FINANCIAL LEVERAGE AND

THE COST OF CAPITAL

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The objective of the research reported in this dissertation is to conduct an empirical test of the hypothesis that, excluding income tax effects, the cost of capital to a firm is independent of the degree of financial leverage employed by the firm. This hypothesis, set forth by Franco Modigliani and Merton Miller in 1958, represents a challenge to the traditional view on the subject, a challenge which carries implications of considerable importance in the field of finance. The challenge has led to a lengthy controversy which can ultimately be resolved only by subjecting the hypothesis to empirical test.

Most previous tests of the Modigliani-Miller hypothesis have been based on cross-sectional regression analysis of financial data for companies in the electric utility industry. However, the industry is a poor testing ground for the hypothesis. First, the range of debt-equity ratios employed in the industry is very narrow. Second, the effect of government rate regulation is subject to debate. A recent study has concluded that the effect of leverage on the value of a regulated firm can only be estimated if specific supply and demand conditions of that firm are known. Therefore, any test of the

Modigliani-Miller hypothesis based on a cross-sectional analysis of electric utility companies is of doubtful validity.

The test reported in this dissertation was based on cross-sectional regression analysis of financial data from fifty-two companies in an unregulated industry, the food industry, for the years 1972 through 1975. Examination of debt-equity ratios for the industry revealed that very low debt-equity ratios are significantly represented and that a reasonably good distribution is encountered over a fairly broad range. The time period covered begins and ends at roughly comparable points in the business cycle and thus provides a representative sample of the full range of cyclical business environment.

The basis of the test was Modigliani and Miller's Proposition II, a corollary of their fundamental hypothesis. Proposition II, in effect, states that equity investors fully discount any increase in risk due to financial leverage so that there is no possibility for the firm to reduce its cost of capital by employing financial leverage. The results of the research reported in this dissertation do not support that contention. The study indicates that, if equity investors require any increase in premium for increasing financial leverage, the premium required is significantly less than that predicted by the Modigliani-Miller Proposition II, over the range of debt-equity ratios covered by this study. The conclusion, then, is that it is possible for a firm to

reduce its cost of capital by employing financial leverage.

A secondary conclusion that can be drawn from this study is that earning power is an important variable to consider for inclusion in a regression model intended for use in investigating the effect of financial leverage on the cost of capital. The estimated partial regression coefficient of the earning-power variable was negative and highly significant in every cross-section year. Furthermore, earning power showed strong negative partial correlation with the debt-equity ratio. Therefore, omission of the earning-power variable from the regression model would have introduced upward bias into the estimated regression coefficient of the debt-equity ratio, making it appear that investors were reacting adversely to increasing debt-equity ratio. However, models used in previous tests of the Modigliani-Miller hypothesis have not included earning power.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

The cost of capital is important to the firm. Assuming
that the objective of the firm is to maximize shareholder
wealth, the cost of capital becomes a basic criterion in the
firm's investment decisions.[1] Therefore, any factor which
may impinge on the cost of capital deserves attention. One
such factor, the degree of financial leverage employed by the
firm, is the subject of the research reported in this dis-
sertation. The objective of the research is to conduct an
empirical test of the hypothesis that, excluding income tax
effects, the cost of capital to a firm is independent of the
degree of financial leverage employed by the firm.

The hypothesis under test represents a challenge to
the traditional view on the subject. This challenge of the
traditional view has led to a lengthy controversy and the

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[1]An early treatment of this subject is contained in
Diran Bodenhorn, "On the Problem of Capital Budgeting,"
Journal of Finance, XIV (December, 1959), 473-492. For
other treatments of the subject, see, e.g., Ezra Solomon,
The Theory of Financial Management (New York, Columbia
University Press, 1963), especially chapters II and III;
James T. S. Porterfield, Investment Decisions and Capital
Costs (Englewood Cliffs, Prentice-Hall, 1965), especially
chapters II, III, and IV; James C. T. Mao, Quantitative
Analysis of Financial Decisions (New York, Macmillan Co.,
1969), chapters X, XI, and XII; or Adolph E. Grunewald and
Erwin Esser Nemmers, Basic Managerial Finance (New York,
Holt, Rinehart and Winston, 1970), chapters XVI and XVII.

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implications of the challenge are of considerable signifi-
cance in the field of finance. The proponents of each view
base their positions on contrasting theoretical models.
Resolution of the controversy must ultimately depend on em-
pirical studies testing the validity of the theoretical
models. The research reported in this dissertation does not
support the hypothesis of independence between cost of capital
and the degree of leverage employed by the firm.

The Divergent Views

Two divergent views on the effect of financial leverage
on the cost of capital have developed: the traditional view
and a view primarily associated with Modigliani and Miller.

The Traditional View

The traditional view of the financial structure of the
firm is that the cost of capital may be minimized by select-
ing an optimum degree of financial leverage.[2] This view may
be discussed in terms of the following model of the value of
the firm:

$$P = \frac{NI}{k_e} + \frac{C}{k_d} \qquad (1)$$

where

P = the value of the firm

NI = annual net income

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[2]George C. Philippatos, *Financial Management: Theory and Techniques* (San Francisco, Holden-Day, 1973).

$$k_e \quad = \quad \text{equity capitalization rate}$$

$$k_d \quad = \quad \text{debt capitalization rate}$$

$$C \quad = \quad \text{annual interest payments on debt}$$

Three stages of market reaction to leverage are claimed. During the first stage, when relatively small amounts of debt are added to the firm's capital structure, there is little or no increase in capitalization rates applied by investors to the streams of income going to holders of equity and debt securities. With the debt capitalization rate lower than the equity capitalization rate, substitution of debt for equity causes the value of the firm to rise and the average cost of capital to decline. As further additions are made to the firm's debt-equity ratio, a point is reached where the debt and equity capitalization rates begin to rise more rapidly. Eventually, the rising discount rates prevent the firm from realizing any advantage from the substitution of debt for equity. Then the value of the firm is unchanged by variations in the degree of financial leverage. Finally, a third stage is reached in which the debt-equity ratio has reached such large proportions that the discount rates rise rapidly, the value of the firm declines, and the average cost of capital increases.

The Modigliani-Miller View

In 1958, Modigliani and Miller published their proposition that the degree of financial leverage employed by a firm

is a matter of indifference.[3] They predicated their proposition on an assumption of perfect capital markets and rational investors. Under these assumptions and in the absence of income taxes, they maintained that the value of the firm, in equilibrium, is given by

$$P = \frac{\bar{E}}{k} \qquad (2)$$

where

$\bar{E}$ = expected earnings before interest[4]

k = capitalization factor appropriate to the firm's risk class

In other words, the value of the firm is determined by capitalizing the stream of income derived from the assets possessed by the firm. The rate at which the income stream is capitalized is independent of the way in which the assets are financed but varies as a function of the business risk class to which the firm belongs. According to the Modigliani-Miller definition of class, two firms belong to the same

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[3]Franco Modigliani and Merton H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," American Economic Review, XLVIII (June, 1958), 262-297.

[4]Here and in the subsequent discussion, E represents the arithmetic mean value of the stream of before-interest earnings of the firm. The variable E is a random variable distributed in accordance with a subjective (on the part of investors) probability distribution. The value of $\bar{E}$ is the expected value of the random variable E. Other earnings variables to be introduced subsequently will be defined analogously. For example, E^T represents the mean value of the stream of before-interest earnings, net of taxes. The value $\bar{E}^T$ represents the expectation of the random variable E^T.

class if the probability distribution of $E/\bar{E}$ is the same for both firms.

Market assessment of the firm must, in equilibrium, converge with the value of the firm indicated by the Modigliani-Miller model because any deviations from this value will provide incentive for arbitrage action which will tend to eliminate the deviations. For example, should a leveraged firm in the same class with an unleveraged firm become overvalued relative to the latter, the stockholders of the former could sell their shares, borrow additional funds, and invest in the unleveraged firm. In this way, the investors could duplicate their original stream of earnings at lower cost. This action would continue until their activities caused the discrepancies in firm values to disappear. Should the unleveraged company become overvalued relative to the leveraged company, the shareholders of the former need merely sell their shares and buy bonds and shares in the leveraged company in the proper proportions to duplicate their original stream of earnings at lower cost and, in the process, restore equilibrium to the market. It is to be noted that this arbitrage process assures equal discount rates on the part of investors for all firms in a business risk class regardless of leverage preferences of investors, since every investor can establish the precise level of portfolio leverage he prefers regardless of which company's shares he includes in his portfolio.

In 1963, Modigliani and Miller amended their original proposition as a result of reconsidering the effect of income taxes.[5] Since interest payments are tax deductible, leveraged companies retain more of their earnings after taxes for distribution to their security holders. The value of the firm then is given by

$$P = \frac{\overline{E}(1 - T)}{k} + TD \tag{3}$$

where

D = value of the firm's debt.

Thus, as leverage increases, the value of the firm increases and the cost of capital decreases. This alteration in Modigliani and Miller's original proposition softens the difference between their view and the traditional view but by no means obliterates it.

The 1963 study just described took into account the effect of corporate income taxes and the tax deductibility of corporate interest payments. However, the existence of personal income taxes was ignored. Since then, Miller has completed a study in which personal income taxes are included. In 1977, he published the results of that study.[6] He has concluded that even after considering income taxes, the

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[5]Franco Modigliani and Merton H. Miller, "Corporate Income Taxes and the Cost of Capital: A Correction," American Economic Review, LIII (June, 1963), 433-443.

