\([E(\tilde{R}_m) - E(\tilde{R}_Z)] \beta_L'\) where \(\beta_L'\) is the beta levered by adding interest-bearing debt, the CAPM equation for \(E(\tilde{R}_L')\) is equal to

\[ E(\tilde{R}_L') = E(\tilde{R}_Z) + [E(\tilde{R}_m) - E(\tilde{R}_Z)] \beta_L'. \] (4-7)

Comparing (4-7) with (4-6) reveals that

\[ \beta_L' = \beta_U \left[ 1 + \frac{R_f}{E(\tilde{R}_Z)} \frac{D_i}{S_L'} (1 - \tau) \right] \] (4-8)

or equivalently,

\[ \beta_L' = \beta_U + \beta_U \frac{R_f}{E(\tilde{R}_Z)} \frac{D_i}{S_L'} (1 - \tau). \] (4-9)

Equation (4-9) merits some discussion. First, the concept of an unlevered beta while not unfamiliar to finance theoreticians has not received much attention in the literature. Only Rubinstein,\(^2\) Hamada,\(^3\) and more recently, Copeland and Weston\(^4\) have dealt with the subject in any detail.\(^5\) The unlevered beta is a measure of the covariance between the return generated by the firm's investments and the return on the market portfolio. It is easily seen that in a mean-variance world, \(\beta_U\) is the measure of business risk. Consequently, the MM concept of the "equivalent risk class" is represented by firms with equivalent unlevered betas. A firm with no leverage would by Equation (4-9) have a levered beta, \(\beta_L'\), equal to \(\beta_U\). Its total risk would simply equal its business risk. As each unit of debt were added,

\(^2\)Ibid.


\( \beta_L' \) would increase as investors recognize that the addition of debt results in the assumption of a new type of risk, financial risk. Beta is, thus, "hyped up" as debt is incremented. This effect is transmitted into the capital markets as higher required equity returns.

In SLM capital market theory all investors and firms borrow and lend at the same risk-free rate. As indicated in the previous chapter, this assumption is invoked by equating \( R_f \) to \( E(R_Z) \). Equation (4-9), thus, reduces to

\[
\beta_L' = \beta_U + \beta_U \frac{D_i}{S_L'} (1 - \tau) \tag{4-10}
\]

a result noted in the works referenced in footnotes 2, 3 and 4. It is apparent that the advantage which banks may possess in the credit markets results in a lower financial risk premium required by bank shareholders than required by firm shareholders. Empirical estimation of Equation (4-9) and (4-10) then presents a possibility for testing the theory's hypothesis.

Equations (4-9) and (4-10) may be jointly stated as the linear model

\[
\beta_{L_j'} = \gamma_0 + \gamma_1 \frac{D_{ij}}{S_{L_j'}} + \varepsilon \tag{4-11}
\]

where the subscript \( j \) refers to the \( j^{th} \) firm. The hypotheses are that

\[
\gamma_0 = \beta_U
\]

\[
\gamma_1 = \begin{cases} 
\beta_U \frac{R_f}{E(R_Z)} (1 - \tau) & \text{for banks} \\
\beta_U (1 - \tau) & \text{for firms}
\end{cases}
\]
The difference, if any, between the regression results for the bank and firm samples should be attributed to the \( \frac{R_f}{E(R_z)} \) factor which reflects the relative advantage banks have over firms in the credit markets. If this advantage is real, then the \( \gamma_1 \) value for banks should be significantly less than the \( \gamma_1 \) value for firms. At this point no statements can be made about the possible value of the ratio of \( R_f \) to \( E(R_z) \). In fact an estimate of this ratio is not really necessary as long as \( R_f \) is significantly (in a statistical sense) less than \( E(R_z) \). In the next section, however, some discussion will be presented on how estimates of this ratio might be used.

Several important conditions must hold for (4-11) to be an ordinary least squares regression. The well-known econometric assumptions about the behavior of the disturbance must be upheld and the parameter values of \( \gamma_0 \) and \( \gamma_1 \) must not vary across firms in the sample. This latter condition is the same as requiring that the unlevered betas be constant across the sample. That requirement is, not surprisingly, the same as the MM equivalent risk class assumption. It is easily seen that if \( \beta_{Uj} \) varies from one \( j^{th} \) unit to the next, then the firms are not of the same business risk nor are the regression parameters stable.

Another point that should be briefly mentioned here is that significant differences of the correct direction in the \( \gamma_1 \) values for banks and firms will not be sufficient to validate the model unless the \( \gamma_0 \) or \( \beta_U \) values are the same for the bank and firm samples. This condition is not likely to hold; therefore, some adjustment for the samples' differing degrees of business risk must be made. This point
will be discussed in some detail later and a different test will be derived to deal with the problem.

**General Discussion of Test Procedures**

In this section a relatively general overview of the test procedures will be presented. More complete details will be given in Chapter 5 where the test results are actually presented, analyzed, and interpreted.

One method of testing the theory will involve a comparison of regression results for a sample of banks with samples of non-banks, henceforth, referred to as "firms." Through a set of tests which will be detailed in Chapter 5, regression estimates will be compared to the theorized parameters of Equations (4-9) for banks and (4-10) for firms. Note that the only difference in the two equations is the \( \frac{R_f}{E(R_Z)} \) factor in Equation (4-9). In (4-10), \( \frac{R_f}{E(R_Z)} \) is implicitly assumed to equal unity, reflecting the absence for firms of the favorable borrowing position claimed by banks. Whether \( \frac{R_f}{E(R_Z)} = 1 \) for firms should be revealed by the data.

Another method of examining the results will involve a comparison of the implied estimates of \( \frac{R_f}{E(R_Z)} \) derived from the bank regressions with external estimates of that ratio. The risk-free rate was obtained from publicly quoted money market rates and the ex post zero beta portfolio returns were obtained from Professor Richard Roll of the Graduate School of Management of the University of California at Los Angeles. The estimates are the intercept estimates from Fama-MacBeth.\(^6\)

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tests which were mentioned in Chapter 2. Some serious questions can be raised about the usefulness and unbiasedness of these estimates and these will be discussed when the results are presented in Chapter 5, but the returns should still serve a practical purpose as some preliminary, albeit imperfect, evidence on the model's accuracy.

The composition of the samples is an important component of any empirical study. The banks and firms examined must have available financial statement data and publicly traded equity. More importantly, they must be reasonably homogeneous with respect to business risk. Elton and Gruber have shown how the failure to control for business risk can bias results of tests of equity valuation models. With this caveat in mind considerable care was taken to preserve this assumption and other desirable qualities. How this was done will be discussed later.

The Bank Sample

The bank sample was selected from COMPUSTAT's bank-and-price-dividends-earnings files. Approximately 136 banks and bank holding companies were available; however, not all of them could be used in each regression. Some had missing data for certain time periods. Others had to be eliminated if preferred stock were present in their financial structures since preferred stock was not incorporated in

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9The time periods examined will be discussed later.
the model.\textsuperscript{10} A few others were jettisoned if they reported negative earnings per share over the time period examined. This screening factor was designed to eliminate banks that were experiencing financial problems which might preclude their being able to command any borrowing advantage in the credit markets.

The data screening process considerably reduced the number of available banks. Appearing in the regressions were from 70 to 100 with around 90 being the average. A listing of the complete sample of banking firms is presented in Appendix C.

It was assumed that the bank sample was homogeneous with respect to business risk. The assumption is quite important and certainly subject to some criticism; however, these 136 banking organizations are the largest in the country and operate under a very similar set of risky conditions. Their returns are subject to similar uncertainties with respect to interest rates and general economic conditions. On the contrary, however, certain banks have greater exposure in the more uncertain international arena.

The homogeneity of banking institutions would be a timely study of some interest. No need exists for undertaking that here. Earlier in this report it was noted that the model applies only to large banks. It would be naive to extend either the theory or the assumption of equivalent business risk to many more than one hundred or so banks, but with a warning of caution, this research will proceed

\textsuperscript{10}Preferred stock could have been built into the model but would have unnecessarily complicated it and would have yielded no important results.
with the assumption that this set of large banks with publicly traded stock comprise an appropriate sample with reasonable homogeneity.

The Firm Samples

The samples of corporate firms were more difficult to obtain. COMPSTAT's Industrial and Price-Dividends-Earnings files were the primary data sources. Firms with preferred stock were eliminated as were firms with fiscal years not ending in December. The latter requirement considerably simplified data collection and computer programming. Naturally some firms had missing data. From approximately 2,200 original firms in the data files, the available set was reduced to 257 firms.

As discussed earlier the homogeneity of business risk assumption had to be satisfied. In Chapter 2 the controversy over industries being represented by SIC codes was mentioned. Given the evidence against SIC grouping as an appropriate proxy for a risk class, an alternative procedure was pursued.

Since the concept of a risk class is reflected in the unlevered beta, an attempt was made to estimate unlevered betas for the 257 firms. Hamada derived a formula which theoretically converted empirically observed levered stock market returns into unlevered returns. Assuming the tax adjusted version of the MM theory were correct, the unlevered returns are given by the following equation:

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12 Hamada, loc. cit.
where $R_{Ut}$ is the unlevered return in time $t$, $d_t$, $c_{gt}$, $p_t$, and $I_t$ represent common stock cash dividends, capital gains, preferred stock cash dividends, and interest, respectively, in time period $t$, $\tau$ is the tax rate, $V$ and $D$ are the market values of the firm and debt, respectively, in period $t-1$. The interpretation of the above equation is that preferred dividends (which will from here on be dropped from this study) and the tax adjusted interest payments are returned to the stockholders. These amounts are considered to be cash payments that would accrue to the owners in the absence of leverage. The factor $(V - \tau D)_{t-1}$ is the value of the equity if the firm were unlevered and easily follows from the MM equation, $V_L = V_U + \tau D$ where $V_U$ is the unlevered equity value. Clearly, Equation (4-12) is only a rough approximation of the unlevered equity return. It assumes that the investment and financing decisions are unrelated so that the presence of leverage has no effect on the types of investment projects the firm undertakes. This assumption might not be appropriate at all and is at least violated to a minor degree by the inclusion of taxes which creates a form of non-separation of investment and financing decisions. In spite of its weaknesses, the approach appears to be the only suitable solution to the problem and certainly offers potential for further applications in finance.

Equation (4-12) can be converted to its counterpart in the bank financial structure model and is given as

$$R_{Ut} = \frac{d_t + c_{gt} + p_t + I_t(1 - \tau)}{(V - \tau D)_{t-1}} \quad (4-13)$$
Each term in (4-13) except the bracketed term can be easily measured. For corporations $D_{dt}$ would represent the value of the firm's trade credit or other non-interest bearing debt. If this theory's main hypothesis is true, then for firms $R_f = E(\tilde{R}_z)$ and the bracketed term becomes simply $\tau$, reflecting the tax subsidy of debt financing. Since the objective of the research is to show that for firms $R_f = E(\tilde{R}_z)$, it would not be appropriate to assume that the two values are equal. Instead, it will be assumed that the ratio of $R_f$ to $E(\tilde{R}_z)$ is .5. This assumption injects a bias into the $R_{Ut}$'s unless .5 is the actual ratio, but the bias is applied to all firms in the sample, not just a selected few. The $R_{Ut}$'s and $\beta_U$'s may be biased but should be satisfactory when used in the context of their relation to each other. Since it will ultimately be the relative rankings of the $\beta_U$'s that will be the items of interest, their precise values are of a somewhat lesser significance. Nonetheless, it is necessary to at least acknowledge that the bias might have a slight effect on the relative rankings of firms due to their different degrees of financial leverage.

Given the 48 percent corporate tax rate, the unlevered return estimates can be derived. Then a market model regression of the form

$$\tilde{R}_{Uit} = \alpha_i + \beta_{Uit} R_{mt} + \tilde{\varepsilon}_{it} \quad (4-14)$$

may be completed. This regression was run for each firm $i$ ($i = 1, \ldots, 257$) using quarterly data over the period 1Q/1971 through 4Q/1978 for a total of 32 quarterly observations.\textsuperscript{13} The quarterly return on the

\textsuperscript{13}The use of unlevered betas from the above regression was also considered as a possibility for improving the homogeneity of the bank sample but data availability and comparability problems between the several data sources precluded this option.
Standard and Poor's 500 Stock Index was used as the measure of market wide return. The estimating process is again subject to some criticism. The small number of observations limited the accuracy of the parameter estimates somewhat, but more observations would increase the likelihood of instability of the firm's business risk through time. Although the business risk profile of a firm changes only very slowly, over a longer period significant shifts are sometimes observed. Some compromise of these factors along with the limitations of data availability had to be made.

Table 1 presents some summary statistics from the estimates of both levered and unlevered betas for the sample of 257 firms. The most significant fact is the expected differential between the levered and unlevered betas with the levered betas naturally being the larger. It is apparent, however, that the levered betas were not necessarily representative of the entire market since the average levered beta should have been much closer to one. A possible explanation for this occurrence might lie with the data screening procedures which prevented the sample from being purely random. It is not possible to test this hypothesis, but a more likely explanation lies in the use of only 32 quarterly observations in the regression. Smith has shown that the length of the interval has a definite effect on beta estimates with quarterly data producing larger estimates than monthly data. His results, however, are based on considerably more observations than used here; and it is not clear what a combination of small number of observations and

---

Table 1
Characteristics of the Sample Distributions of Levered and Unlevered Betas for 257 Firms

<table>
<thead>
<tr>
<th></th>
<th>Levered</th>
<th>Unlevered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>1.346</td>
<td>1.060</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>.587</td>
<td>.434</td>
</tr>
<tr>
<td>Standard Error of the Mean</td>
<td>.037</td>
<td>.027</td>
</tr>
<tr>
<td>Skewness</td>
<td>.817</td>
<td>.712</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>.465</td>
<td>.592</td>
</tr>
<tr>
<td>Maximum</td>
<td>3.371</td>
<td>2.619</td>
</tr>
<tr>
<td>Minimum</td>
<td>.168</td>
<td>.107</td>
</tr>
<tr>
<td>Percentiles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>99th</td>
<td>2.949</td>
<td>2.285</td>
</tr>
<tr>
<td>95th</td>
<td>2.467</td>
<td>1.896</td>
</tr>
<tr>
<td>90th</td>
<td>2.171</td>
<td>1.700</td>
</tr>
<tr>
<td>10th</td>
<td>.757</td>
<td>.554</td>
</tr>
<tr>
<td>5th</td>
<td>.550</td>
<td>.432</td>
</tr>
<tr>
<td>1st</td>
<td>.259</td>
<td>.192</td>
</tr>
<tr>
<td>Average Standard Error of β</td>
<td>.366</td>
<td>.300</td>
</tr>
</tbody>
</table>

quarterly data have on the parameter estimates. The significance of that issue is an intellectual curiosity, but probably of little importance here given that the levered betas were still significantly larger than the unlevered betas.