[6]Merton H. Miller, "Debt and Taxes," Journal of Finance, XXXII (May, 1977), 261-275.

original form of the Modigliani-Miller hypothesis is the correct one. His conclusion appears to follow from the basic assumptions of the Modigliani-Miller hypothesis. As Miller states, "Like so many other propositions in financial economics this, too, is 'obvious once you think of it.'"[7] The only restriction imposed on the personal income tax rate is that the rate paid by the marginal holder of a stock be substantially less than his rate on income from bonds. As Miller points out, this restriction appears to be reasonable because of the clientele effect: high dividend paying stocks will be preferred by low tax bracket investors while stocks yielding more return in the form of capital gains will tend to be accumulated by investors in higher income tax brackets. It appears to be likely that this revision will become the accepted version of the Modigliani-Miller hypothesis. Nevertheless, since Modigliani has not yet commented on the revision, the term "Modigliani-Miller hypothesis," as used in this dissertation, will imply the 1963 version of the hypothesis. The 1977 version will be referred to as the Miller amendment of the Modigliani-Miller hypothesis.

Various writers have questioned the realism of the world in which Modigliani and Miller have chosen to operate. Baumol and Malkiel have shown that when transactions costs are considered the investor can no longer be indifferent to

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[7]Ibid., p. 268.

the financial structure of the firm.[8] This change in attitude occurs because of the greater costs incurred in generating personal leverage to compensate for a perceived deficiency in corporate leverage as compared to the costs incurred in "undoing" excessive corporate leverage. If corporate leverage is lower than the investor desires, he must borrow funds and buy shares. Therefore, his brokerage fees will be higher than they would have been had the corporation provided the degree of leverage he desired. On the other hand, if corporate leverage is higher than the investor desires, the investor simply purchases a combination of stocks and bonds rather than stocks alone. The total volume of his transactions remains the same as if he were content with the corporate level of leverage and the brokerage fees will be somewhat reduced because the transactions cost on bonds are lower than those on stocks. These considerations, in addition to consideration of the tax advantages of bond financing, lead Baumol and Malkiel to the conclusion that "it is desirable for the firm to employ as much debt as is consistent with considerations of financial prudence."[9]

Another factor that has aroused comment is the possibility of financial embarrassment by the firm. It has been

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[8]William J. Baumol and Burton G. Malkiel, "The Firm's Optimal Debt-Equity Combination and the Cost of Capital," _Quarterly Journal of Economics_, LXXXI (November, 1967), 547.

[9]_Ibid._, p. 571.

pointed out by Stiglitz[10] that the possibility of default on
bond payments makes a bond a risky investment. As a result,
bonds of different companies are not interchangeable; nor
are bonds that a firm issues when it has a low debt-equity
ratio identical to those it issues when it has a high debt-
equity ratio.

Several writers have considered in detail the effect of
the risk of ruin on the cost of capital. Baxter has concluded
that merely approaching a questionable financial condition
will result in significant increase in the cost of capital.[11]
Bierman and Thomas have concluded that, under some circum-
stances, the risk of ruin must be taken into account with the
introduction of the first dollar of debt financing.[12] Smith
has argued that the arbitrage action postulated by Modigliani
and Miller fails when there is positive risk of default.[13]
Kraus and Litzenberger have formally introduced corporate
taxes and bankruptcy penalties into a state variable model

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[10]Joseph E. Stiglitz, "A Re-Examination of the
Modigliani-Miller Theorem," American Economic Review, LIX
(December, 1969), 784-793.

[11]Nevins D. Baxter, "Leverage, Risk of Ruin and the
Cost of Capital," Journal of Finance, XXII (September,
1967), 395-403.

[12]Harold Bierman, Jr., and L. Joseph Thomas, "Ruin
Considerations and Debt Issuance," Journal of Financial and
Quantitative Analysis, VII (January, 1972), 1361-1378.

[13]Vernon L. Smith, "Corporate Financial Theory under
Uncertainty," Quarterly Journal of Economics, LIII (August,
1970), 451-471; "Default Risk, Scale, and the Homemade Lev-
erage Theorem," American Economic Review, LXII (March, 1972),
66-76.

which they have used to demonstrate that, as financial leverage is increased, the growing probability of incurring bankruptcy penalties eventually offsets the tax advantage of debt and results in a rising cost of capital.[14]

Robichek and Myers studied direct and indirect costs of bankruptcy as well as the effects of present borrowing on the future financing and investment strategies of the firm. They argue that these factors invalidate the Modigliani-Miller Hypothesis even in the absence of any market imperfections.[15]

Various market imperfections may have significant impact on the behavior of the cost of capital as a function of financial leverage. Durand has pointed out that Regulation T places very significant limitation on the use of margin.[16] Furthermore, many institutions use no margin at all due to either legal restrictions or practice of the prudent man rule. Another significant market imperfection arises from the fact that the individual borrower must usually pay higher interest rates than the corporate borrower; and he does not enjoy the advantage of limited liability as does the corporate

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[14]Alan Kraus and Robert H. Litzenberger, "A State-Preference Model of Optimal Financial Leverage," Journal of Finance, XXVIII (September, 1973), 911-922.

[15]Alexander A. Robichek and Stewart C. Myers, "Problems in the Theory of Optimal Capital Structure," Journal of Financial and Quantitative Analysis, I (June, 1966), 1-35.

[16]David Durand, "The Cost of Capital, Corporation Finance, and the Theory of Investment: Comment," American Economic Review, XLIX (September, 1959), 645.

borrower.[17] A model of investor behavior was developed by Glenn to demonstrate that statutory restrictions on portfolio choices and shorting practices of major financial institutions may have significant capital market implications.[18] Resek has used the concept of multidimensional risk to show that personal and corporate leverage are not interchangeable in the general case and, on this basis, questions the validity of the Modigliani-Miller hypothesis.[19] Rubinstein has argued that, in a segmented security market, differing degrees of risk aversion on the part of equity and debt investors could lead to dependence of firm valuation on debt-equity ratio.[20] In a somewhat similar approach, Stiglitz has argued that when debt and equity holders differ in their expectations, the firm value becomes a function of the debt-equity ratio.[21]

It is apparent that there is ample reason to question the usefulness of Modigliani and Miller's view of the cost

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[17]Burton G. Malkiel, The Debt Equity Combination of the Firm and the Cost of Capital: An Introductory Analysis (New York, General Learning Press, 1971), p. 22.

[18]David W. Glenn, "Super Premium Security Prices and Optimal Corporate Financing Decisions," Journal of Finance, XXXI (May, 1976), 504-524.

[19]Robert W. Resek, "Multidimensional Risk and the Modigliani-Miller Hypothesis," Journal of Finance, XXV (March, 1970), 47-51.

[20]Mark E. Rubinstein, "Corporate Financial Policy in Segmented Securities Markets," Journal of Financial and Quantitative Analysis, VIII (December, 1973), 749-761.

[21]Joseph E. Stiglitz, "Some Aspects of the Pure Theory of Corporate Finance: Bankruptcies and Take-Overs," Bell Journal of Economics and Management Science, III (Autumn, 1972), 458-482.

of capital. Granted their assumptions, their conclusions have not been questioned. Indeed, as Philippatos states, in the artificial world of perfect capital markets and rational investors, the Modigliani-Miller model is tautological.[22] The crucial question is whether the effects of market imperfections and institutional rigidities are sufficiently significant to destroy the usefulness of the Modigliani-Miller proposition in the real world. To shed light on this question, it is necessary to submit their hypothesis to empirical test.

Methodology

The test of the Modigliani-Miller hypothesis reported in this dissertation was based on cross-sectional analysis of companies in the food industry, using single-stage, least-squares, multiple regression analysis. Fifty-two companies, basically consisting of companies in the food processing and beverage groups of The Value Line Investment Survey, were included in the study. Data regarding these firms were obtained from The Value Line Investment Survey, Standard and Poor's Stock Guide, Moody's Industrial Manual, and the COMPUSTAT data base. In case of conflict between the sources, Standard and Poor's Stock Guide or Moody's Industrial Manual was accepted as authoritative (no instances of conflicts between the latter two sources were noted). Financial data for the

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[22]Philippatos, Financial Management, p. 294.

years 1972 through 1975 were utilized. Thus the period covered begins and ends at roughly comparable points in the business cycle and provides a representative sample of the full range of cyclical business environment.

Study Limitations

The test of the Modigliani-Miller hypothesis was conducted in the food industry. While it is believed that the results of this study have implications for companies outside the food industry, it is possible that special conditions existing in the food industry affected the results obtained. Further tests in other industrial groups will be necessary before the results obtained in this test can be assumed to have general applicability. However, the research reported in this dissertation will be useful to anyone undertaking such additional tests.

Significance of the Study

As indicated above, the traditional view is that the cost of capital is a convex function of financial leverage. This view is consonant with the traditional practice of most firms in which the selection of an optimum debt-equity ratio is a matter of high corporate policy. According to Malkiel,

> Choosing an optimal combination of debt and equity funds to be used by a firm and determining the cost to the company of the mix of funds acquired are among the most important problems faced by corporate financial managers. Traditionally, these questions have been examined jointly as the relationship between a firm's capital structure (that is, its

debt-equity combination) and its cost of capital.
The problems are central to the firm . . . .[23]

In contrast to the traditional view, the Modigliani-Miller
position is that, fundamentally, the cost of capital is in-
dependent of the financing decision. It follows, then, that
the selection of a debt-equity ratio, far from being a matter
of crucial policy decision, is one of indifference. There-
fore, resolution of these divergent views is a matter of
importance to the financial management of the firm.

In addition to its significance at the microeconomic
level, the Modigliani-Miller hypothesis has implications at
the macroeconomic level. In 1961, Miller and Modigliani
published a paper in which they showed that the assumptions
of perfect capital markets and investor rationality which
supported their demonstration of the validity of the
Modigliani-Miller hypothesis of investor indifference with
regard to debt-equity ratios can also be used to demonstrate
that investors will be indifferent between dividends and re-
tained earnings.[24] Thus, the ultimate conclusion is that
the financial policy of the firm is of no consequence. Re-
garding the macroeconomic significance of this conclusion,
Stiglitz states,

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[23]Malkiel, The Debt-Equity Combination of the Firm
and the Cost of Capital, p. 1.

[24]Merton H. Miller and Franco Modigliani, "Dividend
Policy, Growth, and the Valuation of Shares," Journal of
Business, XXXIV (October, 1961), 411-433.

> If the hypothesis that the financial policy of the firm makes no difference to the firm's market valuation is correct, it also means that if firms maximize their market value, the real decisions are the only decisions that count, and the financial decisions have no bearing on them. In particular, it means that analyses of the real sector based on "flow of funds analysis" . . . are not likely to give us much insight into what is really going on . . . .[25]

The Modigliani-Miller hypothesis may also be viewed as a defense of the capitalistic system.[26] In the past, various economists have pointed out what they perceived to be weaknesses of the capitalistic system. For example, Kalecki developed his principle of increasing risk.[27] He reasoned that, for an entrepreneur with a given level of equity capital, the marginal risk would increase with the amount invested. Therefore, the cost of capital would increase with the amount of the entrepreneur's investment and this increasing cost would automatically limit the size of his firm. Regarding this point, Kalecki commented:

> The limitation of the size of the firm by the availability of entrepreneurial capital goes to the very heart of the capitalist system. Many economists assume, at least in their abstract theories, a state of business democracy where anybody endowed with entrepreneurial ability can obtain capital for starting a business venture. This picture of the

[25]Joseph E. Stiglitz, "On the Irrelevance of Corporate Financial Policy," American Economic Review, LXIV (December, 1974), 851-852.

[26]This line of reasoning was suggested by Peyton Foster Roden in class lectures during the Spring of 1975. Melvin F. Brust, unpublished class notes, College of Business Administration, North Texas State University, Denton, Texas.

[27]Michal Kalecki, Essays in the Theory of Economic Fluctuations (New York, Russell and Russell, 1939), pp. 95-106.

activities of the 'pure' entrepreneur is, to put it mildly, unrealistic.[28]

As another example, Joan Robinson discussed the tendency for markets to come under domination by "old-established, powerful firms." She described the financial aspects of the tendency in the following words:

> The ossifying effects of success operate also through the supply of finance. At any moment the bulk of profits is accruing to the older firms while the most lively would-be innovators have to borrow from outside and so find funds harder to come by.[29]

She also considered the problem posed to the capitalist system by the thrift of rentiers. Regarding this problem, she commented:

> At any time, the more thrifty have rentiers been over the past, the larger is the proportion of debts to assets for entrepreneurs as a whole, and the harder or more expensive it is likely to be to raise new finance. . . .
> Thrift, in short, makes possible a high rate of accumulation and yet sets obstacles in the way of achieving it. This paradoxical operation of the capitalist rules of the game is one of the main subjects which we hope to be able to elucidate by economic analyses.[30]

Clearly, the problems posed to the capitalist system by factors discussed by these economists are less serious if the Modigliani-Miller hypothesis is true.

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[28]Michal Kalecki, _Theory of Economic Dynamics: An Essay on Cyclical and Long-Run Changes in Capitalist Economy_ (New York, Rinehart and Company, 1954), p. 94.

[29]Joan Robinson, _Essays in the Theory of Economic Growth_ (London, Macmillan Co., 1963), p. 77.

[30]Joan Robinson, _The Accumulation of Capital_, 3d ed. (London, Macmillan Co., 1969), p. 55.

The discussion above indicates the significance of the Modigliani-Miller hypothesis at both the microeconomic and macroeconomic levels. Recently, renewed interest in the subject has been displayed in the literature. For example, Stiglitz has extended the work of Modigliani and Miller to show, in the context of a general equilibrium model, that financial policies are irrelevant to the valuation of the firm.[31] On the other side of the controversy, Scott has developed a new theoretical model of firm valuation indicating the existence of an optimal capital structure.[32] Of course, the crux of the matter remains the question of whether real-world market operations depart sufficiently far from the theoretical models to invalidate them; i.e., the controversy must ultimately be resolved by submitting the hypothesis to empirical test.

A number of empirical tests of the hypothesis have been reported in the literature. However, as will be indicated in the review of existing literature on empirical tests of the hypothesis contained in Chapter II, the only rigorous tests of the hypothesis have been based on cross-sectional studies of companies in the electric utility industry. Unfortunately, for at least two reasons, the electric utility

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[31]Joseph E. Stiglitz, "On the Irrelevance of Corporate Financial Policy," American Economic Review, LXIV (December, 1974), 851-866.

[32]James H. Scott, Jr., "A Theory of Optimal Capital Structure," Bell Journal of Economics, VII (Spring, 1976).

industry is a poor testing ground for the hypothesis. These reasons will be discussed in the following paragraphs.

One reason that the electric utility industry is an unsuitable testing ground is that the range of debt-equity ratios existing in the industry is very restricted. To illustrate this point, the frequency distribution (for the year 1975) of debt-equity ratios in the capital structure of the one hundred American electric utilities followed by the Value Line Investment Survey is shown in Table I. A list of the companies represented in this table appears in Appendix A. It will be noted that eighty-four of the companies have debt-equity ratios falling between 1.5 and 2.25 and that all but three of the companies have debt-equity ratios between 1.25 and 2.50. It is doubtful whether valid conclusions regarding the effect of the debt-equity ratio on the cost of capital could be based on a study of a group of companies with such a narrow range of debt-equity ratios.

Recently, an even more serious challenge to the validity of tests conducted on companies in the electric utility industry has appeared. This challenge will be discussed in the following paragraphs.

In 1968, Brigham and Gordon reported the results of a study on companies in the electric utility industry.[33] This study was particularly notable in that it was the first to

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[33]Eugene F. Brigham and Myron J. Gordon, "Leverage, Dividend Policy, and the Cost of Capital," Journal of Finance, XXIII (March, 1968), 85-103.

TABLE I

FREQUENCY DISTRIBUTION OF DEBT-EQUITY RATIOS
IN THE CAPITAL STRUCTURE OF ELECTRIC
UTILITY COMPANIES (1975)*

Debt-Equity Ratio**	Number of Companies			
	East	Central	West	Nationwide
0.65 and less than 0.75	0	0	1	1
0.75 and less than 1.00	0	0	0	0
1.00 and less than 1.25	0	1	0	1
1.25 and less than 1.50	0	3	3	6
1.50 and less than 1.75	2	9	8	19
1.75 and less than 2.00	11	16	7	34
2.00 and less than 2.25	6	15	10	31
2.25 and less than 2.50	1	5	1	7
2.50 and less than 2.75	0	0	0	0
2.75 and less than 3.00	0	0	0	0
3.00 and less than 3.10	0	1	0	1
Total	20	50	30	100

*Source: Arnold Bernhard and Co., The Value Line
Investment Survey, following issues:
      East   July 8, 1977   pp. 203-237
      Central May 6, 1977   pp. 704-750
      West   June 17, 1977   pp. 1698-1715

**Based on book values, considering preferred stock
as a debt obligation.

take into account the effect of regulatory action on the earn-
ings stream from a utility. Brigham and Gordon stated that
rates of utilities are regulated so that after-tax earnings
plus interest is equal to a predetermined percentage of a
utility's assets. Therefore, the corporate income tax is an
expense and not a distribution of income. As a result, they
argue that, if the Modigliani-Miller hypothesis is valid and
equation (3) is true for an unregulated firm, the value of a
regulated firm would be given by

$$P = \frac{\bar{E}^T}{k} = \frac{\bar{E}_{NL}(1 - T)}{k} \qquad (4)$$

where

$\bar{E}^T$ = expected earnings before interest, net
of taxes

$\bar{E}_{NL}$ = expected earnings of the unlevered firm
before taxes

Equation (4) is the same as equation (2) except that $\bar{E}$ is
replaced by $\bar{E}^T$. Thus, according to this argument, if the
Modigliani-Miller hypothesis is true, the value of a regu-
lated firm is independent of financial leverage when corporate
income taxes are taken into account just as the value of an
unregulated firm is independent of financial leverage in the
absence of corporate income taxes. Brigham and Gordon's
empirical study, on the contrary, showed that the value of
electric utility companies increased with increasing leverage;
and thus their results did not support the Modigliani-Miller
hypothesis.

In 1971, Elton and Gruber published an article in which they maintained that Brigham and Gordon's conclusion regarding the value of a regulated firm, as stated in equation (4), was incorrect.[34] They pointed out that equation (4) would be valid only if E^T and E_{NL} represented income streams belonging to the same risk class; i.e., equation (4) would be valid only if the probability distributions of $E^T/\bar{E}^T$ and $E_{NL}/\bar{E}_{NL}$ were identical. This is true because, as discussed earlier in this chapter, under the assumptions of the Modigliani-Miller hypothesis, the rate at which an income stream is capitalized is independent of financial leverage and is determined only by the risk class to which it belongs. They then proceeded to show that, under the assumption that Brigham and Gordon's statement of the effect of regulatory action on the earnings stream of a regulated firm was correct, the probability distribution of $E^T/\bar{E}^T$ was not independent of leverage. They further showed that the probability distribution of $E(1 - T)/\bar{E}(1 - T) = E/\bar{E}$ was independent of leverage. They, therefore, concluded that, under the assumptions supporting the Modigliani-Miller hypothesis, the value of the regulated firm is correctly given by equation (3) and not by equation (4) as contended by Brigham and Gordon.