The sample of 257 unlevered betas were then ranked by size. It was decided that two samples would be selected so that the final results
could not easily be attributed to sample sensitivity. Ideally each sample would consist of firms with the same unlevered beta estimates, but this desirable property would be impossible to obtain given the need for a satisfactory sample size. Rather it was decided that a specified range of unlevered betas would provide reasonable homogeneity. Obviously the smaller the range, the more homogeneous the sample, but the smaller the sample size. The final selection became a trade-off between sample size and homogeneity.

Table 2 presents a listing of the number of firms falling in selected ranges of unlevered betas. A choice was made to include all firms in the range of .70-.90 in one sample, hereafter called Sample 1, and all firms in the range of .95-1.15 in the other sample, hereafter called Sample 2. Availability of some data necessary to a later analysis set the final sample sizes at 61 for Sample 1 and 57 for Sample 2. Appendixes D and E provide listings of the firms in the two samples. Appendix F provides more detailed statistics on the distribution of unlevered betas and returns for Samples 1 and 2. The data, while interesting, have little significance for the study. It should be noted that the mean unlevered beta for Sample 1 was .81 and for Sample 2 was 1.05. Though the two samples, thus, appear to be heterogeneous with respect to each other, this fact is of no significance since the objective of having two samples was simply to avoid sample sensitive results.

It is clear that certain criticisms of these tests can easily be levied. To avoid some rather obvious ones, however, the following sections will deal specifically with problems and special considerations inherent in the tests.
### Table 2

**Number of Firms in Original Sample of 257 Falling in Selected Ranges of Unlevered Betas**

<table>
<thead>
<tr>
<th>Range of .20</th>
<th>#</th>
<th>Range of .15</th>
<th>#</th>
<th>Range of .10</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>.71- .90</td>
<td>69</td>
<td>.71- .85</td>
<td>44</td>
<td>.71- .80</td>
<td>33</td>
</tr>
<tr>
<td>.76- .95</td>
<td>60</td>
<td>.76- .90</td>
<td>48</td>
<td>.76- .85</td>
<td>30</td>
</tr>
<tr>
<td>.81-1.00</td>
<td>56</td>
<td>.81- .95</td>
<td>41</td>
<td>.81- .90</td>
<td>29</td>
</tr>
<tr>
<td>.86-1.05</td>
<td>58</td>
<td>.86-1.00</td>
<td>45</td>
<td>.86- .95</td>
<td>30</td>
</tr>
<tr>
<td>.91-1.10</td>
<td>52</td>
<td>.91-1.05</td>
<td>40</td>
<td>.91-1.00</td>
<td>27</td>
</tr>
<tr>
<td>.96-1.15</td>
<td>54</td>
<td>.96-1.10</td>
<td>40</td>
<td>.96-1.05</td>
<td>28</td>
</tr>
<tr>
<td>1.01-1.20</td>
<td>47</td>
<td>1.01-1.15</td>
<td>39</td>
<td>1.01-1.10</td>
<td>25</td>
</tr>
<tr>
<td>1.06-1.25</td>
<td>44</td>
<td></td>
<td></td>
<td>1.06-1.15</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.11-1.20</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.15-1.25</td>
<td>18</td>
</tr>
</tbody>
</table>

*Several other ranges were examined. The above examples were selected as being representative.*

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**Circumvention of Financial Intermediation**

A critical assumption underlying the theory concerns the efficacy of the bank to hold a natural monopoly in the financial intermediation process. The existence of multiple banks is possible, but no firm or individual is allowed to circumvent the financial intermediation process. Obviously some realism is being sacrificed. The occurrence of periods of financial disintermediation is certainly evidence that firms and even individuals can and often do bypass the intermediary. Financial disintermediation to any great extent tends to occur during periods of very high interest rates and results from ceilings on time and savings deposit rates. A more common phenomenon is the ability of many large corporations to borrow in the commercial paper market, oftentimes through captive finance subsidiaries. In fact these finance companies such as General Motors Acceptance Corporation might even be considered intermediaries themselves. The presence of this factor will make it even
more difficult to detect significant differences between financial risk premiums for banks and firms. The samples were examined for the presence of firms issuing commercial paper. Using Moody's Bond Record which provides ratings of commercial paper, it was noted that nineteen firms in Sample 1 and nine in Sample 2 had commercial paper rated as of January, 1978. It would be helpful to simply reject those firms but the sample sizes would become much too small. It was, thus, felt that this factor could not be controlled, but, if anything, would result in a downward, conservative bias.

**Time Periods**

The dependent variable is the estimate of the company's (levered) beta obtained from a time series regression of the observed stock market return on the observed return on the Standard and Poor's 500 Stock Index, the surrogate for the market return. Note that the independent variable is the debt/equity ratio, a measure observed at a given point in time. Theoretically a specific beta value exists at a point in time and is influenced by the debt/equity ratio at the same point in time. Since beta must be estimated across time, the dependent and independent variables are not time-consistent. The question then becomes one of measuring the debt/equity ratio at either the beginning, middle, or end of the time period over which beta is estimated. No clear evidence exists for favoring a specific point in time at which to measure the debt/equity ratio. Consequently, it seemed appropriate to examine various time points.

---

Beta estimates were derived using monthly data over three, four, and five year periods. The earliest month included was June, 1979. The financial structure data were measured as of year end 1975, 1976, 1977 and 1978. Table 3 lists the time periods involved in what came to a total of twenty regressions. It is important to note that the twenty regressions are clearly not independent and the results should not be interpreted as though they were. They should, however, be sufficient for detecting any evidence of the hypothesized relationships.

Questions are frequently raised about the stability of betas through time. This study suffers from no serious drawbacks not already present in other studies with respect to beta instability. One potential problem with the bank sample, however, had to be addressed.

The conversion of many banks to holding companies was a phenomenon of frequent occurrence in the early years of the 1970-79 decade. Since some banking organizations in the sample were, ergo, "banks" at the beginning of the period and "holding companies" at the end, a structural shift in beta might have occurred when the organizational form was changed. This shift if it took place could bias the results of the tests. Findings from a study by Brewer and Dukes proved to be of some aid in examining this possibility.

In their paper, Brewer and Dukes examined 41 banking organizations for differences in slopes and intercepts (β's and α's) from regressions

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16 In Chapter 3 a discussion was presented on the applicability of the model to either the bank or holding company form of organization.

Table 3
Time Periods Involved in the Twenty Regressions

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
<td>12/75 - 12/78</td>
<td>36</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td>12/74 - 12/78</td>
<td>48</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td>12/73 - 12/78</td>
<td>60</td>
<td>End</td>
</tr>
<tr>
<td>1977</td>
<td>6/76 - 6/79</td>
<td>36</td>
<td>Centered</td>
</tr>
<tr>
<td></td>
<td>12/72 - 12/77</td>
<td>60</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td>12/73 - 12/77</td>
<td>48</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td>12/74 - 12/77</td>
<td>36</td>
<td>End</td>
</tr>
<tr>
<td>1976</td>
<td>6/75 - 6/78</td>
<td>36</td>
<td>Centered</td>
</tr>
<tr>
<td></td>
<td>12/74 - 12/78</td>
<td>48</td>
<td>Centered</td>
</tr>
<tr>
<td></td>
<td>6/74 - 6/79</td>
<td>60</td>
<td>Centered</td>
</tr>
<tr>
<td></td>
<td>12/71 - 12/76</td>
<td>60</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td>12/72 - 12/76</td>
<td>48</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td>12/73 - 12/76</td>
<td>36</td>
<td>End</td>
</tr>
<tr>
<td>1975</td>
<td>12/70 - 12/75</td>
<td>60</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td>12/71 - 12/75</td>
<td>48</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td>12/72 - 12/75</td>
<td>36</td>
<td>End</td>
</tr>
<tr>
<td></td>
<td>12/73 - 12/77</td>
<td>48</td>
<td>Centered</td>
</tr>
<tr>
<td></td>
<td>6/74 - 6/77</td>
<td>36</td>
<td>Centered</td>
</tr>
<tr>
<td></td>
<td>6/73 - 6/78</td>
<td>60</td>
<td>Centered</td>
</tr>
<tr>
<td></td>
<td>12/75 - 12/78</td>
<td>36</td>
<td>Beginning</td>
</tr>
</tbody>
</table>

of security return on a market index for the time period prior to and after conversion to the holding company form of organization. They found that in eight cases beta shifted upward after conversion to the holding company and in two cases beta shifted downward. It is difficult to determine whether these results should be cause for alarm in the present study. Fortunately, Brewer and Dukes published the before and after beta estimates for each of the 41 banking firms in their paper making it possible to further analyze their results. A Wilcoxon Matched-Pairs Signed-Ranks test was performed on the Brewer and Dukes
data to determine whether the shifts in beta were a more general phenomenon or were simply present for a few banks. Ranking the absolute values of the differences in the before and after betas and using the large sample (N>25) approximation of the distribution of the Wilcoxon T-statistic revealed that there was no structural shift in the betas. The null hypothesis that the before and after betas were equal could not be rejected at a reasonable level of significance as the probability of a Type I error was .19. Although clearly some shifts in betas occur, it can reasonably be concluded that such shifts are few in number or are a result of sampling error or external, random, factors.

The Returns Generation Process

Modeling the returns generation process is a subject receiving considerable attention in the finance literature. Recently the most popular approach has been via the stochastic calculus incorporating the familiar Geometric Brownian motion "random walk" process. This methodology has considerable theoretical appeal, but is not particularly practical for empirical purposes. The market model remains the most viable procedure for modeling the returns generation process.

The question may arise as to whether the market model is appropriate for describing the returns generation process where the Black zero-beta model is the equilibrium model. It turns out that the model is suitable although it does not precisely specify the returns generation process.

Fama has discussed this issue in his book\textsuperscript{19} and some of the material which follows is extracted thereof although it is somewhat well known anyway. Given the zero-beta model
\begin{equation}
E(R_i) = E(R_Z) + [E(R_m) - E(R_Z)] \beta_i, \tag{4-15}
\end{equation}
if it is assumed that the returns on the security, the market, and the zero-beta portfolio are trivariate normally distributed, the process may be modeled as
\begin{equation}
\tilde{R}_{it} = \alpha_i + \beta_{iz}\tilde{R}_{zt} + \beta_{im}\tilde{R}_{mt} + \varepsilon_{it} \tag{4-16}
\end{equation}
where there are now two "beta" factors in addition to an "alpha." It is known that
\begin{align}
\alpha_i &= E(R_{it}) - \beta_{iz}E(R_{zt}) - \beta_{im}E(R_{mt}), \tag{4-17} \\
\beta_{iz} &= \frac{\text{cov}(\tilde{R}_{i}, \tilde{R}_{z})}{\text{var}(\tilde{R}_{z})}, \quad \text{and} \quad \beta_{im} = \frac{\text{cov}(\tilde{R}_{i}, \tilde{R}_{m})}{\text{var}(\tilde{R}_{m})}. \tag{4-18}
\end{align}
An equivalent version of (4-15) uses the fact that $\beta_{iz} = 1 - \beta_{im}$ so that
\begin{equation}
\tilde{R}_{it} = \alpha_i + (1 - \beta_{im})\tilde{R}_{zt} + \beta_{im}\tilde{R}_{mt} + \varepsilon_{it} \tag{4-19}
\end{equation}
or
\begin{equation}
\tilde{R}_{it} = \alpha_i + \tilde{R}_{zt} + \beta_{im}(\tilde{R}_{mt} - \tilde{R}_{zt}) + \varepsilon_{it}. \tag{4-20}
\end{equation}
If the market is efficient, then $\alpha_i = 0.0$ and the model is given as
\begin{equation}
\tilde{R}_{it} = \tilde{R}_{zt} + \beta_{im}(\tilde{R}_{mt} - \tilde{R}_{zt}) + \varepsilon_{it}. \tag{4-21}
\end{equation}
which differs slightly from the basic market model. The most notable difference is seen in (4-19). If $\tilde{R}_{it}$ is regressed on $\tilde{R}_{mt}$, as in the market model, and (4-19) is the correct process, then the regression has an "omitted" variable, $\tilde{R}_{zt}$.

The statistical consequences of an omitted variable are discussed in Kmenta.\textsuperscript{20} It is convenient that $R_{zt}$ and $R_{mt}$ are independent because this fact guarantees unbiasedness in the $\hat{\beta}_{im}$ estimate. Unless $R_{zt} = 0.0$, $\alpha$ is biased, and in any case $\sigma^2(\hat{\beta}_{im})$ is upwardly biased. These problems, however, are of no interest here since $\alpha_i$ will not be used at all, and $\hat{\beta}_{im}$ will not need to be tested for significance. Other variables might be erroneously omitted although there is no reason to believe that they are; but otherwise, the single factor market model is quite suitable for the purposes of this study.

\textbf{Errors in Measurement of $\beta$}

A frequent concern in econometric tests of the capital asset pricing model has been the error present in the measurement of beta. Since beta estimated from a time series regression obviously contains error, its incorporation as an independent variable in cross-sectional regressions of the average security return on beta results in inconsistent ordinary least squares estimators and a slope estimate which underestimates the true parameter.\textsuperscript{21} In the tests performed here, however, the measurement error is in the dependent variable. The consequences of measurement error in the dependent variable are somewhat trivial. If the measurement error meets the same assumptions as those of the residual disturbance term and the error and residual are uncorrelated, then the ordinary least squares estimators are unbiased and consistent. One less than


desirable property, however, is that the variance of the residuals will be inflated as a result of the measurement error in the dependent variable falling into the residuals. A search through several econometrics texts turned up no formal proofs of these statements, so proofs were derived and are presented in Appendix G.

The implication of inflated residual variance is relatively minor. The larger residual variance results in larger standard errors of \( \hat{\gamma}_0 \) and \( \hat{\gamma}_1 \). The standard errors of the estimators are certainly important in statistical tests of significance, but the inflated error variance injects a conservative downward bias in the test statistic which renders it somewhat more difficult to reject null hypotheses in significance tests. If the null hypothesis can be rejected, conclusions drawn can, thus, be supported with more confidence than usual.