In 1976, Jeffrey F. Jaffee and Gershon Mandelker reported the results of their study of the valuation of regulated

[34]Edwin J. Elton and Martin J. Gruber, "Valuation and the Cost of Capital for Regulated Industries," _Journal of Finance_, XXVI (June, 1971), 661-670.

firms.[35] They pointed out that Elton and Gruber failed to take into account the effect of rate changes on the quantity of a firm's product demanded. When this effect is taken into account, Elton and Gruber's result and Brigham and Gordon's result are shown to be special cases of a more general situation. It is shown that both of these special cases are applicable only under the assumption of certain supply-demand configurations. Further, they conclude that "there is no a priori method of estimating the effect of leverage on the value of a regulated firm without a knowledge of the specific supply and demand conditions of that firm."[36] This, of course, means that all studies which have been based on cross-sectional studies of companies drawn from the electric utility industry are of doubtful value in resolving the controversy over the validity of the Modigliani-Miller hypothesis.

In 1971, Van Horne wrote in regard to the controversy, "Additional empirical studies, particularly studies dealing with industries other than the public utility industry, are needed."[37] In light of recent developments, this need is even greater today. The research reported in this dissertation will help to fill that need.

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[35]Jeffrey F. Jaffe and Gershon Mandelker, "The Value of the Firm under Regulation," Journal of Finance, XXXI (May, 1976), 701-713.

[36]Ibid., p. 702.

[37]James C. Van Horne, Financial Management and Policy (Englewood Cliffs, N.J., Prentice-Hall, 1971), p. 222.

CHAPTER II

REVIEW OF EXISTING EMPIRICAL EVIDENCE

Prior to the announcement of the Modigliani-Miller hypothesis in 1958, very little empirical research on the effect of financial leverage on the cost of capital was reported in the literature. However, one such study was reported by Allen in 1954.[1] He performed a detailed study of forty-three electric utility companies for the years 1947 and 1948 and a less detailed study of eighty-eight utility companies for the year 1952. On the basis of scatter diagrams of share yield versus debt-ratio, he concluded that the traditional view regarding the effect of capital structure was not valid. He stated:

> From these analyses, it is evident that investors, as indicated by the market prices that their trading establishes are fully aware of the added risk resulting from a higher proportion of senior capital, and fully discount this risk in the prices they pay. Therefore, there is, in fact, no real possibility of decreasing the "cost of capital" by going further into debt. Rather, it seems safe to conclude that, over a fairly broad range, capital structure has no material effect on over-all cost of capital . . . .[2]

Of course, such a sweeping conclusion is hardly justified by such scanty evidence. Nevertheless, it represented a start

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[1] Ferry B. Allen, "Does Going into Debt Lower the 'Cost of Capital'?" _Analysts Journal_, X (August, 1954), 57-61.

[2] _Ibid._, p. 60.

at empirical investigation and stimulated further research.
For example, it inspired a study by Smith of financial data
of forty-two oil companies for the year 1953 to determine
whether the same conditions would be found in the oil indus-
try.[3] These two studies were used by Modigliani and Miller
as the source of data for initial tests of their hypothesis.
In addition to scatter diagrams, they considered the results
of a simple regression analysis of the data collected by Allen
and Smith and found support for their hypothesis.[4] However,
these studies were admittedly deficient as tests of their
hypothesis and were cited by them as merely suggestive, with
the hope that further empirical testing would thereby be
stimulated. They were certainly not disappointed in this ex-
pectation, as the remainder of this chapter will demonstrate.

In 1963, Barges reported the results of a study based
on simple regression analysis of financial data from three
separate industries.[5] He considered sixty-one companies in
the railroad industry, sixty-three companies in the department
store industry, and thirty-four companies in the cement

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[3]R. Smith, Cost of Capital in the Oil Industry (Pitts-
burgh, Carnegie Institute of Technology, 1955), cited by
Franco Modigliani and Merton H. Miller, "The Cost of Capital,
Corporation Finance and the Theory of Investment," American
Economic Review, XLVIII (June, 1958), 281.

[4]Franco Modigliani and Merton H. Miller, "The Cost of
Capital, Corporation Finance and the Theory of Investment,"
American Economic Review, XLVIII (June, 1958), 261-288.

[5]Alexander Barges, The Effect of Capital Structure on
the Cost of Capital (Englewood Cliffs, N.J., Prentice-Hall,
1963), pp. 40-76.

production industry. He interpreted his results as supporting the traditional view of the effect of debt-equity ratio on the cost of capital. Although he avoided some of the problems associated with the initial tests reported by Modigliani and Miller, deficiencies remained that precluded unambiguous interpretation of the results of his study. One difficulty was occasioned by the fact that he did not report standard errors for the estimated regression coefficients. As a result, tests of statistical significance could not be made. Another problem was that he, as did Modigliani and Miller in their initial study, treated an industry as constituting a homogeneous risk class. He could then use a simple regression model to determine the effect of financial leverage. This treatment is difficult to justify since it would seem reasonable to expect individual companies in an industry to exhibit significantly heterogeneous characteristics.

Weston undertook a study in which he attempted to avoid some of the weaknesses observed in earlier tests.[6] In the first place, he selected the electric utility industry as his testing ground. He selected this industry because he felt that a regulated industry such as the electric utility industry would more nearly fulfill the requirements of a homogeneous risk class. In addition, he explicitly introduced two additional control variables to compensate

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[6]J. Fred Weston, "A Test of Cost of Capital Propositions," _Southern Economic Journal_, XXX (October, 1963), 105-112.

partially for remaining heterogeneity. The control variables
that he introduced were firm size as measured by total assets
and growth as measured by the ten-year compound earnings
growth rate. This approach represented a considerable ad-
vance over previous studies. He found, in contrast to the
earlier findings of Modigliani and Miller, that the average
cost of capital decreased significantly with leverage. Thus
Weston's results were consistent with the traditional view
of the effect of financial leverage on the cost of capital.
However, as discussed in Chapter I of this dissertation, when
income tax effects are taken into account, the Modigliani-
Miller hypothesis also predicts a decline of the cost of
capital with an increase in financial leverage, although of
a lesser amount. Unfortunately, Weston's test was not sharp
enough to make this distinction. Therefore, although his
results were consistent with the traditional view, they were
not shown to be inconsistent with the Modigliani-Miller hy-
pothesis.

Another empirical study was published in 1964 by Beranek.[7]
An ambitious study, it was begun in 1957 and not completed
until 1964. Thus, while it was published subsequent to the
appearance of the Barges and Weston studies, it was apparently
not influenced by them. He performed studies on four separate
groups of companies. The groups on which the studies were

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[7]William Beranek, The Effect of Leverage on the Market
Value of Common Stock (Madison, University of Wisconsin,
1964).

performed consisted of an unspecified number of banks, eighty-eight electric utility companies, fifty-two railroads, and one hundred "industrial" companies. He used multiple regression models of share price to determine the effect of financial leverage on the cost of equity capital. In addition to leverage, he took into account earnings, dividends, and a risk variable. A different risk variable was chosen for each group of companies. For example, the risk variable chosen for the group of electric utility companies was the ratio of residential sales to total sales. He reasoned that this variable constituted a useful measure of risk because residential sales are more stable than industrial sales. The results of the tests were interpreted to support the Modigliani-Miller hypothesis. Unfortunately, deficiencies of the test prevented them from being very convincing. Beranek concluded,

> The weight of the evidence from the combined significance test for each industry leans heavily toward the M-M hypothesis. . . . Inadequacies in both the test and the data, however, prevent one from discriminating definitively among the contending hypotheses.[8]

The results of a study by Wippern were published in 1966.[9] He performed a multiple regression analysis of price-earnings ratios for a sample of fifty companies from various industries. He introduced a set of control variables consisting of a measure of earnings growth rate, dividend payout

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[8]Ibid., p. 73.

[9]Ronald F. Wippern, "Financial Structure and the Value of the Firm," Journal of Finance, XXIII (December, 1966), 615-633.

rate, and company size (net plant). He concluded that the results of his study did not support the Modigliani-Miller hypothesis. However, his results are difficult to interpret unambiguously. As the leverage variable in his regression analysis, he utilized a quantity which he termed a "proxy uncertainty variable." It combined measures of business risk and financial risk into a single variable. The results of his regression analysis of price-earnings ratios, therefore, did not directly reveal the influence of financial leverage on the price-earnings ratio. A further regression of his leverage variable on debt-equity ratio was required to dis-entangle the relationship. The result of using this complex measure of leverage was twofold. In the first place, the im-plicit assumption was made that investors respond in the same manner to business risk and to financial risk. This assump-tion in itself must inevitably raise questions as to the validity of any conclusions reached regarding the effect of financial leverage. In the second place, the statistical properties of the quantities finally compared were obscure; yet this question was not addressed. Therefore, although Wippern states that the displayed data "show that the values of the observed coefficients for the pooled estimates and for the 1956, 1958, and 1961 cross-section years are below the values predicted by the Modigliani-Miller theory for all industries, in many cases by wide margins,"[10] there is no

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[10]Ibid., p. 631.

way to judge the statistical significance of those differences.

In 1966, Modigliani and Miller reported the results of a test that was more carefully drawn than the tests which they reported in their 1958 article.[11] They selected as their testing ground the electric utility industry for the same reason that Weston did; i.e., they could obtain a large sample with relatively homogeneous component firms. They analyzed financial data from sixty-three firms in the electric utility industry for the years 1954, 1956, and 1957. In addition to the basic financial leverage variable, they took into account company size and growth. Their results again supported their hypothesis.

These new tests were also subjected to criticism: for example, by Crockett and Friend;[12] Robichek, McDonald, and Higgins;[13] and Gordon.[14] In particular, Gordon criticized the study because of the failure of Modigliani and Miller to

[11]Merton H. Miller and Franco Modigliani, "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-1957," American Economic Review, LVI (June, 1966), 334-391.

[12]Jean Crockett and Irwin Friend, "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-57: Comment," American Economic Review, LVII (December, 1967), 1258-1267.

[13]Alexander A. Robichek, John G. McDonald, and Robert C. Higgins, "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-1957: Comment," American Economic Review, LVII (December, 1967), 1279-1287.

[14]Myron J. Gordon, "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-57: Comment," American Economic Review, LVII (December, 1967), 1267-1277.

take into account effects of regulatory action on the electric utility industry. He argued that when the effects of regulation were properly taken into account, the results which Modigliani and Miller had obtained actually contradicted their theorem rather than supported it. He stated,

> . . . using a utility sample actually gave results that were against their leverage theorem, since regulatory agencies treat the income tax as an expense in determining the income a utility is allowed to earn. Only if their sample had consisted of non-regulated industrial companies would their results have been evidence in support of their theorem.[15]

In 1968, Brigham and Gordon published a study of the cost of capital in the electric utility industry.[16] They analyzed financial data for sixty-nine electric utility companies for the years 1958 through 1962, using a model which overcame some of the objections to the Modigliani-Miller model. They used a single-stage regression procedure to replace Modigliani and Miller's more controversial two-stage technique. Their model took into account the effect of regulatory action on the earnings stream from a utility and included an index of pre-tax earnings instability as a proxy for business risk. They also included variables representing growth, percent of revenue derived from sale of electricity, and an index of firm size. Their results did not support the

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[15]Ibid., p. 1271.

[16]Eugene F. Brigham and Myron J. Gordon, "Leverage, Dividend Policy, and the Cost of Capital," Journal of Finance, XXIII (March, 1968), 85-103. For further discussion of this study, see pages 18-22 of this dissertation.

Modigliani-Miller theorem. In subsequent work, Gordon
extended this study to include the years 1958 through 1968.
The results of this extended study, which were published
in 1974, also failed to support the Modigliani-Miller the-
orem.[17]

In the meantime, in 1969, Melnyk reported the results of
a study in which he attempted to avoid some of the difficul-
ties common to cross-sectional analyses.[18] He performed
separate time-series analyses of financial data from eight
utility companies for the years 1950 through 1964. He re-
ported that "in general, the results of this study tend to
support the traditional theory."[19] While certain problems
encountered in cross-sectional analyses are avoided in this
type of analysis, time-series analysis is subject to diffi-
culties of its own. In the first place, the range of debt-
equity ratios occurring in one company over a fifteen-year
period is likely to be extremely narrow. In the second place,
although one is dealing with a single company and thus may
expect greater homogeneity in some characteristics of the
company than would be encountered in a cross-sectional

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[17]Myron J. Gordon, The Cost of Capital to a Public Util-
ity (East Lansing, Michigan State University, 1974).

[18]Z. Lew Melnyk, "Cost of Capital and Valuation under
Financial Leverage: The Case of Gas and Electric Utilities,"
Public Utility Valuation and the Rate Making Process: Con-
ference Proceedings (Ames, Iowa, Iowa State University,
1969), pp. D-1 to D-40.

[19]Ibid., p. D-8.

analysis, the changing environment of the firm introduces new heterogeneous factors which are difficult to evaluate.

Another study reported in 1969 was that of Sarma and Rao.[20] They performed a study of thirty Indian engineering companies, using a model identical to that employed by Modigliani and Miller in their 1966 study. The results of their test indicated that leverage had non-tax advantages and thus did not support the Modigliani-Miller hypothesis.

In 1971, Rao and Litzenberger used a similar model to investigate a sample of twenty-eight Indian utilities and a sample of seventy-seven American utilities.[21] Their study indicated that the Modigliani-Miller hypothesis was valid in the case of the American sample but not in the case of the Indian sample. They, therefore, concluded that market imperfections were more severe in a developing economy than they are in a highly developed one such as that of the United States. Of course, this study and the Sarma and Rao study are subject to the same limitations as the Modigliani and Miller 1966 study.

The work cited above includes the most important tests of the Modigliani-Miller hypothesis. Other studies, however, have been reported that impinged on the issue.

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[20]L. V. L. N. Sarma and K. S. Hanumanta Rao, "Leverage and the Value of the Firm," _Journal of Finance_, XXIV (September, 1969), 673-677.

[21]Cherukuri U. Rao and Robert H. Litzenberger, "Leverage and the Cost of Capital in a Less Developed Capital Market: Comment," _Journal of Finance_, XXVI (June, 1971), 777-785.

A study by Benishay examined empirically the effects of various factors, including financial leverage, on rates of return on equities of fifty-six companies from various industries, selected on the basis of criteria not fully explained.[22] Unaccountably, he used as a measure of return a weighted average of after-tax earnings such that 10/18 of the weight is given to a year of study and 1/18 of the weight to each of the eight preceding years. The study is of interest from the standpoint of the light it sheds on the influence of certain factors such as company size. However, it does not shed any light on the controversy over the influence of financial leverage. On this point, Benishay commented, "The debt-equity ratio relationship shows inconclusive results difficult to interpret unequivocally."[23]

In an ambitious study, Arditti empirically examined the relationship between the return realized by holders of stocks in Standard and Poor's Composite Index and various risk measures, including the first three moments of the probability distribution of returns and a measure of financial leverage.[24] As a measure of return he used the geometric mean of annual returns (dividends plus capital gains)

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[22]Haskel Benishay, "Variability in Earnings-Price Ratios of Corporate Equities," _American Economic Review,_ LI (March, 1961), 81-94.

[23]_Ibid.,_ p. 93.

[24]Fred D. Arditti, "Risk and the Required Return on Equity," _Journal of Finance,_ XXII (March, 1967), 19-36.

realized over the period 1946 to 1963. As a measure of financial leverage he used the arithmetic mean of the long-term debt-to-equity ratio over the same period. The study thus does not lend itself to an unambiguous determination of the effect of financial leverage on the cost of capital. The study is interesting primarily from the standpoint of investigating significance of the moments of the probability distribution of returns as measures of risk perceived by the investor in equity shares.

Cohen and Smyth also performed a study of the effect of various factors, including financial leverage, on the price-earnings ratios of equity shares in 203 of the largest United States industrial firms.[25] Their data was based on seven-year averages ending in 1968. Their model was not structured in a manner to permit testing of the Modigliani-Miller hypothesis. As they state, "it appears that our regression is not relevant to the MM controversy."[26] Their results are allegedly of interest from the standpoint of practical financial management. However, even such a claim must be questioned. It is difficult to ascribe any meaning to a cross-sectional analysis based on data averaged over such a long period.

Malkiel and Cragg performed a study of price-earnings ratios of 178 companies in which they used historical measures

[25]Stanley Cohen and David J. Smyth, "Some Determinants of Price-Earnings Ratios of Industrial Common Stock," Quarterly Review of Economics and Business, XIII (Winter, 1973), 49-60.

[26]Ibid., p. 54.

of share price, earnings instability, and financial leverage; and financial analysts' predictions of earnings, dividend payout ratio, and earnings growth rate.[27] Although a test of the Modigliani-Miller hypothesis was not the primary purpose of the paper, the results were interpreted to support the hypothesis. The difficulty with this approach is that it is impossible to know what the analysts' predictions really represent and just what they took into account, both objectively and subjectively, in arriving at their predictions. Therefore, the study must be discounted as evidence bearing on the Modigliani-Miller controversy.

Robichek, Higgins, and Kinsman reported the results of yet another study of the effect of financial leverage on the cost of capital in the electrical utility industry by means of a cross-sectional regression analysis of equity yields.[28] They tried to avoid difficulties encountered by other investigators of the effect of leverage in the electric utility industry by abandoning any effort to test the Modigliani-Miller hypothesis. They did not take into account the effect of variables other than leverage. The results they obtained in this way they believed would be of interest for practical

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[27]Burton G. Malkiel and John G. Cragg, "Expectations and the Structure of Share Prices," American Economic Review, LX (September, 1970), 601-617.

[28]Alexander A. Robichek, Robert C. Higgins, and Michael Kinsman, "The Effect of Leverage on the Cost of Equity Capital of Electric Utility Firms," Journal of Finance, XXVIII (May, 1973), 353-367.

application by financial managers or regulators. They stated

their objective in the following words:

> Thus, the results to be reported in this study
> should be considered as simply measuring the effect
> of the leverage variable (however defined) on the
> cost of equity capital. They should not be inter-
> preted as a test of [the Modigliani-Miller hypothe-
> sis].[29]

The fallacy in this approach is that the financial manager

or regulator must make a decision for a particular company

in a particular environment which may not correspond to that

of the group of companies included in the study. With no

control variables introduced into the regression analysis,

there is no assurance that the observed variation of cost of

capital is actually due to variation of financial leverage.

Part or all of the effect attributed to variation of finan-

cial leverage may, actually, be due to variation of other

factors that were correlated with financial leverage.