**Omitted Variables**

The problem of omitted variables was discussed with respect to the exclusion of an \( R_{zt} \) factor in the market model regressions. In the regression of beta on leverage, it is possible that other variables should be included in the model. If the omitted variable(s) are correlated with the included variable, both slope and intercept estimates are biased and inconsistent.\(^{22}\) Previous studies have attempted to predict beta from accounting data and have generally employed multiple regression with at least two variables being statistically significant.\(^{23}\)

\(^{22}\)Kmenta, loc. cit.

\(^{23}\)No less than seven studies were located in leading finance journals. A few of the more representative ones are William J. Breen and Eugene M. Lerner, "Corporate Financial Policies and Market Measures of Risk and Return," *Journal of Finance*, 28: 339-52, May, 1973; Barr
It is not necessarily true that these models are more appropriately specified. More than likely they are not since they are not supported by any economic theory. They are to be more precise, ad hoc models which simply use any and all financial ratios to predict beta. It is felt that the model developed in Chapter 3 captures the effect of other variables in the intercept term, $\beta_U$. Since total risk consists only of business and financial risk, the variables included in multiple regression models must be surrogates for these two forms of risk. The capturing of $\beta_U$ and the debt/equity ratio should be a more satisfactory approach and should preclude the existence of other variables.

One possibility for an omitted variable, however, results from the measurement of the debt/equity ratio which includes all interest bearing debt. Unfortunately, it was necessary to comingle all forms of debt to avoid having a much more complicated model and one which is unestimatable due its requiring several implicit variables. For example, if the firm had risk-free short-term debt and risky long term debt, it would be necessary to measure the value of the equity with

Rosenberg and Walt McKibben, "The Prediction of Systematic and Specific Risk in Common Stocks," *Journal of Financial and Quantitative Analysis*, 8: 317-33, March, 1973; and Donald J. Thompson, "Sources of Systematic Risk in Common Stocks," *Journal of Business*, 47: 173-88, April, 1974. Also in Barr Rosenberg and Phillip R. Perry, "The Fundamental Determinants of Risk in Banking," *Proceedings From a Conference on Bank Structure and Competition* (Chicago: Federal Reserve Bank of Chicago, 1978), pp. 402-77, multiple regression was applied to the prediction of bank betas. The results of these studies generally confirm the hypothesis that leverage is related to beta but there was considerable inconsistency from test to test. In Uri Ben-Zion and Sol Shalit, "Size, Leverage, and Dividend Record as Determinants of Equity Risk," *Journal of Finance*, 30: 1015-26, September, 1975, regression of beta on leverage was performed on about 1,000 firms. The results showed a positive relationship but reveal no insights on the question at hand since no attempt was made to control business risk.
the effects of long and short term debt removed, the value of the equity if the firm had only short term debt, and the bond beta. Obviously considerable simplification was necessary, and it is certainly true that some problems will no doubt be a result of the comingling of debt and incomplete specification of what may well be a far more complex process.

Effects of the Traditional Theory of Finance

The relationship between beta and leverage for the firms has been assumed to be described by the MM theory. As indicated in Chapter 2, the MM theory has not been satisfactorily tested. Any reliance on the validity of the MM theory must be held with guarded caution. The alternative argument, the traditional theory of corporate financial structure, could easily have an effect on the results.

Under the traditional theory and with no taxes, as debt is added the financial risk premium required by stockholders does not increase by a large enough amount to completely offset the increase in the expected equity return resulting from the use of leverage. No economic rationale exists to explain this argument. It is generally assumed that investors recognize that leverage is beneficial up to a certain degree. If the traditional argument is valid, the slopes of both the bank and firm regressions are lower than given by Equations (4-9) and (4-10). Some multiplicative factor which is between zero and one would implicitly appear in the model and produce a lower slope. While recognition of the traditional theory complicates this analysis somewhat, it provides a possible explanation for a lower than hypothesized slope
estimate and does not affect the major implication of banks' financial risk premiums being smaller than those of firms.

**Book or Market Value Data**

The theory is specified in terms of market value data. The book value of the banks' and firms' debt in addition to the market values will, however, be used in order to avoid the data collection difficulties of obtaining market prices for the debt. Since much of the debt is non-marketable, the concept of a market value may well be meaningless in many cases. For the equity, however, market value is certainly meaningful.

Considerable debate has ensued over the use of book or market values in tests such as these. Market value measures may distort test results. If the stock market had a major movement on the day of measurement of the debt/equity ratio, the ratio may not accurately reflect the normal, relatively stable leverage of the company. Book value measures may provide better estimates of the leverage, and thus, have some merit in themselves. In the tests conducted here and reported in Chapter 5 both book and market value measures will be used in the hope that at least one will prove to be a significant factor.

**Ex Post Versus Ex Ante Data**

Virtually any economic theory involving uncertainty requires the specification of ex ante variables. As is the usual case, only ex post data are available. No satisfactory solution to this problem has ever appeared in the finance and economics literature. Generally

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24 The debate has appeared in several of the studies reviewed in Chapter 2 especially those of Barges, Wippern, and Brigham and Gordon.
assumed is that in the long run, expectations are realized so that no inconsistency between \textit{ex ante} and \textit{ex post} data exists. Since this study is no different from any other with respect to this problem, there is little that can or need be done about it.

The basic structure of the testing procedure has now been outlined. Chapter 5 presents a more detailed description of the data, the specific tests employed, and the results.
Chapter 5

EMPIRICAL TESTS

In this chapter the results of the empirical tests which were performed on the bank and firm samples will be presented. Initially the bank results will be reported and discussed with emphasis placed on the extent to which the data agree or disagree with the model. Next, the firm results will be presented. While interesting in themselves, the firm results become only significant when they are viewed in comparison with the bank results. It will be shown that the statistical implications are at least consistent with a world in which banks command an advantage over firms in their financing operations. The results will, thus, prove to be supportive of the theory but should be regarded as preliminary in nature.

The Bank Tests

As it will be recalled, the complete bank sample consisted of 136 banking firms. Not all of the firms appeared in each regression. The sample statistics which will initially be reviewed are based on the full sample.

Table 4 presents statistics from the time series estimates of the bank betas based on monthly data and over the periods discussed in Chapter 4. The average beta did not vary much from one period to the next; but since some of the time periods overlapped, the result is not surprising. The average bank beta appeared to be about .90. This result is somewhat higher than previously reported estimates of
Table 4
Sample Statistics from Estimated Bank Beta Coefficients
(N = 136)

<table>
<thead>
<tr>
<th>Estimated Over</th>
<th>( \bar{\beta} )</th>
<th>( \sigma )</th>
<th>Skewness*</th>
<th>Kurtosis*</th>
</tr>
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<tbody>
<tr>
<td>12/70 - 12/75</td>
<td>.94</td>
<td>.33</td>
<td>.42</td>
<td>.50</td>
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<tr>
<td>12/71 - 12/75</td>
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<td>.37</td>
<td>.42</td>
<td>.52</td>
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<td>.97</td>
<td>.33</td>
<td>.29</td>
<td>.35</td>
</tr>
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<td>12/72 - 12/75</td>
<td>.94</td>
<td>.38</td>
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<td>.67</td>
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<td>.32</td>
<td>.41</td>
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<tr>
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<td>.31</td>
<td>.24</td>
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<td>.46</td>
<td>.38</td>
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<td>.37</td>
<td>.52</td>
<td>.50</td>
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<td>.11</td>
<td>-.30</td>
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<td>12/74 - 12/78</td>
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<td>.37</td>
<td>.08</td>
<td>.00</td>
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<tr>
<td>12/75 - 12/78</td>
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<td>.37</td>
<td>.39</td>
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<td>.79</td>
<td>.41</td>
<td>.78</td>
<td>3.01</td>
</tr>
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</table>

*Both Skewness and Kurtosis statistics should equal zero for a normal distribution.

Rosenberg and Guy\(^1\) who obtained an average bank beta of .81 and Chance\(^2\) whose average bank beta was .72. The difference reflects a different


time period involved but in real terms may indicate an upward shift of bank business and/or financial risk.

A Kolmogorov-Smirnov test was performed on each cross-section sample of beta estimates. In each of the 17 cases the null hypothesis that the sample was drawn from a normal distribution could not be rejected at a five percent level of significance. Visual examination of histograms further revealed that the sample distributions were reasonably approximated by the normal distribution. Although normality is not a critical assumption and evidence against it would not necessarily be grounds for abandoning the tests, it does provide a small degree of comfort to any researcher.

In Table 5 sample statistics from calculated debt/equity ratios of the banks are presented. Examining first the book value ratios, it is noted that little difference exists between the mean ratios of the banks over the four years. Of note, however, is the fact that the average ratio does increase slightly each year from 1975 through 1978. The result is a reflection of the declining capital ratios of banks, a fact that has so alarmed regulators. Looking at market value ratios, however, reveals that there was actually no significant increase in the ratio of debt to equity. In fact there was an early decrease followed by a slight increase resulting in a 1978 ratio that was only slightly below the 1975 ratio. Note that the standard deviation of the market value ratios was more than one and one-half times the standard deviation of the book value ratios reflecting the more variable market values. Also it should be noted that the market value ratios exceeded the book value ratios since most bank stocks sell for less than book value.
Table 5
Sample Statistics From Debt/Equity Ratios of Banks
(N = 136)

<table>
<thead>
<tr>
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<th>Mean</th>
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<th>Kurtosis</th>
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</tr>
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<td>.88</td>
<td>1.69</td>
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<td>1977</td>
<td>11.00</td>
<td>1.05</td>
<td>1.74</td>
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<td>1976</td>
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<td>.89</td>
<td>.95</td>
</tr>
<tr>
<td>1975</td>
<td>10.21</td>
<td>.98</td>
<td>1.50</td>
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<tr>
<td>Market Value</td>
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<td></td>
</tr>
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<td>.46</td>
<td>-.50</td>
</tr>
<tr>
<td>1977</td>
<td>14.62</td>
<td>.50</td>
<td>-.33</td>
</tr>
<tr>
<td>1976</td>
<td>13.75</td>
<td>1.04</td>
<td>1.19</td>
</tr>
<tr>
<td>1975</td>
<td>15.89</td>
<td>.89</td>
<td>.51</td>
</tr>
</tbody>
</table>

Finally, the Kolmogorov-Smirnov tests failed to reject the hypothesis of normality in both book and market value calculations and for each of the four years.

The Regression Results

The twenty bank regressions were estimated and the results are presented in Table 6. One-tailed tests of significance were used because both slope and intercept should be non-negative. Recall that the dependent variable is the time series beta estimated over the periods indicated and the independent variable is the debt/equity ratio measured at either 12/75, 12/76, 12/77, or 12/78. The book value results will first be discussed.
<table>
<thead>
<tr>
<th>Debt/Equity At:</th>
<th>Beta Over:</th>
<th>Obs.</th>
<th>( \hat{\gamma}_0 )</th>
<th>( \hat{\gamma}_1 )</th>
<th>( R^2 )</th>
<th>Obs.</th>
<th>( \hat{\gamma}_0 )</th>
<th>( \hat{\gamma}_1 )</th>
<th>( R^2 )</th>
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<td>.513** (.127)</td>
<td>.028** (.011)</td>
<td>.073</td>
<td>92</td>
<td>.850** (.105)</td>
<td>-.001 (.006)</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>12/74 - 12/78</td>
<td>92</td>
<td>.581** (.137)</td>
<td>.030** (.011)</td>
<td>.073</td>
<td>92</td>
<td>.923** (.114)</td>
<td>.001 (.007)</td>
<td>.000</td>
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<tr>
<td></td>
<td>12/73 - 12/78</td>
<td>91</td>
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<td>.038** (.011)</td>
<td>.114</td>
<td>91</td>
<td>.857** (.114)</td>
<td>.004 (.007)</td>
<td>.004</td>
</tr>
<tr>
<td>1977</td>
<td>6/76 - 6/79</td>
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<td>.028** (.012)</td>
<td>.059</td>
<td>94</td>
<td>.695** (.117)</td>
<td>.006 (.008)</td>
<td>.007</td>
</tr>
<tr>
<td></td>
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<td>.022** (.010)</td>
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<td>92</td>
<td>.986** (.104)</td>
<td>-.003 (.007)</td>
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<td>.028** (.011)</td>
<td>.062</td>
<td>96</td>
<td>.910** (.112)</td>
<td>.001 (.007)</td>
<td>.000</td>
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<tr>
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<td>.017** (.012)</td>
<td>.021</td>
<td>97</td>
<td>1.023** (.118)</td>
<td>-.005 (.007)</td>
<td>.005</td>
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<tr>
<td>1976</td>
<td>6/75 - 6/78</td>
<td>99</td>
<td>.532** (.123)</td>
<td>.021** (.011)</td>
<td>.036</td>
<td>99</td>
<td>.836** (.100)</td>
<td>-.006 (.006)</td>
<td>.008</td>
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<tr>
<td></td>
<td>12/74 - 12/78</td>
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<td>.022** (.010)</td>
<td>.045</td>
<td>99</td>
<td>.922** (.094)</td>
<td>-.000 (.006)</td>
<td>.000</td>
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<tr>
<td></td>
<td>6/74 - 6/79</td>
<td>98</td>
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<td>.029** (.010)</td>
<td>.089</td>
<td>98</td>
<td>.863** (.089)</td>
<td>.000 (.006)</td>
<td>.000</td>
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Table 6 (continued)

<table>
<thead>
<tr>
<th>Debt/Equity At:</th>
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<th></th>
<th>Market Value</th>
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<tr>
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<td>$\hat{\gamma}_1$</td>
<td>$R^2$</td>
<td>Obs.</td>
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<tr>
<td>1976 (cont)</td>
<td>12/71 - 12/76</td>
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<td>.625** (0.112)</td>
<td>.031** (0.010)</td>
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<td>93</td>
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<tr>
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<td>12/72 - 12/76</td>
<td>96</td>
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<td>.031** (0.011)</td>
<td>.079</td>
<td>100</td>
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<tr>
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<td>79</td>
<td>.588** (0.120)</td>
<td>.032** (0.011)</td>
<td>.100</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>12/71 - 12/75</td>
<td>93</td>
<td>.527** (0.118)</td>
<td>.039** (0.011)</td>
<td>.123</td>
<td>93</td>
</tr>
<tr>
<td></td>
<td>12/72 - 12/75</td>
<td>96</td>
<td>.580** (0.121)</td>
<td>.034** (0.011)</td>
<td>.089</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>12/73 - 12/77</td>
<td>100</td>
<td>.544** (0.111)</td>
<td>.036** (0.010)</td>
<td>.108</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>6/74 - 6/77</td>
<td>101</td>
<td>.537** (0.113)</td>
<td>.033** (0.011)</td>
<td>.093</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>6/73 - 6/78</td>
<td>98</td>
<td>.589** (0.105)</td>
<td>.031** (0.010)</td>
<td>.094</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>12/75 - 12/78</td>
<td>99</td>
<td>.593** (0.107)</td>
<td>.023** (0.010)</td>
<td>.051</td>
<td>99</td>
</tr>
</tbody>
</table>

**Significant at .05 level.
*Significant at .10 level.
The $R^2$'s were rather low, but this result was expected given that the dependent variable is measured with error. This problem, as discussed in the previous chapter and in Appendix F, also tended to hold down the significance of the estimates. Nonetheless, all of the intercepts were significant at the .05 level, and all but one slope was significant at the .05 level and the remaining one was significant at the .10 level.

The market value results were somewhat disappointing. None of the slopes were significant. Some of the regressions had negative, though insignificant, slopes. Clearly, market value-debt/equity, while theoretically sound, is not a suitable proxy for leverage. This conclusion could not be upheld were it not for the supportive results found using book value. Book value, thus, as it has been argued elsewhere, does have some validity, while lending a measure of stability to estimates of the banks' leverage.

In any regression it is important to consider the effect of outliers. The sampling distribution of debt/equity ratios, though approximately normally distributed, was found to contain some outlying observations which could have distorted the results. Since the debt/equity ratio is bounded from below by zero but has no upper limit, the banks with high debt/equity ratios could easily pull the line of best fit up if their beta estimates were very high or down if their estimates were very low. In a later section it will be shown that the outlier problem was more pronounced for the firm sample than for the bank

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sample. It was, thus, necessary to estimate the bank regressions with a reduced sample so that they would be placed on a more comparative basis with the firms.

The treatment of outlier observations is a complex statistical controversy. For the purposes here it seemed best not to inject a substantial amount of this self-induced bias, but rather to remove only a few observations. As a rough approximation, observations which were more than 1.645 standard deviations to the right of the mean were deleted. In a normal distribution, this maneuver would eliminate the largest five percent of the items.

The results of the reduced sample regressions are presented in Table 7. Anywhere from five to eight fewer observations were used in the regressions. The results, however, were not appreciably different. Two of the book value regressions which were significant at the .05 level before were here significant at the .10 level, but otherwise, the results were essentially the same. Also, the market value regressions were basically unaffected.

Comparison With Estimates of the $R_f/E(\tilde{R}_z)$ Ratio

From Equations (4-9) and (4-11), it is apparent that the slope coefficient, $\hat{\gamma}_1$, should be equal to $\beta_U(R_f/E(\tilde{R}_z))(1 - \tau)$. Since $\hat{\gamma}_0$ should equal $\beta_U$, then $\hat{\gamma}_1$ should be equivalent to $\hat{\gamma}_0(R_f/E(\tilde{R}_z))(1 - \tau)$. Given an independent estimate of the $R_f/E(\tilde{R}_z)$ ratio, and the fact that $\tau = .48$, an implied slope can be computed and compared to the actual slope.

The $E(\tilde{R}_z)$ estimates as indicated earlier were obtained from Professor Richard Roll of the Graduate School of Management of UCLA.
<table>
<thead>
<tr>
<th>Debt/Equity At:</th>
<th>Beta Over:</th>
<th>Obs.</th>
<th>Book Value</th>
<th>Market Value</th>
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<td>$\hat{\gamma}_1$</td>
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<td></td>
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<td>( .014)</td>
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<td>.035**</td>
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**Significant at .05 level.
*Significant at .10 level.
The federal funds rate was used as the risk-free rate since it probably best approximates the rate at which banks borrow and is certainly one of the lowest money market rates. The estimates represented monthly rates over the period from January, 1970 through December, 1978 for a total of 108 observations. Since the $E(\tilde{R}_z)$ estimates were only crude approximations, it was felt best to average the ratio over the entire 108 month period rather than attempt to break down the nine year period into a number of smaller periods. The average of the monthly estimates of the ratio was .044.

Table 8 compares the implied slope estimates using $(R_f/E(\tilde{R}_z)) = .044$ with the actual slope estimates from the twenty reduced sample regressions. Only the book value regressions are reported. The results seem to indicate that the actual slope is even smaller than would be predicted by the model. The differences, however, are in many instances small, and the results are encouraging in that they imply that the model is a reasonably good approximation of the leverage-beta relationship for banks. The differences, nonetheless, would be supportive of a multiplicative factor between zero and one in the slope. If such a factor exists, it should also be seen in the firm regressions and will be kept in mind when those results are reported.

Until now the model has performed reasonably well. Although further scrutiny of the bank data will be done, the results so far are enlightening as they imply that Equation (4-9) and not (4-10) is a better indicator of the true relationship between leverage and beta for banks. The next logical step is to proceed to the firm tests to determine how well the model fits the data from Samples 1 and 2.
Table 8
Implied and Actual Slope Estimates
From Bank Regressions

<table>
<thead>
<tr>
<th>Regression</th>
<th>Implied*</th>
<th>Reduced Sample Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debt/Equity At: Beta Over:</td>
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</tr>
<tr>
<td>1978 12/75 - 12/78</td>
<td>.014</td>
<td>.019</td>
</tr>
<tr>
<td>12/74 - 12/78</td>
<td>.014</td>
<td>.026</td>
</tr>
<tr>
<td>12/73 - 12/78</td>
<td>.012</td>
<td>.036</td>
</tr>
<tr>
<td>1977 6/76 - 6/79</td>
<td>.010</td>
<td>.034</td>
</tr>
<tr>
<td>12/72 - 12/77</td>
<td>.014</td>
<td>.029</td>
</tr>
<tr>
<td>12/73 - 12/77</td>
<td>.013</td>
<td>.034</td>
</tr>
<tr>
<td>12/74 - 12/77</td>
<td>.016</td>
<td>.023</td>
</tr>
<tr>
<td>1976 6/75 - 6/78</td>
<td>.012</td>
<td>.021</td>
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<tr>
<td>12/74 - 12/78</td>
<td>.014</td>
<td>.028</td>
</tr>
<tr>
<td>6/74 - 6/79</td>
<td>.010</td>
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<td>.013</td>
<td>.037</td>
</tr>
<tr>
<td>12/73 - 12/76</td>
<td>.011</td>
<td>.046</td>
</tr>
<tr>
<td>1975 12/70 - 12/75</td>
<td>.012</td>
<td>.040</td>
</tr>
<tr>
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<td>.011</td>
<td>.046</td>
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<td>.012</td>
<td>.037</td>
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<td>.035</td>
</tr>
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<td>.034</td>
</tr>
<tr>
<td>12/75 - 12/78</td>
<td>.013</td>
<td>.023</td>
</tr>
</tbody>
</table>

*Estimated as $\gamma_0(.044)(1 - .48)$.

The Firm Tests

Statistics from the time series estimates of the firm betas are presented in Table 9. Little variation existed for the betas over the time periods. Sample 1 betas averaged about .94 while Sample 2 betas averaged about 1.24. Kolmogorov-Smirnov tests for normality of the sample distributions revealed that the null hypothesis that beta was normally distributed across firms could not be rejected at the
## Table 9

### Sample Statistics From Estimated Firm Beta Coefficients

<table>
<thead>
<tr>
<th>Estimated Over</th>
<th>Sample 1 (N = 61)</th>
<th>Sample 2 (N = 57)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\bar{\beta}$</td>
<td>$\sigma$</td>
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<tr>
<td>12/71 - 12/75</td>
<td>.95</td>
<td>.27</td>
</tr>
<tr>
<td>12/71 - 12/76</td>
<td>.97</td>
<td>.25</td>
</tr>
<tr>
<td>12/72 - 12/75</td>
<td>.94</td>
<td>.28</td>
</tr>
<tr>
<td>12/72 - 12/76</td>
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<td>.95</td>
<td>.23</td>
</tr>
<tr>
<td>12/73 - 12/76</td>
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<td>.30</td>
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<td>12/73 - 12/77</td>
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<td>.27</td>
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<td>6/74 - 6/77</td>
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<td>.30</td>
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<td>12/74 - 12/77</td>
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<td>.41</td>
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<td>6/73 - 6/78</td>
<td>.92</td>
<td>.23</td>
</tr>
<tr>
<td>12/73 - 12/78</td>
<td>.94</td>
<td>.24</td>
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<tr>
<td>6/74 - 6/79</td>
<td>.96</td>
<td>.25</td>
</tr>
<tr>
<td>6/75 - 6/78</td>
<td>.95</td>
<td>.33</td>
</tr>
<tr>
<td>12/74 - 12/78</td>
<td>.80</td>
<td>.40</td>
</tr>
<tr>
<td>12/75 - 12/78</td>
<td>1.03</td>
<td>.39</td>
</tr>
<tr>
<td>6/76 - 6/79</td>
<td>1.10</td>
<td>.44</td>
</tr>
</tbody>
</table>

*Both Skewness and Kurtosis statistics should equal zero for a normal distribution.
.05 level for either sample in any of the 17 time periods considered. The data, thus, appeared to be reasonably "clean," a comforting factor.

Table 10 presents sample statistics of the debt/equity ratios of the two samples of firms. The mean book value ratios varied little from one year to the next. The market value ratios varied somewhat more over time, tending to decrease chronologically. As expected, the standard deviation of the market value ratios was considerably higher than that of the book value ratios. Kolmogorov-Smirnov tests were not as encouraging as in the other data distributions. The null hypothesis that the debt/equity ratios were normally distributed was rejected at the .05 level for the Sample 1 market value ratios of 1975 and 1976 and for all of the Sample 2 results, book and market values and for each year. Although it is not as convenient to be working with some non-normally distributed data, the assumption is not as important for the independent variable as for the dependent variable. It may also prove useful in explaining some of the later results.

A final point about the data should be noted. Sample 1 firms had lower business risk, as measured by the unlevered beta, than Sample 2 firms. From Table 10 Sample 1 firms had lower debt/equity ratios than Sample 2 firms. According to theory, Sample 1 firms should, therefore, have lower beta coefficients than Sample 2 firms. This hypothesis is confirmed in Table 9. Although this observation does not prove or disprove anything, it is at least encouraging to note that the data used here have the initial appearance of being consistent with a normal positive relationship between leverage and beta. Were they not consistent, further examination would be pointless.
Table 10
Sample Statistics From
Debt/Equity Ratios of Firms

Sample 1 (N = 61)

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean</th>
<th>Mean</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
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<td>1.03</td>
<td>.80</td>
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<tr>
<td>1977</td>
<td>.42</td>
<td>.29</td>
<td>.36</td>
<td>-.57</td>
</tr>
<tr>
<td>1976</td>
<td>.41</td>
<td>.28</td>
<td>.56</td>
<td>.13</td>
</tr>
<tr>
<td>1975</td>
<td>.42</td>
<td>.35</td>
<td>1.43</td>
<td>2.60</td>
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</table>

Market Value

<table>
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<th>Mean</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
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<td>.59</td>
<td>1.65</td>
<td>3.54</td>
</tr>
<tr>
<td>1977</td>
<td>.55</td>
<td>.51</td>
<td>1.29</td>
<td>1.46</td>
</tr>
<tr>
<td>1976</td>
<td>.49</td>
<td>.48</td>
<td>1.41</td>
<td>1.81</td>
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<tr>
<td>1975</td>
<td>.65</td>
<td>.79</td>
<td>2.12</td>
<td>4.82</td>
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</table>

Sample 2 (N = 57)

<table>
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<tr>
<th>Year</th>
<th>Mean</th>
<th>Mean</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1978</td>
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<td>.55</td>
<td>1.74</td>
<td>3.77</td>
</tr>
<tr>
<td>1977</td>
<td>.62</td>
<td>.68</td>
<td>3.45</td>
<td>15.90</td>
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<tr>
<td>1976</td>
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<td>2.92</td>
<td>10.34</td>
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<tr>
<td>1975</td>
<td>.68</td>
<td>.64</td>
<td>2.89</td>
<td>12.71</td>
</tr>
</tbody>
</table>

Market Value

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean</th>
<th>Mean</th>
<th>Skewness</th>
<th>Kurtosis</th>
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</thead>
<tbody>
<tr>
<td>1978</td>
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<tr>
<td>1977</td>
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<td>2.57</td>
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<tr>
<td>1976</td>
<td>.82</td>
<td>.96</td>
<td>2.43</td>
<td>6.39</td>
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<td>1975</td>
<td>1.19</td>
<td>1.45</td>
<td>2.27</td>
<td>5.56</td>
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</tbody>
</table>

The twenty regressions for Samples 1 and 2 were estimated and the results for the full samples are presented in Tables 11 and 12. The Sample 1 results were somewhat surprising. The book value regressions were not very satisfactory. Only in two cases were the slopes significant at the .05 level; three times they were significant at the .10 level. The market value regressions, however, were much better than both the book value regressions and the bank market value regressions. Eleven
Table 11
Sample 1 Regressions

<table>
<thead>
<tr>
<th>Debt/Equity At:</th>
<th>Beta Over:</th>
<th>Book Value</th>
<th>Market Value</th>
</tr>
</thead>
<tbody>
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<td>Obs.</td>
<td>( \hat{\gamma}_0 )</td>
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<tr>
<td>1978</td>
<td>12/75 - 12/78</td>
<td>61</td>
<td>.943** (.081)</td>
</tr>
<tr>
<td></td>
<td>12/74 - 12/78</td>
<td>61</td>
<td>.891** (.069)</td>
</tr>
<tr>
<td></td>
<td>12/73 - 12/78</td>
<td>61</td>
<td>.965** (.052)</td>
</tr>
<tr>
<td>1977</td>
<td>6/76 - 6/79</td>
<td>61</td>
<td>.996** (.025)</td>
</tr>
<tr>
<td></td>
<td>12/72 - 12/77</td>
<td>61</td>
<td>.905** (.052)</td>
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<tr>
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<td>12/73 - 12/77</td>
<td>61</td>
<td>.864** (.061)</td>
</tr>
<tr>
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<td>12/74 - 12/77</td>
<td>61</td>
<td>.759** (.092)</td>
</tr>
<tr>
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<td>6/75 - 6/78</td>
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<td>.639** (.087)</td>
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<tr>
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<td>.854** (.073)</td>
</tr>
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<td>6/74 - 6/79</td>
<td>61</td>
<td>.917** (.057)</td>
</tr>
<tr>
<td>Debt/Equity At:</td>
<td>Beta Over:</td>
<td>Book Value</td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------</td>
<td>------------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Obs.</td>
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<tr>
<td>1976 (cont)</td>
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<td>.910**</td>
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<td>.923**</td>
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<td>12/73 - 12/76</td>
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<td>.898**</td>
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<td>.961**</td>
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<td>.929**</td>
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<td>.930**</td>
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**Significant at .05 level.
*Significant at .10 level.
## Table 12
Sample 2 Regressions

<table>
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<tr>
<th>Debt/Equity At:</th>
<th>Beta Over:</th>
<th>Obs.</th>
<th>Book Value</th>
<th>Market Value</th>
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<td>$\hat{\gamma}_1$</td>
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<td>Book Value</td>
<td>Market Value</td>
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<td>(.071)</td>
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<td>.277**</td>
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</table>

**Significant at .05 level.
*Significant at .10 level.
slopes were significant at the .05 level and five more were significant at the .10 level. The Sample 2 regressions were considerably better for both the book and market value tests. All twenty regressions in both cases produced slopes that were significant at the .05 level.