Another approach that has been taken in attempting to

develop empirical evidence on the effect of capital struc-

ture on the cost of capital is to test for the existence of

differing financial structures in different industries. The

relevance of such arguments is commented on by Solomon:

> One kind of evidence in favor of the traditional
> position is that companies in the various industry
> groups appear to use leverage as if there is some
> optimum range appropriate to each group. While
> significant intercompany differences in debt ratios
> exist within each industry the average usage of

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[29]Ibid., pp. 355-356.

leverage by broad industry groups tends to follow
a consistent pattern over time.[30]

Guthmann and Dougall have made a similar observation:

> . . . the adherence to similar financial standards
> by major companies in certain industries indicates
> that they may have hit upon an industry pattern of
> financing that represents a search for optimum
> capital structure. The major electric utility and
> consumer finance companies have fairly common finan-
> cial patterns and are characteristically heavy users
> of debt. Neither industry could accept the idea
> that an all-common stock or a low-debt capital
> structure would offer the same overall cost of
> capital and the same market value of total capital
> structure as a financial plan that includes large
> debt.[31]

One study that adopted this approach was that of Schwartz and

Aronson.[32] Their study included analyses of the financial

structure of firms from four broad classes: railroads, utili-

ties, mining companies, and industrials. They performed

F-tests of the hypothesis that intra-industry debt-equity

ratios could be considered as samples from the same popula-

tion. On the basis of these tests, they concluded that firms

in any given class tend to adopt a certain financial struc-

ture. Hence, they conclude that there must exist an optimal

financial structure, thus supporting the traditional view

of the effect of financial leverage. There are, however,

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[30]Ezra Solomon, The Theory of Financial Management
(New York, Columbia University Press, 1963), p. 98.

[31]Harry G. Guthmann and Herbert E. Dougall, Corporate
Financial Policy, 4th ed. (Englewood Cliffs, Prentice-
Hall, Inc., 1962), p. 235.

[32]Eli Schwartz and J. Richard Aronson, "Some Surrogate
Evidence of the Concept of Optimal Financial Structure,"
Journal of Finance, XXII (March, 1967), 10-18.

objections which can be made to the tests. In an effort to overcome these objections, Scott performed another study, the results of which were published in 1972.[33] His study differed from the earlier study in several respects. He examined the financial structure in twelve industries rather than in only four. Furthermore, the industries which he selected did not include regulated industries, as did the earlier study. Scott felt that inclusion of regulated industries in the study could bias results since the regulatory process may influence preferred financial structure in those industries. Finally, he conducted tests for each year in a continuous ten-year period, thus testing for persistence of financial structure patterns. He found that there was strong evidence of differing financial structure in different industries. However, there remains a fundamental problem in the interpretation of the results. The mere fact that firms in some class tend toward the same financial structure does not necessarily imply that that structure is optimal for the class. Solomon commented on this point as follows:

> While significant intercompany differences in debt
> ratios exist within each industry the average usage
> of leverage by broad industry groups tends to follow
> a consistent pattern over time. However this kind
> of observation in itself is not proof that an optimum
> leverage structure actually exists. Convincing proof
> that a company is actually better off, in the sense
> that it has a higher market value or a lower overall

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[33]David F. Scott, Jr., "Evidence on the Importance of Financial Structure," _Financial Management_, I (Spring, 1972), 45-50.

cost of capital, at one level of leverage rather than another is hard to find.[34]

Two other studies should be mentioned here. A study of a sample of eighty-six utility firms and of another sample of thirty-nine electronics firms was performed by Van Horne and McDonald to illustrate a proposed new technique for investigating the impact of dividend policy on price-earnings ratios.[35] A measure of financial leverage was included as an additional explanatory variable. However, the model employed by them admittedly exhibited empirical shortcomings even for its intended purpose of investigating the impact of dividend policy. The authors considered the study as merely demonstrating the proposed technique. Another study directed primarily at investigating the impact of dividend policy on the cost of capital was performed by Higgins.[36] He studied a sample of eighty-one electric utilities. Although the model employed by Higgins took into account a measure of financial leverage, the measure of financial leverage was incorporated in such a way that its impact could not be isolated.

[34]Solomon, Financial Management, p. 98.

[35]James C. Van Horne and John G. McDonald, "Dividend Policy and New Equity Financing," Journal of Finance, XXVI (May, 1971), 507-519.

[36]Robert C. Higgins, "Growth, Dividend Policy and Capital Costs in the Electric Utility Industry," Journal of Finance, XXIX (September, 1974), 1189-1201.

In summary, a review of the literature on existing empirical evidence regarding the effect of financial leverage on the cost of capital shows that the only rigorous tests of the Modigliani-Miller hypothesis have been performed by making use of the results of cross-sectional regression analysis of financial data on companies in the electric utility industry. Unfortunately, as shown in Chapter I of this dissertation, the electric utility industry is a poor testing ground for this purpose. As a result, the question of the validity of the Modigliani-Miller hypothesis in the real world remains unanswered.

CHAPTER III

DESIGN OF THE REGRESSION MODEL

The Modigliani-Miller hypothesis regarding the effect of financial structure of the firm on the cost of capital to the firm was announced in an article published in 1958.[1] In that article Modigliani and Miller set forth two propositions. In Proposition I, they asserted that the value of the firm is independent of financial structure. This proposition implies that the average cost of capital is not affected by financial leverage. However, the crucial issue is contained in Proposition II, a corollary of Proposition I. This proposition specifies the relation between the cost of equity capital and the financial structure of the firm. According to Proposition II, the expected equity yield k_e of a firm belonging to a given risk class is given by

$$k_e = k_0 + (k_0 - r)D/S \qquad (1)$$

where

k_0 = capitalization rate for a pure equity stream of income in the class, net of taxes

r = capitalization rate for a sure stream of income

D = debt of the firm

S = value of common shares of the company

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[1]Franco Modigliani and Merton H. Miller, "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review*, XLVIII (June, 1958), 262-297.

After a reconsideration of the effect of corporate income tax, Modigliani and Miller revised their original propositions.[2] In Proposition I, then, the assertion is that, aside from the income tax advantage of debt, the value of the firm is independent of financial structure. In the amended form of Proposition II, the after-tax expected yield is given by

$$k_e = k_o + (1 - T)(k_o - r)D/S \qquad (2)$$

where

T = marginal income tax rate

In 1977, Miller concluded that when personal as well as corporate income taxes are considered, the original form of the hypothesis is the correct one.[3] Therefore, according to the Miller-amended version of the hypothesis, expected equity yield is given by equation (1), even in a world with income taxes.

Either Proposition I or Proposition II may be used as the basis of a test of the Modigliani-Miller hypothesis. Modigliani and Miller used Proposition I as the basis of their two tests. Thus, in their work, the focus was on the average cost of capital. In the research reported in this dissertation, Proposition II is used as the basis of the test. Thus, the focus is on the cost of equity capital; and equation (1)

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[2]Franco Modigliani and Merton H. Miller, "Corporate Income Taxes and the Cost of Capital: A Correction," American Economic Review, LIII (June, 1963), 433-443.

[3]Merton H. Miller, "Debt and Taxes," Journal of Finance, XXXII (May, 1977), 261-275.

or (2) is used as the basis of the regression model employed in the study. Measurement problems and the selection of additional explanatory variables will be discussed below.

The Dependent Variable

The first choice to be made is that of a variable to be used as a proxy for expected equity yield. A measure of yield that is sometimes used is the earnings-price ratio. This measure was the one used in the studies initially cited by Modigliani and Miller in support of their hypothesis.[4] However, the earnings-price ratio is an appropriate measure of equity yield only in the static situation of a no-growth company. A number of common share valuation models (from each of which a measure of equity yield may be derived) have been developed for application to the dynamic situation of a growing company. These include the Gordon-Shapiro dividend valuation model, the Walter dividend valuation model, the Solomon investment opportunities model, the earnings valuation model, and the discounted-cash-flow model. However, it can be shown that all of these models are formally equivalent.[5] Hence, the computed value of expected equity yield is not

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[4]Ferry B. Allen, "Does Going into Debt Lower the 'Cost of Capital'?" Analysts Journal, X (August, 1954), 58.

[5]For a demonstration of this equivalence, see Eugene F. Fama and Merton H. Miller, The Theory of Finance (New York, Holt, Rinehart and Winston, Inc., 1972), pp. 86-92; James C. T. Mao, Quantitative Analysis of Financial Decisions (New York, Macmillan Company, 1969), pp. 471-477; and George C. Philippatos, Financial Management: Theory and Technique (San Francisco, Holden-Day, Inc., 1973), pp. 364-374.

affected by the choice of valuation model. The most convenient measure, and a widely-used one, is that derived from the Gordon-Shapiro model.[6] According to this model, if earnings and dividends grow at the rate g, the expected yield is given by

$$k_e = (d/p) + g \qquad\qquad (3)$$

where

k_e = expected equity yield

d = current annual dividend

p = market price per share of common stock

g = annual growth rate of earnings.

This measure of equity yield is the one selected for use in testing the Modigliani-Miller hypothesis in this study.

It does not necessarily follow that the yield defined by equation (3) must be used in the regression model. The purpose of the regression model is to determine the degree of investor response to debt-equity ratio in formulating the market valuation of required return on equity. For this purpose, either the earnings-price ratio or the dividend-price ratio could be used, since the two are directly related by the payout ratio. The choice is to be made on the basis of which measure acts as the most convenient and sensitive indicator of investor response. For this purpose, it is helpful to consider the nature of company dividend policy.