Because of the possibility that outliers might be distorting the results, the regressions were reestimated without the firms which had the highest five percent of the debt/equity ratios. Recall that this procedure was earlier discussed. The argument for doing so relates to the possibility that a few extremely high debt/equity ratio firms might have had extremely high or low betas. Visual examination of the data raised this suspicion. This phenomenon would tend to pull the slope estimate considerably upwards or downwards. Since the debt/equity ratio is bounded on the lower end by zero, no real outliers exist at that end. With the outliers rejected, the regressions were reestimated and results are presented in Tables 13 and 14.

Overall it appears as if the outliers had the suspected effect. The Sample 1 regressions were improved and the Sample 2 regressions were slightly impaired. The Sample 1 book value regressions now produced twelve cases that were significant at the .05 level and one at the .10 level while the market value regressions resulted in seven being significant at the .05 level. The Sample 2 results had all twenty of the book value slopes being significant at the .05 level and twelve market value slopes being significant at the .05 level. The results from the two samples now appear to be quite similar and, thus, provide a satisfactory base from which to launch further tests. Although one may always be accused of manipulating the data when discarding observations, the
| Debt/Equity At: | Beta Over: | Book Value | | | Market Value |
|----------------|------------|------------|-----------|------------|
|                | Obs. | \( \hat{\gamma}_0 \) | \( \hat{\gamma}_1 \) | \( R^2 \) | Obs. | \( \hat{\gamma}_0 \) | \( \hat{\gamma}_1 \) | \( R^2 \) |
| 1978           | 12/75 - 12/78 | 55 | .834** (.092) | .561** (.210) | .119 | 57 | .916** (.077) | .205** (.117) | .052 |
|                | 12/74 - 12/78 | 55 | .805** (.078) | .428** (.178) | .099 | 57 | .815** (.064) | .251** (.098) | .106 |
|                | 12/73 - 12/78 | 55 | .916** (.057) | .114 (.130) | .014 | 57 | .964** (.046) | -.051 (.071) | .009 |
| 1977           | 6/76 - 6/79 | 56 | .931** (.106) | .476** (.239) | .068 | 56 | .953** (.085) | .300** (.154) | .066 |
|                | 12/72 - 12/77 | 56 | .854** (.055) | .278** (.124) | .085 | 56 | .918** (.044) | .011 (.078) | .000 |
|                | 12/73 - 12/77 | 56 | .812** (.065) | .265** (.146) | .057 | 56 | .905** (.052) | -.078 (.094) | .012 |
|                | 12/74 - 12/77 | 56 | .665** (.096) | .614** (.216) | .130 | 56 | .682** (.067) | .294** (.121) | .099 |
| 1976           | 6/75 - 6/78 | 57 | .583** (.096) | .580** (.225) | .108 | 56 | .667** (.083) | .300** (.173) | .053 |
|                | 12/74 - 12/78 | 57 | .780** (.079) | .499** (.184) | .118 | 56 | .790** (.054) | .319** (.113) | .128 |
|                | 6/74 - 6/79 | 57 | .850** (.060) | .330** (.140) | .092 | 56 | .935** (.049) | .002 (.101) | .000 |
| Debt/Equity At: | Beta Over: | Book Value | | Market Value | |
|---------------|------------|------------|---------------|--------------|
|               |            | Obs. | $\hat{\gamma}_0$ | $\hat{\gamma}_1$ | $R^2$ | Obs. | $\hat{\gamma}_0$ | $\hat{\gamma}_1$ | $R^2$ |
| 1976 (cont)   | 12/71 - 12/76 | 57  | .849** | .363** | .112 | 56  | .925** | .054 | .006 |
|               | 12/72 - 12/76 | 57  | .863** | .313** | .086 | 56  | .929** | .024 | .001 |
|               | 12/73 - 12/76 | 57  | .851** | .213  | .026 | 56  | .939** | -.137 | .025 |
| 1975          | 12/70 - 12/75 | 55  | .961** | .067  | .003 | 56  | .974** | -.006 | .000 |
|               | 12/71 - 12/75 | 55  | .934** | .008  | .000 | 56  | .957** | -.071 | .018 |
|               | 12/72 - 12/75 | 55  | .936** | -.006 | .000 | 56  | .953** | -.072 | .017 |
|               | 12/73 - 12/77 | 55  | .845** | .130  | .013 | 56  | .901** | -.065 | .016 |
|               | 6/74 - 6/77   | 55  | .848** | .090  | .004 | 56  | .897** | -.082 | .019 |
|               | 6/73 - 6/78   | 55  | .853** | .194* | .036 | 56  | .895** | .018  | .001 |
|               | 12/75 - 12/78 | 55  | .815** | .641** | .123 | 56  | .909** | .227** | .082 |

**Significant at .05 level.  
*Significant at .10 level.
<table>
<thead>
<tr>
<th>Debt/Equity At:</th>
<th>Beta Over:</th>
<th>Book Value</th>
<th>Market Value</th>
</tr>
</thead>
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<tr>
<td></td>
<td></td>
<td>Obs.</td>
<td>( \hat{\gamma}_0 )</td>
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<td>12/75 - 12/78</td>
<td>54</td>
<td>1.018**</td>
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<td></td>
<td></td>
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<td>(.123)</td>
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<tr>
<td></td>
<td>12/74 - 12/78</td>
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<td>1.061**</td>
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<td>(.091)</td>
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<td>12/73 - 12/78</td>
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<td>.993**</td>
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<td>.783**</td>
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<td>12/74 - 12/78</td>
<td>53</td>
<td>1.042**</td>
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<td>6/74 - 6/79</td>
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<td>.941**</td>
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<td>1976 (cont)</td>
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<td>12/71 - 12/76</td>
<td>53</td>
<td>1.073**</td>
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<td>(.073)</td>
<td>(.123)</td>
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<td>12/72 - 12/76</td>
<td>53</td>
<td>1.068**</td>
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<td>(.125)</td>
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<td></td>
<td>12/73 - 12/76</td>
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<td>(.143)</td>
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<td>1975</td>
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<td>.980**</td>
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<td>(.078)</td>
<td>(.114)</td>
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<td>54</td>
<td>1.048**</td>
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<td>(.073)</td>
<td>(.105)</td>
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<td></td>
<td>12/75 - 12/78</td>
<td>54</td>
<td>.959**</td>
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<td></td>
<td></td>
<td>(.121)</td>
<td>(.175)</td>
</tr>
</tbody>
</table>

**Significant at .05 level.
*Significant at .10 level.
apparent confirmation of the initial suspicions about the possible existence and effects of outliers would seem to be sufficient evidence in support of using the reduced samples.

An interesting result was the fact that the average intercept of the twenty book value regressions was 0.839 for Sample 1 and 1.020 for Sample 2. The intercept should be an estimate of the unlevered beta. The average unlevered beta from the 32 quarter estimation procedure was a surprisingly close 0.806 for Sample 1 and 1.049 for Sample 2. These results provide considerable support for using these statistical procedures for deriving unlevered beta estimates.

It was not expected that book and market value results would be approximately equal. The results were, however, quite encouraging in both samples. It would appear, nonetheless, that the book value measure of debt/equity is a better specification of leverage when using this model. For comparison with the bank sample results, it, therefore, seems especially appropriate to consider only the book value results since the bank market value regressions were unsatisfactory. For those reasons no further attention will be directed to the market value regressions. The implication is not that market value is an incorrect method of measuring leverage but that it simply serves no productive purpose in the remaining tests which involve a comparison of bank and firm regression results.

Comparison of Bank and Firm Results

In Chapter 4 Equation (4-9) was given as the correct relationship between leverage and beta for banks while Equation (4-10) was presumed to specify the relationship between leverage and beta for firms. The
difference between (4-9) and (4-10) is attributed to the $\frac{R_f}{E(R_Z)}$ factor, a parameter which as previously discussed lies in the zero to one range. The slope of (4-9) must be lower than the slope of (4-10). Empirically, this hypothesis would imply that $\gamma_1$ for banks should be significantly lower than $\gamma_1$ for firms. A t-test for the differences could be performed and in fact was performed. The results supported the hypothesis that $\gamma_1$ was lower for banks than for firms, but the results are not unbiased. The slope, $\gamma_1$, is linearly related to the intercept, $\gamma_0$, by virtue of the fact that the slope, theoretically $\beta_U(R_f/E(R_Z))(1 - \tau)$, contains the intercept $\beta_U$. The average bank intercept was .545 which as compared to average firm intercepts of .839 for Sample 1 and 1.020 for Sample 2 implies that the business risk (unlevered beta) for banks was somewhat lower than for firms. A lower business risk and regression intercept would tend to suppress the slope of the bank regressions.

Regardless of whether (4-9) or (4-10) were correct, the size of the financial risk premium is directly related to the business risk of the company. If the company begins with low business risk, investors require only small premiums for increments of financial leverage. If it begins with high business risk, then additional units of financial leverage require much higher risk premiums. Banks may have smaller financial risk premiums than some groups of firms such as these because their business risk is lower. Their asset portfolios are more liquid and their cash flows may be less uncertain than those of many firms. It would not be possible, therefore, to simply compare slope estimates. Some adjustment must be made to reflect the different degrees of business risk of the bank and firm samples.
Combining (4-9), (4-10), and (4-11), the slope parameter can be written as

\[ y_1 = \beta_0 K (1 - \tau) \]

where \( K = \begin{cases} \frac{R_f}{E(R_z)} & \text{for banks} \\ 1 & \text{for firms} \end{cases} \)

Noting that \( \gamma_0 \) should be equal to \( \beta_0 \) and \( 1 - \tau \) should equal .52 and substituting these identities reveals that

\[ y_1 = .52 \gamma_0 K. \] (5-2)

Now form the ratio of slope to intercept,

\[ y_1/y_0 = .52K, \] (5-3)

where \( y_1/y_0 = .52(R_f/E(R_z)) \) for banks and \( y_1/y_0 = .52 \) for firms.

Dividing by \( y_0 \) is tantamount to adjusting for different degrees of business risk, a procedure somewhat akin to normalizing variables measured in different units by dividing by their respective standard deviations. The ratios should hold regardless of any differences in intercepts. If \( y_0 \) is considerably smaller for banks than for firms, \( y_1 \) must be more than proportionately smaller for banks than firms for the overall ratio \( y_1/y_0 \) for banks to be lower than \( y_1/y_0 \) for firms. If the lower intercept is the only reason for the bank slope being lower than the firm slope, then the ratios \( y_1/y_0 \) for banks and firms would be equal.

The \( y_1/y_0 \) ratios can be easily estimated. The bank ratios should be tested against the null hypothesis that they are significantly less than .52, being brought down by the multiplicative effects of the
The firm ratios should be tested against the hypothesis that they are equal to .52. The test statistic is a "t" and is derived in Appendix H. Note that for the test to be valid \( \gamma_0 \) must be non-zero but since this point was previously statistically tested, no problems should arise.

The results of the tests are presented in Table 15. The null hypothesis that \( \gamma_1/\gamma_0 = .52 \) would be rejected in cases where \( \hat{\gamma}_1 \) is considerably smaller than \( .52\hat{\gamma}_0 \). A one-tailed test was used to reflect the fact that the ratio of \( R_f \) to \( E(\tilde{R}_z) \) for firms should be no larger than unity. Naturally statistical phenomena occasionally result in cases where \( R_f/E(\tilde{R}_z) \) for firms was greater than one. These instances showed up as positive t-statistics but they were neither large nor frequent enough to cause alarm.

Clearly the bank ratios were significantly less than .52 and the applicability of Equation (4-10) to banks is rejected. Equation (4-9) appears to be a much more suitable specification of the relationship between leverage and beta for banks. The results for firms, were somewhat mixed. Excepting the 1975 regressions, the results showed little support against the hypothesis that \( R_f/E(\tilde{R}_z) = 1 \) for firms. In only a couple of cases was the null rejected. The 1975 results, however, showed almost complete support for the hypothesis that \( \gamma_1/\gamma_0 < .52 \) and thus \( R_f/E(\tilde{R}_z) < 1 \) for firms. Several possible explanations can be considered.

The assumption is and has always been made that the ratio of \( R_f \) to \( E(\tilde{R}_z) \) is small enough to cause a significant difference in the bank and firm slopes. This assumption is equivalent to assuming that \( R_f/E(\tilde{R}_z) \) is less than one in a statistical sense, a seemingly plausible hypothesis.
### Table 15

**Tests of the Ratio $\gamma_1/\gamma_0$ for Banks and Firms**

*(Reduced Samples - Book Value)*

<table>
<thead>
<tr>
<th>Debt/Equity: Beta Over:</th>
<th>Banks Sample 1 $t^1$</th>
<th>Sample 2 $t^1$</th>
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<td>$\hat{\gamma}_1/\hat{\gamma}_0$</td>
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<tr>
<td>12/78 - 12/78</td>
<td>.031 &amp; -3.11**</td>
<td>.673 &amp; 0.54</td>
</tr>
<tr>
<td>12/74 - 12/78</td>
<td>.042 &amp; -2.83**</td>
<td>.532 &amp; 0.05</td>
</tr>
<tr>
<td>12/73 - 12/78</td>
<td>.072 &amp; -2.22**</td>
<td>.124 &amp; -2.49**</td>
</tr>
<tr>
<td>12/72 - 12/77</td>
<td>.061 &amp; -2.52**</td>
<td>.326 &amp; -0.90</td>
</tr>
<tr>
<td>12/74 - 12/77</td>
<td>.033 &amp; -3.13**</td>
<td>.923 &amp; 1.03</td>
</tr>
<tr>
<td>12/71 - 12/76</td>
<td>.078 &amp; -2.80**</td>
<td>.995 &amp; 1.03</td>
</tr>
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<td>12/74 - 12/78</td>
<td>.046 &amp; -2.74**</td>
<td>.389 &amp; -0.67</td>
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<tr>
<td>12/76 - 12/77</td>
<td>.080 &amp; -3.11**</td>
<td>.428 &amp; -0.48</td>
</tr>
<tr>
<td>12/73 - 12/77</td>
<td>.063 &amp; -3.17**</td>
<td>.363 &amp; -0.83</td>
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<td>.096 &amp; -2.17**</td>
<td>.250 &amp; -1.10</td>
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<td>.078 &amp; -2.23**</td>
<td>.070 &amp; -2.29**</td>
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<td>.154 &amp; -1.61*</td>
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<td>6/74 - 6/77</td>
<td>.067 &amp; -2.62**</td>
<td>.106 &amp; -1.63*</td>
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<td>6/73 - 6/78</td>
<td>.061 &amp; -3.11**</td>
<td>.227 &amp; -1.52*</td>
</tr>
<tr>
<td>12/75 - 12/78</td>
<td>.039 &amp; -3.62**</td>
<td>.787 &amp; 0.78</td>
</tr>
</tbody>
</table>

$1^H_0$: $\gamma_1/\gamma_0 = .52$ vs. $H_1$: $\gamma_1/\gamma_0 < .52$

Reject $H_0$ if $t < -1.29$ at $\alpha = .10$, $t < -1.66$ at $\alpha = .05$.

**Significant at .05 level.

*Significant at .10 level.

Naturally, some abnormalities could have existed in the 1975 debt/equity data. From Table 10 for Sample 1 the 1975 data had considerably greater skewness and kurtosis than the 1976-78 data. While this point could explain the results for Sample 1, it would not be a
factor in the Sample 2 results which would appear to be unexplainable. Note, however, that the regression of the 12/75 - 12/78 beta on the 1975 leverage produced similar and theoretically correct results for both samples. Quite possibly it would be more appropriate to place the debt/equity ratio at the beginning of the time period than at the end although this did not appear to be a problem with the bank results or over the other time periods.

Equation (4-9) seems likely to be a satisfactory specification of the bank relationship while Equation (4-10) is somewhat satisfactory for firms but certainly contains an element of doubt. What may be occurring is that there may be another multiplicative factor reflecting some unexplainable reason why marginal units of financial leverage do not increase beta on the order of \( \beta_U(1 - \tau) \). The evidence in favor of this unknown factor would support a traditionalist's view of corporate financial structure. Although this research does not purport to provide a direct test of the MM versus traditionalists controversy, the results do seem to favor the traditionalists. It will be recalled that when discussing the bank results, evidence of an unknown multiplicative factor was uncovered. The evidence has resurfaced in the firm regressions.

A final glance at the data still seem to support the theoretical model of bank financial structure. Although a direct test of the ratio \( \gamma_1/\gamma_0 \) for banks against firms is not available,\(^5\) casual examination of the ratios for banks compared to firms reveals that the bank ratios seem to be considerably smaller than the firm ratios. Some exceptions are

\(^5\)Such a test would require specification of non-linear functions of random variables and at this time seems impossible to develop.
in the 1975 results. Overall, however, the bank ratios are clustered in the range of .03 - .10. Of the twenty bank \( \hat{\gamma}_1/\hat{\gamma}_0 \) ratios, the average is .064 with a median of .065. For Sample 1 the average is .381 with a median of .360 and for Sample 2 the average is .391 with a median of .345. If the 1975 results are deleted, the results appear even better. For banks the average mean and median are nearly the same as before with both equal to .061. For Sample 1 the mean is .441 and the median is .461 while for Sample 2, the mean is .498 and the median is .511.

Although these observations are merely intuitive and not statistical, they appear to stand out quite noticeably.

Recapitulation

The empirical research on the bank financial structure model is now complete. The evidence reveals that the model is somewhat well supported and does seem to be properly specified. Banks would appear to command a borrowing advantage over firms. The advantage shows up as a smaller financial risk premium for banks than for firms. Even though banks undoubtedly have relatively low business risk, even after adjusting for differences in business risk, the advantage still remains.

Unfortunately, it is not possible to test alternative versions of the model. If that were possible, the results would indeed be interesting. Such tests, however, would require measurement of factors such as costs and service charges of deposits.\(^6\) No doubt these parameters have their individual and joint effects. Like many other imperfections they must often be disregarded in model building and testing.

\(^6\) A test of the single-period version of the model would require an estimation of the value of the bank's equity if it had only deposits and, moreover, would be a much more complex estimating equation.
The model is not an attempt to predict bank betas. Indeed any attempt to predict betas that ignores the "regression" tendency\(^7\) would surely provide poor estimates. The model is simply a method of "drawing some numbers out of the box" and determining whether they are consistent with the model's implications.

Most importantly, the evidence here should only be considered a modest dose of preliminary findings. Recall that the twenty regressions were not independent of each other and should not be viewed as additive evidence. Numerous other criticisms, discussed in Chapter 4, can also be easily levied. It is probably true that the theory like many others cannot really be "tested," but one should not infer that research which purports to provide some evidence is not worthwhile. Hopefully further research will reveal new insights into both the theoretical and empirical aspect of bank financial structure decisions.

Chapter 6

SUMMARY, CONCLUSIONS, AND IMPLICATIONS

The effect of financial leverage on valuation and shareholder wealth of the banking firm was examined both theoretically and empirically. It was assumed that market imperfections made possible the creation of a bank which would operate in capital, loan, and deposit markets. The valuation of equity shares was assumed to be described by Black's zero-beta version of the Capital Asset Pricing Model. Although the Black model is a perfect market model, it served as a framework within which imperfections could be introduced.

A firm operating in a market without an intermediary was converted to a bank, charged with the responsibility of providing banking services, and allowed to issue demand deposits. The deposits were of the form of an initial inflow followed by outflows which equal inflows so that a constant level of deposit financing was maintained. A perpetuity model was assumed in the text although a single-period version was presented in an appendix. No taxes were assumed. Deposits were initially considered to be costless, riskless, non-interest bearing, and requiring no reserves. It was shown that the value of the bank and the wealth of its shareholders would be increased by using deposit leverage. It was later verified that the presence of costly deposits, interest on deposits, and reserve requirements would reduce the benefits offered by deposit leverage but would not likely eliminate them. Required rate of return and cost of capital formulas were derived and reflected the advantage of deposits as a source of financing.
A second form of financing was introduced. Banks were allowed to issue risk free interest-bearing liabilities. It was proven that the use of this form of leverage was also advantageous to banks and their owners but less so than were deposits. An incentive for banks to maximize their use of such financing was shown to exist. Required rate of return and cost of capital formulas under this form of financing were presented and they also reflected the advantage of this source of financing.

Empirical tests examined the effects of financial leverage on the systematic risk of banks. It was proven that if banks possess an advantage over non-banks (firms) in their financing activities, then that advantage would be reflected in smaller increases in systematic risk as units of financial leverage are added. Data from samples of banks and firms were tested for evidence of this phenomenon. A number of different time periods were examined and the majority of the tests supported the theory. Given that this evidence is preliminary in nature, and further testing is needed, the theory was tentatively accepted.

If banks do possess an advantage in their use of leverage, it is no surprise then that they appear to maximize the use of debt financing. Since such an advantage is a result of the imperfections of the marketplace and the need for the services of financial intermediaries, the benefits to their shareholders represent the incentives necessary to induce risk-takers to become intermediaries.

It is often argued that banks are too heavily leveraged. While this statement may have some truth to it, the fact is that leveraging is an essential function of an intermediary and must be done in order for a firm to operate as an intermediary. Since society expects banks to lever themselves more heavily than non-banks and the imperfect nature of the
market provides an incentive for them to do so, it makes little sense to complain that banks use too much leverage. Nonetheless, the model does point out that a wealth transfer from depositors to bank shareholders occurs. Like a form of windfall gain, society should recognize that any attempt to reduce this gain whether by taxation or by restrictions on bank leverage will result in a much lower level of intermediation services. Take away the incentive to be an intermediary and you reduce the level of savings in the economy. Reduce the level of savings and you reduce the level of investment and economic growth. This fact can be easily seen by considering the effect of the bank's financing advantage on its required rate of return on projects.

It was shown in Chapter 3 that the advantage of deposit and credit market financing served to reduce the bank's required rate of return on projects (loans). The bank will not lend unless it can earn its required rate of return. Thus, by keeping the required rate of return as low as possible, an incentive exists for banks to lend because more projects will have positive net present values than if the required rate of return were higher. This lending, of course, is desirable in a growing economy. Even during periods of high inflation when such lending may not be desired, there are temporary means such as reductions in the money supply of reducing bank lending that do not permanently eradicate the incentive to lend.

Given that an incentive exists for banks to borrow and lend, the wealth transfer previously mentioned is converted into a greater level of economic growth which, of course, benefits society. Thus, even though banks would appear to benefit greatly at the expense of the public, they
should not be restricted from doing so. Here the "invisible hand" paradigm of Adam Smith\(^1\) applies. We all benefit.

The model was developed under the assumption that the bank's shares were publicly traded in an efficient market. Obviously such a restriction eliminates many of the 14,000 banks in this country. For those to which it does apply, however, the correct assessment by investors of the business and financial risk of the bank serves as a deterrent to the use of excessive leverage or otherwise engaging in extremely high risk projects. Thus, the capital markets should be capable of regulating those banks without government intervention. Given the evidence provided here which indicates that the market is apparently capable of recognizing the effect of leverage on equity risk, it is strongly argued that capital adequacy controls on those banks be dropped.

For those banks which do not have shares publicly traded in an efficient market, this model provides no guidelines. It is somewhat disappointing to be compelled to conclude that regulators can serve a useful function here; but until a practical model of small bank equity risk comes along and suggests otherwise, public regulation would appear to be the only choice.

A final word is in order about the banking practice called "spread management." In Chapter 1 it was noted that "spread management banking" seems to be inconsistent with the MM theory of finance. Bank hurdle rates appear to be somewhat less than a simple weighted average cost of capital and are probably tied to the cost of debt. According to the

theory presented here, the weighted average cost of capital as it is usually derived for firms is not strictly applicable to banks. It should incorporate the advantage that banks possess in their financing operations. This advantage is built into the required rate of return formulas of Chapter 3 and suggests that the theoretical hurdle rates on banks may be very close to the hurdle rates determined in practice. Thus, "spread management" bankers may have already been considering the relative advantage of debt financing when estimating hurdle rates. Non-separation of investment and financing decisions for banks may hold both theoretically and in the real world.

Much work remains to be done before the issues in bank financial structure theory are clearly resolved. More sophisticated models under relaxed assumptions and complete models of market equilibrium with financial intermediation would be desirable goals for further research. Likewise, further empirical evidence on the effects of financial leverage on risk for both banks and firms is needed. Attempts to provide such evidence will present formidable challenges given statistical and data availability problems. The probability of success, however, is not sufficiently small to deter future efforts.
BIBLIOGRAPHY

Books


Periodicals


**Other**


APPENDIX A

THE RELATIONSHIP BETWEEN VALUATION, SHAREHOLDER WEALTH, AND EQUITY PRICE

Theorem A.1: Any change in the value of the firm is accompanied by an equal change in the same direction of shareholder wealth.

Proof: Define shareholder wealth of the levered and unlevered firms as $SHW_L$ and $SHW_U$, respectively. By definition $SHW_U = S_U$, the value of their equity in the unlevered firm. If $D_L$ of debt is issued and the proceeds are used to repurchase shares, then shareholder wealth of the levered firm will equal the cash received from the sale of the shares which equals $D_L$ plus the resulting value of their shares, or

$$SHW_L = S_L + D_L.$$ 

It is now apparent that since $V_U = S_U$, $SHW_U = V_U$; and because $V_L = S_L + D_L$, $SHW_L = V_L$. Clearly, any increase or decrease in the value of the firm results in an equivalent increase or decrease in shareholder wealth.

Q.E.D.

Theorem A.2: Any change in the value of the firm, and therefore, shareholder wealth, results in a change in the same direction in the equity price.

Proof: The price of the levered firm's equity is given as

$$P_L = S_L/N_L$$

where $S_L$ is the market value of the levered firm's equity as before and $N_L$ is the number of shares. The price, $P_L$, can also be written as
\[
P_L = \frac{V_L - D_L}{N_L} \quad (A-1)
\]

since \( S_L = V_L - D_L \). The value of the levered firm will equal the value of the unlevered firm plus any change in the value of the unlevered firm, or \( V_L = V_U + dV_U \); therefore, by substituting this definition into (A-1), \( P_L \) is given as

\[
P_L = \frac{V_U + dV_U - D_L}{N_L}. \quad (A-2)
\]

The change in stock price is given as

\[
dP = P_L - P_U. \quad (A-3)
\]

The value of the unlevered firm is defined as \( V_U = N_U P_U \) or the number of shares times the price per share. Substituting this definition for \( V_U \) in (A-2), then substituting (A-2) into (A-3), and putting terms over the same denominator gives

\[
dP = \frac{N_U P_U + dV_U - D_L - P_U N_U}{N_L} \quad (A-4)
\]

The number of levered shares is given as \( N_L = N_U - D_L/P_U \). Substituting this definition for \( N_L \) in the numerator leaves

\[
dP = \frac{N_U P_U + dV_U - D_L - P_U(N_U - D_L/P_U)}{N_L} \quad (A-5)
\]

which simplifies to

\[
dP = \frac{dV_U}{N_L}. \quad (A-6)
\]

Obviously, \( dP \geq 0 \) as \( dV_U \geq 0 \) and vice versa. So, price, value, and shareholder wealth all vary directly. Note that no assumptions have been made about the type of valuation process so these statements apply to the bank model presented in the text, the MM model, or any other model.