Lintner conducted an empirical investigation of company dividend policy in which he found that most managements make

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[6]Burton G. Malkiel, _The Debt-Equity Combination of the Firm and the Cost of Capital: An Introductory Analysis_ (New York, General Learning Press, 1971), p. 8.

a strong effort to maintain stability of dividend payments.[7]
There tends to be, therefore, a strong bias against change
of the current dividend rate. He noted,

> With the possible exception of 2 companies which
> sought a relatively fixed percentage pay-out,
> consideration of what dividends should be paid at
> any given time turned, first and foremost in every
> case, on the question whether the existing rate of
> payment should be changed.[8]

In addition, even when a change was made, there was a notable
lag in responding to the full amount of change justified by
current financial data. With respect to this point, he
stated,

> The principal device used to achieve this consistent
> pattern was a practice or policy of changing divi-
> dends in any given year by only part of the amounts
> which were indicated by changes in current financial
> figures. Further partial adjustments in dividend
> rates were then made in subsequent years if still
> warranted.[9]

Thus, in information theoretic terms, management policy acts
as a filter between financial performance of the firm and an-
nounced dividend rates. Such a filter acts to smooth out
random fluctuations; i.e., it removes noise content of sig-
nals emanating from the firm. This removal of noise content
could, of course, be beneficial for the purpose being con-
sidered here. However, unfortunately, a filter of this type
also attenuates any information content of the signals with

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[7]John Lintner, "Distribution of Incomes of Corporations
among Dividends, Retained Earnings, and Taxes," American
Economic Review, XLVI (May, 1956), 97-113.

[8]Ibid., p. 99.   [9]Ibid., p. 100.

comparable periodicities. Since the regression process itself
acts to suppress random fluctuations (without suppressing in-
formation content, since the process acts on cross-sectional
data rather than on time-series data), it is believed that
potential loss of information is more significant than the
added noise suppression resulting from dividend policy de-
cisions. Perhaps an even more important consideration is the
fact that the filtering process is not uniformly applied from
company to company. On this point, Lintner reported,

> With respect to speed of adjustment, two companies
> sought to make a reasonably full adjustment in
> dividends within each year, while most of the others
> generally sought to move some part of the way within
> each year. Among the latter, the fraction generally
> "made up" in each year varied from one-half to as
> little as one-fifth or one-sixth.[10]

The general nature of the Lintner study was confirmed by a
later study conducted by Fama and Babiak.[11]

As a result of a consideration of the above-described
characteristics of dividend payments, it was concluded that
the earnings-price ratio was a superior selection as the yield
variable in the regression model. Of course, it is possible
that investors are influenced in their valuation of the earn-
ings stream by the dividend rate. However, such influence
can be taken into account by including a dividend-rate

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[10]Ibid., pp. 102-103.

[11]Eugene F. Fama and Harvey Babiak, "Dividend Policy:
An Empirical Analysis," Journal of American Statistical
Association, LXIII (December, 1968), 1132-1161.

variable as one of the independent variables. This topic will be discussed below.

The denominator of the earnings-price ratio was taken as the price at the close of the cross-section year. The numerator was taken as equal to earnings per share as reported, less extraordinary items, for the four most recent quarters preceding the end of the cross-section year.

Financial Leverage

The primary independent variable in the regression model is, of course, a measure of financial leverage. The specific measure used is the debt-equity ratio. In establishing the precise definition of this ratio, three questions had to be answered. One question was whether the debt-equity ratio should be defined in terms of market values or book values of debt and equity. Another question was concerned with which claims against assets of the firm should be included in debt for the purpose of computing the debt-equity ratio. Finally, of course, there was the question of which claims should be included in equity. These questions are addressed in sequence below.

Book or Market Value

Modigliani and Miller used market values for the debt-equity ratio in the original statement of their hypothesis. Therefore, there is an initial presumption in favor of market values. However, there are cogent reasons for considering

the book value of debt-equity ratio to be a superior measure of financial leverage for a study such as the one reported in this dissertation.

In the first place, there is the problem of spurious correlation. The dependent variable is defined in terms of the ratio of an income to the market price of equity. Thus, if the debt-equity ratio were defined in terms of the market values, the market value of equity would appear in the denominator of terms on both sides of the equation. To the extent that there are uncorrelated components present in the numerator and denominator of the debt-equity ratio, this relationship would lead to spurious correlation of the dependent variable with the debt-equity ratio in the regression model and consequent positive bias in the estimated coefficient of the debt-equity ratio.

In the second place, the market value of debt-equity ratio is not a pure measure of financial risk but incorporates elements of business risk as well.[12] That this confusion exists can be appreciated by considering the fact that an increase in business risk to which a firm is subject may result in a decrease in the market value of the firm's common shares that is not accompanied by commensurate decrease in the market value of the firm's debt. Thus, variation in business

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[12]The possibility of this confusion was first noted by Alexander Barges, The Effect of Capital Structure on the Cost of Capital (Englewood Cliffs, N.J., Prentice-Hall, Inc., 1963), pp. 26-31.

risk to which a firm is subject can alter the market value of the debt-equity ratio.

In the third place, the market value of the debt-equity ratio is an unstable quantity and its value at any given point in time may be very difficult to establish. The vagaries of the stock market are sufficient to cause the market values of stocks to be highly unstable although, for actively traded issues, easy to establish at any particular time. On the other hand, the market value of debt, while not normally subject to as much variation as the market value of equity, may be very difficult to establish. A firm typically has numerous outstanding debt issues, with differing coupon rates and maturity dates. Except for certain fairly actively traded bond issues, the market value of debt must be established by applying an appropriate discount rate to the remaining interest payments. The valuation process is thus likely to be a difficult and uncertain one. As a result, it seems highly unlikely that investors would use such an approach to evaluating financial risk as an element in the investment decision-making process. This belief is reinforced by the fact that stock analyses provided by leading investor service companies contain data on the book value of debt while no consideration is given to the market value of debt.[13]

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[13]See, for example, The Value Line Investment Survey (New York, Arnold Bernhard and Co.); Moody's Handbook of Common Stocks (New York, Moody's Investor's Service, Inc.); and Standard Stock Reports (New York, Standard and Poor's Corporation).

Finally, the market value of the debt-equity ratio is an inappropriate measure for management control. Selection of an objective debt-equity ratio is a strategic decision, not a short-term tactical decision. Therefore, to be appropriate for management control of financial leverage, a measure which possesses some stability is required. Furthermore, it should be a pure measure of financial risk, not intermingled with business risk. If a study such as the one reported in this dissertation is to have any value in the field of financial management, the financial leverage variable must be one that would be useful for purposes of management control.

For the reasons cited above, the book value of debt-equity ratio was selected for use in this study.

Debt Claims

In some previous studies of this subject, financial leverage was defined so that it was concerned only with the capital structure of the company; i.e., only equity and long-term debt were taken into account. However, a debt-equity ratio which takes into account only these two factors is a poor measure of financial risk. On this point, Christy and Roden state:

> Including all short-term debt in this ratio [the debt-equity ratio] is extremely important. Short term debt is inherently more dangerous to business than long term debt is. By definition, not only interest, but also the principal amount, of short term debt must be paid off within the

coming year. With long term debt, only interest payments are due during the next twelve months.[14]

Schwartz made the following comments on this subject:

> For many writers on corporation finance the term "the capital structure of the firm" seems to include only those sources of funds which are represented by securities. This is too narrow a definition. . . . In its arbitrary distinction it implies that the borrower's risk involved in securing funds through fixed debt is somehow greater than borrowing on current account. (The reverse is likely to be true.) . . . The adoption of this broader definition of financial structure, i.e., the liability and net-worth side of the balance sheet, allows us to concentrate on what is recognized as the best single measure of gross risk--the ratio of total debt (including current items) to net worth.[15]

Therefore, the financial leverage variable used in this study does not ignore short-term obligations.

There is also a question of how preferred stock should be handled. Although in a legal and accounting sense preferred stock has the status of an equity claim, its leverage effect on common-share earnings is that of debt. Therefore, preferred stock is included in the definition of debt.

The defining equation for debt is:

$$\text{debt} = \text{current liabilities} - \text{cash and equivalent} +$$
$$\text{long-term debt} + \text{preferred stock}$$

Current liabilities are reduced by the amount of cash and equivalent because liabilities incurred to support the latter

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[14]George A. Christy and Peyton Foster Roden, _Finance: Environment and Decisions_ (New York, Canfield Press, 1976), p. 240 n.

[15]Eli Schwartz, "Theory of the Capital Structure of the Firm," _Journal of Finance_, XIV (December, 1959), p. 19.

do not contribute to financial risk to the same degree as do
other liabilities.

Equity Claims

The defining equation for equity in the debt-equity
ratio is:

equity = common equity + deferred income

taxes + investment tax credit

Deferred income taxes and investment tax credit, although
treated as liabilities for accounting purposes, are here in-
cluded in equity because this treatment results in a debt-
equity ratio that is more accurately representative of
relative financial risk.

The issue of how postponed disbursements for income tax
should be reported has been the subject of heated debate.
The Accounting Principles Board considered the subject at
length and concluded in favor of interperiod allocation of
income taxes. This method is prescribed for postponed income
tax resulting from accelerated depreciation. However, either
the deferral or the flow-through method of accounting is ac-
ceptable for investment tax credits.[16]

The stand of the Accounting Principles Board is based on
the concept that, from a fundamental accounting standpoint,
postponed taxes are a liability that should be recognized as

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[16]Current Text, Vol. I of APB Accounting Principles,
2 vols. (New York, Commerce Clearing House, Inc., 1973),
pp. 2651-2653 and 2683-2687.

are other accrued expenses. However, from the standpoint of establishing financial risk, deferred taxes represent a liability which is junior to other liabilities. In the case of stable or increasing investment in depreciable assets, the deferred income tax account may never be reduced. The same is true in the event of steeply declining revenues. Furthermore, in the case of the investment tax credit, its inclusion in equity has the advantage of placing companies which practice flow-through accounting on an equal basis with those which practice deferral accounting.