Q.E.D
APPENDIX B

THE MODEL IN A SINGLE-PERIOD WORLD

Deposit Financing

Since the levered firm must repay $D_d$ one period later, let the return to the unlevered and levered firms' shareholders be given as

$$E(R_U) = \frac{E(\tilde{\text{NOI}})}{S_U} - 1 = E(\tilde{R}_z) + \lambda \text{cov}(\tilde{R}_U, \tilde{R}_m) \quad (B-1)$$

$$E(R_L) = \frac{E(\tilde{\text{NOI}})}{S_L} - \frac{D_d}{1 + E(\tilde{R}_z)} - 1 = E(\tilde{R}_z) + \lambda \text{cov}(\tilde{R}_L, \tilde{R}_m). \quad (B-2)$$

Rewrite (B-1) and (B-2) to isolate $E(\tilde{\text{NOI}})$ and equate these results. Proceeding as in the text produces the valuation equation

$$V_L = V_U + D_d \left[ \frac{E(\tilde{R}_z)}{1 + E(\tilde{R}_z)} \right]. \quad (B-3)$$

The last term in brackets is positive and equal to $1 - 1/(1 + E(\tilde{R}_z))$ reflecting the fact that the increase in the value of the bank of $D_d$ (the perpetuity case) is reduced by the present value of the repayment of principle. Note that the appropriate discount rate is $E(\tilde{R}_z)$, the riskless rate, because the deposits are considered to be riskless.

The required equity return derivation follows essentially the same procedure as in the text where the required equity return for the case of credit market financing was derived. Algebraic details are omitted.

*In the perpetuity case the value of the levered firm did include the present value of the principle repayment discounted at the riskless rate, $E(\tilde{R}_z)$, and could have been given as $V_L = V_U + D_d - D_d/(1 + E(\tilde{R}_z))^{\infty}$ but the last term is zero so the principle repayment has no present value.
but the final equation is given as
\[
E(\tilde{R}_L) = E(\tilde{R}_U) + \left[ E(\tilde{R}_U) - E(\tilde{R}_Z) \right] \frac{Dd}{S_L \left[ 1 + E(\tilde{R}_Z) \right]}.
\] (B-4)

The last (bracketed) term is positive but less than one and dampens the effects of the increase in leverage.

Credit Market Financing

Let the levered firm issue \( D_1 \) of interest-bearing debt at an interest rate of \( R_f \) promising to repay the debt one period later. The expected returns of the firm levered with deposits, \( E(\tilde{R}_L) \), and the firm levered with deposits and interest-bearing debt, \( E(\tilde{R}_L') \), are given as
\[
E(\tilde{R}_L) = \frac{E(\text{NOI}) - Dd}{S_L} - 1 = E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{R}_L, \tilde{R}_m) \] (B-5)
\[
E(\tilde{R}_L') = \frac{E(\text{NOI}) - Dd - D_1(1 + R_f)}{S_L} - 1 = E(\tilde{R}_Z) + \lambda \text{cov}(\tilde{R}_L', \tilde{R}_m). \] (B-6)

Following the same procedure as before it is found that
\[
V_L' = V_L + D_1 \left[ \frac{E(\tilde{R}_Z) - R_f}{1 + E(\tilde{R}_Z)} \right]. \] (B-7)

Again, credit market leverage increases the value of the firm as long as \( E(\tilde{R}_Z) \) exceeds \( R_f \), a necessary condition of the Black model. Compare this result to Equation (3-25) of the text. The bracketed term in (3-25) is equal to \( (E(\tilde{R}_Z) - R_f)/E(\tilde{R}_Z) \) which is greater than the bracketed term in (B-7). When noting that the second term in (B-7) can be written as \( D_1 - D_1(1 + R_f)/(1 + E(\tilde{R}_Z)) \), it is clear that the reduction in the increase in bank value is in an amount equal to the present value of the repayment of the principle. For example, the second term in (B-7) can be compared to the second term in (3-25) or \( D_1 - D_1 R_f/E(\tilde{R}_Z) \). The difference is obviously the present value of the principle repayment taking into account the different discount factors in the two cases.
The required equity return is easily derived and is given as

\[ E(\tilde{R}_L') = E(\tilde{R}_L) + \left[ E(\tilde{R}_L') - E(\tilde{R}_Z) \right] \frac{D_0}{S_0} \frac{1 + R_f}{1 + E(R_2)}. \]  \hspace{1cm} (B-8)

The difference between the single-period and perpetuity cases is that here the last term in (B-8) is larger albeit not large enough to completely offset the advantage brought about by borrowing in the credit markets. In both cases the additional risk premium resulting from the increase in leverage is dampened by the advantage that banks possess in the credit markets.
APPENDIX C

LISTING OF BANK SAMPLE

Bank of New York Co., Inc.
Bankers Trust New York Corp.
Charter New York Corp.
Chase Manhattan Corp.
Chemical New York Corp.
Citicorp
Manufacturers Hanover Corp.
J. P. Morgan & Co.
U. S. Trust Co.
Continental Illinois Corp.
First Chicago Corp.
First National Boston Corp.
Harris Bankcorp Inc.
Mellon National Corp.
Northern Trust Corp.
Shawmut Corp.
State Street Boston Corp.
Baybanks Inc.
CBT Corp.
Continental Bank-Norristown, N.J.
Fidelcor
Fidelity Union Bancorp
First Commercial Bank Holding Co.
First Empire State Corp.
First National State Bancorp
First Pennsylvania Corp.
Girard Co.
Greater Jersey Bancorp
Hartford National Corp.
Heritage Bancorp
Hospital Trust Corp.
Industrial National Corp.
Industrial Valley Bank & Trust
Lincoln First Banks
Marine Midland Banks
Midlantic Banks Inc.
National Central Financial Corp.
New England Merchants Inc.
Philadelphia National Corp.
Provident National Corp.
Republic New York Corp.
United Bank Corp. of New York
United Jersey Banks
Alabama Bancorporation

Banco Popular de Puerto Rico
Bank of Virginia Co.
Barnett Banks of Florida
Citizens & Southern National Bank
Dominion Bankshares
Financial General Bankshares
First & Merchants
First Alabama Bancshares
First Florida Banks Inc.
First Kentucky National
First Maryland Bancorp.
First National Holding Corp.
First Tennessee National Corp.
First Union Corp.
First Virginia Bankshares
Flagship Banks
Florida National Banks
Maryland National Corp.
NCNB Corp.
Northwestern Financial Corp.
Riggs National Bank
South Carolina National Corp.
Southeast Banking Corp.
Sun Banks of Florida
Tennessee Valley Bancorp.
Third National Corp.
Trust Company of Georgia
Union Planters Corp.
United Virginia Bankshares
Virginia National Bankshares
Wachovia Corp.
American Fletcher Corp.
Bancohio Corp.
Bank of Commonwealth
Central Bancorporation Inc.
Centran Corp.
Clevetrust Corp.
Commerce Bancshares
Detroitbank Corp.
Equimark Corp.
First Banc Group of Ohio
First Bank System Inc.
First National Charter Corp.
First National Cincinnati Corp.
General Bancshares
Huntington Bancshares
Indiana National Corp.
Manufacturers National Corp.
Marine Corp.
Marshall & Ilsley Corp.
Mercantile Bancorporation
Michigan National Corp.
National City Corp.
National Detroit Corp.
Northern States Bancorporation
Northwest Bancorporation
Old Kent Financial Corp.
Pittsburgh National Corp.
Society Corp.
Union Commerce Corp.
Union National Bank
Arizona Bank
Colorado National Bankshares
First City Bancorp.
First International Bancshares
First National Bancorporation
American Security Corp.
Atlantic Bancorp.
First Security Corp.
First United Bancorp.
Liberty National Corp.
Mercantile Texas Corp.
Republic of Texas Corp.
Southwest Bancshares
Texas American Bancshares
Texas Commerce Bancshares
United Banks of Colorado
Valley National Bank
Bancal Tri-State Corp.
Bankamerica Corp.
Crocker National Corp.
First Hawaiian Inc.
Hawaii Bancorp Inc.
Rainier Bancorp.
Seafirst Corp.
Security Pacific Corp.
Union Bancorp Inc.
U. S. Bancorp.
Wells Fargo & Co.
Western Bancorporation
First Union Bancorporation
First Wisconsin Corp.
## APPENDIX D

### LISTING OF FIRM SAMPLE 1

<table>
<thead>
<tr>
<th>Name of Firm</th>
<th>SIC Industry Name</th>
</tr>
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<tbody>
<tr>
<td>Day Mines Inc.</td>
<td>Metal Mining</td>
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<tr>
<td>Inexco Oil</td>
<td>Crude Petroleum &amp; Natural Gas</td>
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<td>Superior Oil</td>
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<td>Schlumberger Ltd.</td>
<td>Drilling Oil &amp; Gas Wells</td>
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<td>Kraft Inc.</td>
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<td>Heileman (G.) Brewing Inc.</td>
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<td>Stange Co.</td>
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<td>Union Carbide Corp.</td>
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<td>Lilly (Eli) &amp; Co.</td>
<td>Drugs</td>
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<td>Pfizer Inc.</td>
<td>Drugs</td>
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<td>Smithkline Corp.</td>
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<td>Nestle-Lemur Co.</td>
<td>Perfumes Cosmetics Toiletries</td>
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<td>Shell Oil Co.</td>
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<td>Standard Oil Co. (Calif.)</td>
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<tr>
<td>Carlisle Corp.</td>
<td>Rubber &amp; Misc. Plastics Products</td>
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<tr>
<td>Goodyear Corp.</td>
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<td>Rogers Corp.</td>
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<td>Bethlehem Steel Corp.</td>
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<td>Copperweld Corp.</td>
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<td>Preston Mines Ltd.</td>
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</tr>
<tr>
<td>U. S. Steel Corp.</td>
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<tr>
<td>Eastern Co.</td>
<td>Misc. Metal Works</td>
</tr>
<tr>
<td>Robertson (H. H.) Co.</td>
<td>Misc. Metal Works</td>
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SPS Technologies Inc.
Raymond Industries
Barnes Group Inc.
CMI Corp.
Brown & Sharpe Manufacturing Co.
Mesta Machine Co.
Torin Corp.
International Business Machines
Health-Mor Inc.
Martin-Marietta Corp.
Smith's Transfer
Overseas Shipholding Group
PSA Inc.
Pioneer Corp.
Wilshire Oil of Texas
Nashua Corp.
Safeway Stores Inc.
Fairmount Chemical Co., Inc.

Bolts-Nuts-Screws-Rivets-Washers
Ordnance & Accessories
Fabricated Metal Products NEC
Construction Machinery & Equipment
Metalworking Machinery & Equipment
General Industrial Machinery & Equip.
General Industrial Machinery & Equip.
Office Computing & Accounting Mchs.
Household Appliances
Guided Missiles & Space Vehicles
Trucking-Local & Long Distance
Water Transportation
Air Transportation-Certified
Natural Gas Transmission-Distr.
Wholesale-Elec. Parts & Equip.
Wholesale-Machinery & Equipment
Retail-Grocery Stores
Misc. Chemical Products
## APPENDIX E

### LISTING OF FIRM SAMPLE 2

<table>
<thead>
<tr>
<th>Name of Firm</th>
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<tr>
<td>Eastern Gas &amp; Fuel Association</td>
<td>Bituminous Coal &amp; Lignite Mining</td>
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<td>McIntyre Mines Ltd.</td>
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<tr>
<td>Westmoreland Coal Co.</td>
<td>Bituminous Coal &amp; Lignite Mining</td>
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<td>Dome Petroleum Ltd.</td>
<td>Crude Petroleum &amp; Natural Gas</td>
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<tr>
<td>Hime Oil Co-Cl A</td>
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<tr>
<td>Louisiana Land &amp; Exploration</td>
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<tr>
<td>Nabisco Inc.</td>
<td>Food &amp; Kindred Products</td>
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<td>Dellwood Foods</td>
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<td>Wrigley (Wm.) Jr. Co.</td>
<td>Candy &amp; Other Confectionery</td>
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<td>Olympia Brewing</td>
<td>Malt Beverages</td>
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<td>Pepcom Industries</td>
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<td>U. S. Tobacco Co.</td>
<td>Cigars</td>
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<td>Textile Mill Products</td>
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<td>Triangle Pacific Corp.</td>
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<td>Technical Tape Inc.</td>
<td>Convert Paper-Paperboard Products</td>
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<td>Blair (John) &amp; Co.</td>
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<td>Standard Register Co.</td>
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<td>Petroleum Refining</td>
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<td>General Portland Inc.</td>
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<td>Lukens Steel Co.</td>
<td>Cement Hydraulic</td>
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<td>Harsco Corp.</td>
<td>Blast Furnaces &amp; Steel Works</td>
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<td>Crown Cork &amp; Seal Co., Inc.</td>
<td>Second Smelting-Refining Nonferrous</td>
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<td>Citation Companies</td>
<td>Metal Cans &amp; Shipping Containers</td>
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<td>Caterpillar Tractor Co.</td>
<td>Heating Equipment &amp; Plumbing Fixtures</td>
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<td>Texas International Co.</td>
<td>Construction Machinery &amp; Equipment</td>
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<td>Bethlehem Corp.</td>
<td>Oil Field Machinery &amp; Equipment</td>
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<td>Xerox Corp.</td>
<td>Special Industry Machinery</td>
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<td>Clarostat Manufacturing Co., Inc.</td>
<td>Office Computing &amp; Accounting Mchs.</td>
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<td>Edo Corp.</td>
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<td>Sealectro Corp.</td>
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<td>Electronic Components N E C</td>
</tr>
</tbody>
</table>
Champion Spark Plug
Smith (A. O.) Corp.
American Sterilizer Co.
Branch Industries
Yellow Freight System
Seaboard World Airlines
LSB Industries Inc.
Pittston Co.
Franks Nursery Sales
United Financial of California
Pulte Home Corp.
Webb (Del E.) Corp.
Servisco
U. S. Leasing International Inc.

Electrical Machinery & Equipment
Motor Vehicle Parts-Accessories
Surgical & Medical Instruments
Trucking-Local & Long Distance
Trucking-Local & Long Distance
Air Transportation-Certified
Wholesale-Machinery & Equipment
Wholesale-Nondurable Goods N E C
Retail-Stores N E C
Savings & Loan Associations
Subdivision Development
Hotel-Motels
Service-Linen Supply
Service-Equipment Rental & Leasing
### APPENDIX F

SAMPLE STATISTICS FROM DISTRIBUTIONS

OF UNLEVERED BETAS AND RETURNS

Samples 1 and 2

<table>
<thead>
<tr>
<th>Sample 1 (N = 61)</th>
<th>$\hat{\beta}_U$</th>
<th>$\sigma(\hat{\beta}_U)$</th>
<th>$\hat{R}_{Ut}$</th>
<th>$\sigma(\hat{R}_{Ut})$</th>
<th>$R^2$</th>
<th>Durbin-Watson</th>
<th>Skewness*</th>
<th>Kurtosis*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>.806</td>
<td>.266</td>
<td>.034</td>
<td>.152</td>
<td>.269</td>
<td>2.101</td>
<td>.372</td>
<td>.534</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>.056</td>
<td>.091</td>
<td>.017</td>
<td>.040</td>
<td>.118</td>
<td>.374</td>
<td>.532</td>
<td>1.474</td>
</tr>
<tr>
<td>Std. Error of Mean</td>
<td>.007</td>
<td>.012</td>
<td>.002</td>
<td>.005</td>
<td>.015</td>
<td>.047</td>
<td>.068</td>
<td>.187</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.075</td>
<td>.776</td>
<td>.404</td>
<td>.891</td>
<td>.597</td>
<td>-0.213</td>
<td>1.556</td>
<td>1.553</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-1.247</td>
<td>.196</td>
<td>.054</td>
<td>.336</td>
<td>-0.418</td>
<td>-0.485</td>
<td>.445</td>
<td>2.482</td>
</tr>
<tr>
<td>Maximum</td>
<td>.900</td>
<td>.510</td>
<td>.080</td>
<td>.260</td>
<td>.540</td>
<td>2.840</td>
<td>1.930</td>
<td>5.820</td>
</tr>
<tr>
<td>Minimum</td>
<td>.710</td>
<td>.140</td>
<td>.000</td>
<td>.100</td>
<td>.080</td>
<td>1.200</td>
<td>-0.720</td>
<td>-1.090</td>
</tr>
<tr>
<td>Percentiles:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>99th</td>
<td>.894</td>
<td>.504</td>
<td>.074</td>
<td>.260</td>
<td>.534</td>
<td>2.834</td>
<td>1.676</td>
<td>5.206</td>
</tr>
<tr>
<td>95th</td>
<td>.880</td>
<td>.410</td>
<td>.060</td>
<td>.220</td>
<td>.499</td>
<td>2.644</td>
<td>1.302</td>
<td>3.244</td>
</tr>
<tr>
<td>90th</td>
<td>.870</td>
<td>.380</td>
<td>.050</td>
<td>.200</td>
<td>.436</td>
<td>2.534</td>
<td>1.048</td>
<td>2.634</td>
</tr>
<tr>
<td>10th</td>
<td>.730</td>
<td>.150</td>
<td>.010</td>
<td>.110</td>
<td>.130</td>
<td>1.622</td>
<td>-0.304</td>
<td>-0.854</td>
</tr>
<tr>
<td>5th</td>
<td>.711</td>
<td>.141</td>
<td>.010</td>
<td>.100</td>
<td>.103</td>
<td>1.393</td>
<td>-0.412</td>
<td>-0.997</td>
</tr>
<tr>
<td>1st</td>
<td>.710</td>
<td>.140</td>
<td>.000</td>
<td>.100</td>
<td>.080</td>
<td>1.200</td>
<td>-0.720</td>
<td>-1.090</td>
</tr>
</tbody>
</table>

| Sample 2 (N = 57) |                |                         |                |                         |      |               |           |           |
| Mean             | 1.049          | .304                    | .032           | .180                    | .318 | 2.045         | .630      | .994      |
| Standard deviation | .061           | .091                    | .021           | .038                    | .137 | .417          | .708      | 2.037     |
| Std. Error of Mean | .008           | .012                    | .003           | .005                    | .018 | .055          | .094      | .270      |
| Skewness         | -0.053         | .103-0.424              | .304           | .107                    | -0.627| .423          | 2.894     |           |
| Kurtosis         | -1.367-0.479   | .242                    | .510           | .430                    | 1.918 | .792          | 10.377    |           |
| Maximum          | 1.150          | .500                    | .070           | .270                    | .670 | 3.04          | 2.760     | 10.980    |
| Minimum          | .950           | .140-0.030              | .120           | .120                    | .120 | .072          | -0.940    | -0.970    |
| Percentiles:     |                |                         |                |                         |      |               |           |           |
| 99th             | 1.144          | .500                    | .070           | .264                    | .659 | 2.937         | 2.395     | 7.982     |
| 95th             | 1.315          | .446                    | .061           | .243                    | .608 | 2.596         | 1.926     | 5.400     |
| 90th             | 1.130          | .409                    | .052           | .223                    | .507 | 2.445         | 1.366     | 2.262     |
| 10th             | .960           | .177                    | .000           | .130                    | .170 | 1.607         | -0.260    | -0.468    |
| 5th              | .960           | .140-0.002              | .120           | .140                    | .140 | 1.257         | -0.543    | -0.577    |
| 1st              | .950           | .140-0.030              | .120           | .120                    | .720 | -0.940        | -0.970    |           |

*Both Skewness and Kurtosis should equal zero in a normal distribution
APPENDIX G

ECONOMETRIC IMPLICATIONS OF MEASUREMENT ERROR IN THE DEPENDENT VARIABLE

The true relationship between \( Y_i \) and \( X_i \) is given as

\[
Y_i = \alpha + \beta X_i + \varepsilon_i. \tag{G-1}
\]

The assumptions are

\[
\begin{align*}
E(\varepsilon_i) &= 0 \\
E(\varepsilon_i \varepsilon_j) &= 0, \ i \neq j \\
\sigma^2(\varepsilon_i) &= \sigma^2 \varepsilon \\
\text{cov}(X_i, \varepsilon_i) &= 0 \\
\beta &= \frac{\text{cov}(Y_i, X_i)}{\sigma^2(X_i)} \\
\alpha &= E(Y_i) - \beta E(X_i).
\end{align*}
\]

Assume that the dependent variable, \( Y_i \), is measured with error, \( v_i \), so that

\[
Y_i* = Y_i + v_i. \tag{G-2}
\]

It is assumed that

\[
\begin{align*}
E(v_i) &= 0 \\
\text{cov}(v_i, \varepsilon_i) &= 0 \\
\text{cov}(v_i, Y_i) &= 0 \quad E(v_i v_j) = 0, \ i \neq j \\
\text{cov}(v_i, X_i) &= 0 \\
\sigma^2(v_i) &= \sigma^2 v.
\end{align*}
\]

The model being estimated is, therefore,

\[
Y_i* = \alpha* + \beta* X_i + \omega_i \tag{G-3}
\]

with assumptions

\[
\begin{align*}
E(\omega_i) &= 0 \\
E(\omega_i \omega_j) &= 0, \ i \neq j \\
\sigma^2(\omega_i) &= \sigma^2 \omega \\
\text{cov}(X_i, \omega_i) &= 0 \\
\beta* &= \frac{\text{cov}(Y_i*, X_i)}{\sigma^2(X_i)} \\
\alpha* &= E(Y_i*) - \beta* E(X_i).
\end{align*}
\]

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Substituting (G-2) for $Y_i^*$ in the above definitions of $\alpha^*$ and $\beta^*$ reveals that

$$\beta^* = \frac{\text{cov}(Y_i + \nu_i, X_i)}{\sigma^2(X_i)} = \frac{\text{cov}(Y_i, X_i)}{\sigma^2(X_i)} = \beta \quad (G-4)$$

$$\alpha^* = E(Y_i + \nu_i) - \beta^*E(X_i) = E(Y_i) - \beta E(X_i) = \alpha. \quad (G-5)$$

Since $\alpha^*$ and $\beta^*$ are equal to $\alpha$ and $\beta$, their estimators retain the small sample and asymptotic properties of best linear unbiased estimators. Kmenta discusses this result in the generalized errors-in-equation model.*

**Examination of the Variances of the Residual and OLS Estimators**

The variance of the residuals from the regression containing measurement error in the dependent variable overstates the true variance in the correctly measured regression.

Proof:

Substitute (G-2) into (G-3):

$$Y_i + \nu_i = \alpha^* + \beta^*X_i + \omega_i. \quad (G-6)$$

Noting that $\alpha^* = \alpha$ and $\beta^* = \beta$ and given that $\omega_i = Y_i + \nu_i - \alpha^* - \beta^*X_i$,

$\sigma^2_\omega$ is given as

$$\sigma^2_\omega = \sigma^2(Y_i) + \sigma^2(\nu_i) + \beta^2 \sigma^2(X_i) - 2\beta \text{cov}(Y_i, X_i). \quad (G-7)$$

The term $-2\beta \text{cov}(Y_i, X_i)$ may be written as $-2\beta^2 \sigma^2(X_i)$ and, therefore, (G-7) may be written as

$$\sigma^2_\omega = \sigma^2(Y_i) + \sigma^2(\nu_i) - \beta^2 \sigma^2(X_i). \quad (G-8)$$

Now examine $\sigma^2_\varepsilon$ given that $\varepsilon_i = Y_i - \alpha - \beta X_i$.

$$\sigma^2_\varepsilon = \sigma^2(Y_i) + \beta^2 \sigma^2(X_i) - 2\beta \text{cov}(Y_i, X_i). \quad (G-9)$$

Note that the last term may be written as \(-2\beta^2\sigma^2(X_i)\). Substituting this result leaves

\[ \sigma^2_{\varepsilon} = \sigma^2(Y_i) - \beta^2\sigma^2(X_i). \]  

(G-10)

Comparing (G-10) to (G-8) reveals that

\[ \sigma^2_{\omega} > \sigma^2_{\varepsilon}. \]  

(G-11)

Given that the variance of the residuals is overstated, the variance of the OLS estimators will be similarly affected. It is easily seen that

\[ \sigma^2(\hat{\beta}^\ast) = \frac{\sigma^2_{\omega}}{\sum_i(X_i - \bar{X})^2} > \sigma^2(\hat{\beta}) = \frac{\sigma^2_{\varepsilon}}{\sum_i(X_i - \bar{X})^2} \]  

(G-12)

and

\[ \sigma^2(\hat{\alpha}^\ast) = \frac{1/n + \sigma^2_{\omega}}{\sum(X_i - \bar{X})^2} > \sigma^2(\hat{\alpha}) = \frac{1/n + \sigma^2_{\varepsilon}}{\sum(X_i - \bar{X})^2}. \]  

(G-13)
The test is derived for the following hypotheses:

$$H_0: \gamma_1/\gamma_0 = .52 \quad H_1: \gamma_1/\gamma_0 < .52$$

which can be more conveniently written as

$$H_0: \gamma_1 - .52\gamma_0 = 0 \quad H_1: \gamma_1 - .52\gamma_0 < 0.$$ 

The expression $\gamma_1 - .52\gamma_0$ is a linear combination of normally distributed random variables and is, therefore, normally distributed and given as

$$\hat{\gamma}_1 - .52\hat{\gamma}_0 \sim \text{N}(\gamma_1 - .52\gamma_0, \text{Var}(\gamma_1 - .52\gamma_0)),$$

where

$$\text{Var}(\gamma_1 - .52\gamma_0) = \text{Var}(\gamma_1) + (.52)^2\text{Var}(\gamma_0) - 2(.52)\text{Cov}(\gamma_1, \gamma_0).$$

The variances and covariances of $\hat{\gamma}_1$ and $\hat{\gamma}_0$ are given as

$$\text{Var}(\hat{\gamma}_1) = \sigma^2(1/\Sigma X^2)$$

$$\text{Var}(\hat{\gamma}_0) = \sigma^2(1/n + \bar{X}^2/\Sigma X^2)$$

$$\text{Cov}(\hat{\gamma}_1, \hat{\gamma}_0) = \sigma^2(-\bar{X}/\Sigma X^2)$$

where $\sigma^2 = \text{the population variance of the residual}$

$\Sigma X^2 = \text{the sum of squares (in deviation form) of the independent variable } X$

$n = \text{the number of observations}$

$\bar{X} = \text{the mean of the sample observations of } X.$
The variance of \( \hat{\gamma}_1 - .52\hat{\gamma}_0 \) can now be written as
\[
\text{Var}(\hat{\gamma}_1 - .52\hat{\gamma}_0) = \sigma^2 \left[ \frac{1}{\Sigma x^2} + (.2704)(1/n + \frac{\bar{x}^2}{\Sigma x^2}) + (1.04)(\frac{\bar{x}}{\Sigma x^2}) \right].
\]

An independent Chi-Square may be formed as
\[
\frac{\text{SSE}}{\sigma^2} \sim \chi^2_{n-2}
\]
where SSE is the sum of squared errors from the regression and n-2 are the degrees of freedom. Now a t-statistic may be set up as the ratio of a standard normal divided by the square root of an independent Chi-Square divided by its degrees of freedom.

\[
\frac{\hat{\gamma}_1 - .52\hat{\gamma}_0}{\sqrt{\frac{\text{SSE}}{\sigma^2} \left[ \frac{1}{\Sigma x^2} + (.2704)(1/n + \frac{\bar{x}^2}{\Sigma x^2}) + (1.04)(\frac{\bar{x}}{\Sigma x^2}) \right]}} \sim t_{n-2}
\]

or more conveniently,

\[
\frac{\hat{\gamma}_1 - .52\hat{\gamma}_0}{\sqrt{\frac{\text{SSE}}{n-2} \left( \frac{1}{\Sigma x^2} + (.2704)(1/n + \frac{\bar{x}^2}{\Sigma x^2}) + (1.04)(\frac{\bar{x}}{\Sigma x^2}) \right)}} \sim t_{n-2}
\]

which can be easily calculated from the data.
Donald Malcolm Chance was born July 12, 1951 in Selma, Alabama to Kenneth M. and Doris S. Chance. After graduation from A. G. Parrish High School in Selma, he entered the University of Montevallo, Montevallo, Alabama in the Fall of 1969 and graduated in the Summer of 1972 with a B.S. degree in Business Administration.

He was offered a University Nonservice Fellowship by the Graduate School of the University of Mississippi and matriculated there from 1972 through 1973 receiving an M.B.A. degree at graduation. He was employed by the First National Bank of Birmingham from 1973 through 1977. At the time of his resignation he held the position of Assistant Cashier and Corporate Services Manager.

In the Fall of 1977 he enrolled in the doctoral program at Louisiana State University and is scheduled to receive the Ph.D. degree with a major in Finance and a minor in Quantitative Methods in the Summer of 1980.

Upon graduation Mr. Chance will assume a position as Assistant Professor of Finance at Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

He is married to the former Jan Shewmake of Mobile, Alabama and they have one daughter, Kimberly Renee.
EXAMINATION AND THESIS REPORT

Candidate: Donald M. Chance

Major Field: Finance


Approved:

Charles S. Martin
Major Professor and Chairman

James E. Irwin
Dean of the Graduate School

EXAMINING COMMITTEE:

Ham T. Cary

William D. Lane

Date of Examination: June 16, 1980