Other Independent Variables

Equation (2) can be translated into the following simple regression model:

$$Y_i = a_o + a_1 H_i + u_i \qquad i = 1, \ldots, n$$

where

Y_i = earnings-price ratio for the ith firm

H_i = debt-equity ratio for the ith firm

u_i = ith value of the disturbance term

n = number of firms for which data are available

and a_o and a_1 are unknown parameters. This regression model could then be exercised with the available observations to obtain estimates of the unknown parameters, which could then be compared with the theoretical values obtained from equation (2). As noted in Chapter II, this approach was used by several previous investigators. A problem arises, however, with this approach in that investors are influenced by factors

other than the debt-equity ratio in establishing the market value of the earnings-price ratio. If the omitted variables are not correlated with the debt-equity ratio, no error in the estimated influence of debt-equity ratio is incurred by the omission. However, if the omitted variables are significantly correlated with the debt-equity ratio, the debt-equity ratio is in essence being required to act as a proxy for the omitted variables. The omission of highly correlated variables can, therefore, seriously bias the estimate of the coefficient of the debt-equity ratio.[17] Therefore, additional dependent variables which may influence the earnings-price ratio established by the market were included in the regression model used in this study. These additional variables will be discussed below.

Business Risk

The debt-equity ratio captures only financial risk of the firm, i.e, risk occasioned by financial structure of the firm. However, every firm, even the unleveraged firm, is subject to another form of risk that is commonly called business risk. Robichek and Myers note:

> Customarily a distinction is made between "business risk" and "financial risk." Business risk is the risk inherent in the physical operations of the firm; it arises simply from the inability to insure absolutely stable sales, costs, and profits. The corporation cannot be entirely protected from the vicissitudes of the market. Business risk exists

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[17]For a discussion of the effect of omitted variables, see Carl F. Christ, Econometric Models and Methods (New York, John Wiley and Sons, Inc., 1966), pp. 388-389, or E. Malinvaud, Statistical Methods of Econometrics, translated by Mrs. A. Silvey (Chicago, Rand McNally and Company, 1966), pp. 263-266.

independently of the means by which the firm is financed.[18]

As noted in Chapter II, a number of investigators have based their studies of the effect of financial leverage on the assumption that firms in a given industry constitute a uniform risk class; i.e., that firms in the same industry are subject to equivalent degrees of business risk. However, there is reason to doubt the validity of that assumption. Wippern conducted an empirical test of the equivalent risk class hypothesis.[19] He analyzed data from sixty-one firms distributed over eight industries. As a proxy for the business risk of a firm he used the variability of earnings before interest and taxes of the firm as measured by the antilog of the standard error of the logarithmic regression of income before interest and taxes on time for the ten-year period of 1954 to 1963. The arithmetic mean of these measures for the firms in each industry was then obtained. Finally, the difference between the means for each pair of industries was calculated. This process yielded a matrix of twenty-eight differences which were then tested for statistical significance. Of the twenty-eight differences, only three were found to be significant at the 5 percent level. The latter

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[18]Alexander A. Robichek and Stewart C. Myers, Optimal Financing Decisions (Englewood Cliffs, N.J., Prentice-Hall, Inc., 1965), p. 17.

[19]Ronald F. Wippern, "A Note on the Equivalent Risk Class Assumption," Engineering Economist, XI (April-May, 1966), 13-22.

three differences involved the electric utility industry. The electric utility industry is generally thought of as having a high degree of homogeneity among individual firms within the industry. Yet even the electric utility industry could not be differentiated from four of the seven other industries at the 5 percent level of significance. In general, the analysis indicated that there is as much variation within industry groups as there is among them. Wippern concluded that his analysis "provides clear evidence that industry groups do not provide an adequate basis on which to insure homogeneity of basic business uncertainty."[20] As a result, he was convinced that there is much to be gained in conceptual and statistical validity by introducing explicit measures of basic business risk into empirical analyses. Further tests of the industry risk-class hypothesis were conducted by Gonedes, considering additional industries and using different (nonparametric) statistical techniques.[21] As a proxy for the business risk of a firm he used the relative deviation of the firm's annual rate of growth in earnings before interest and taxes from the firm's compound rate of growth over the ten-year period of 1958-1967. The results of his tests were consistent with those of Wippern.

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[20]Ibid., p. 19.

[21]Nicholas J. Gonedes, "A Test of the Equivalent-Risk Class Hypothesis," Journal of Financial and Quantitative Analysis, IV (June, 1969), 159-177.

As a result of the considerations discussed above, an explicit measure of business risk was included in the regression model used in the studies reported in this dissertation. Since business risk is risk that "exists independently of the means by which the firm is financed," the measure of business risk used must be independent of the financial structure of the firm. Earning power is a measure of profitability which is independent of the financial structure of the firm; and this quantity was separately introduced into the regression model for reasons discussed below. The variability of earning power, as measured by the coefficient of variation based on an eight-year historical record ending in the cross-section year, was used as a measure of business risk.

Firm Size

Investor valuation of the firm may also be influenced by the size of the firm. The rationale supporting this hypothesized effect has been discussed by Benishay.[22] He gave three reasons for believing that, ceteris paribus, increased size would cause investors to increase their valuation of the firm. In the first place, shares of larger firms tend to be traded more actively than those of smaller firms. Consequently, share price is less likely to be affected adversely by block transactions. This attribute, of course, makes the

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[22]Haskel Benishay, "Variability in Earnings-Price Ratios of Corporate Equities," *American Economic Review*, LI (March, 1961), 81-94.

shares more attractive to institutional holders. In the second place, large firms are more widely known. Therefore, less well-informed investors tend to concentrate their holdings in shares of the larger corporations. Finally, shares of larger firms are considered safer holdings by many investors because they believe that the larger firm is less likely to suffer serious consequences from adverse environmental conditions.

Two empirical tests of the effect of firm size on earnings-price ratios have been conducted in the electric utility industry. As discussed in Chapter II, Weston conducted an empirical study of the effect of financial leverage on the average cost of capital for an unspecified number of firms in the electric utility industry for the year 1959. In the course of that study, he investigated the effect of firm size on earnings-price ratios and concluded that it had no significance.[23] The second test was one conducted by Brigham, who used a multiple regression model to investigate the effect of various factors, including firm size, on earnings-price ratios for 113 companies in the electric utility industry during the years 1953 through 1961. He found that firm size had no significant influence.[24]

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[23] J. Fred Weston, "A Test of Cost of Capital Propositions," Southern Economic Journal, XXX (October, 1963), 109.

[24] Eugene F. Brigham, "Cost of Equity Capital to Electric Utilities," Public Utilities Fortnightly, LXXIV (September 24, 1964), 25-35.

As reported in Chapter II, Miller and Modigliani conducted a test of their leverage hypothesis on a sample of sixty-three electric utility companies for the years 1954 through 1957. They investigated the effect of leverage on the average cost of capital by means of a multiple regression model that included a size variable. They concluded that increasing firm size had an inconsequentially small negative influence on the average cost of capital.[25]

A study performed by Archer and Faerber was specifically directed toward investigating the influence of firm size on the cost of equity capital obtained from new common stock flotations.[26] They performed multiple regression analysis of data obtained from the prospectuses of 238 manufacturing firms which issued stock during the years 1960 through 1962. About 55 percent were issues of shares for which no previous public market existed. Earnings-price ratios were based on issue prices per share. They found that the size of the stock issue had substantial influence, but that the size of the firm issuing the stock had only slight influence. However, it may be questioned whether Archer and Faerber were working with a sample that was representative of the general population of stocks. It is possible that substantial bias was introduced

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[25]Merton H. Miller and Franco Modigliani, "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-1957," American Economic Review, LVI (June, 1966), 373.

[26]Stephen H. Archer and LeRoy G. Faerber, "Firm Size and the Cost of Externally Secured Equity Capital," Journal of Finance, XXI (March, 1966), 69-83.

by the fact that the sample consisted entirely of companies which issued new stock during the period under consideration and by the presence of such a large percentage of unseasoned issues.

Three investigators considered the effect of company size among other factors on earnings-price ratios for firms outside the electric utility industry. Benishay performed cross-sectional regression analyses of financial data for fifty-six companies for the years 1954 through 1957.[27] He found consistent, highly significant inverse relation between earnings-price ratio and firm size. Wippern included firm size in his study of the effect of financial structure on the cost of capital.[28] He performed multiple regression analyses of financial data for fifty industrial firms for the years 1956, 1958, 1961, and 1963. As did Benishay, he found significant inverse relation between earnings-price ratios and firm size. The third study was one by Cohen and Smyth in which they considered a sample of companies consisting of 203 of the largest American industrial firms.[29] They performed a single

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[27]Haskel Benishay, "Variability in Earnings-Price Ratios of Corporate Equities," American Economic Review, LI (March, 1961), 81-94.

[28]Ronald F. Wippern, "Financial Structure and the Value of the Firm," Journal of Finance, XXI (December, 1966), 615-633.

[29]Stanley Cohen and David J. Smyth, "Some Determinants of Price/Earnings Ratios of Industrial Common Stock," Quarterly Review of Economics and Business, XIII (Winter, 1973), 49-60.

cross-sectional regression analysis of financial data averaged
over the seven-year period ending in 1968. In contrast to
Benishay's and Wippern's findings, their results showed no
significant variation in earnings-price ratios due to firm
size. However, these negative findings may have been due to
the fact that they were working with only very large firms.

In summary, there is no evidence to indicate any signifi-
cant influence of firm size on earnings-price ratios in the
electric utility industry. However, there is at least some
evidence of significant inverse relation between earnings-
price ratio and firm size for companies outside the electric
utility industry. Therefore, a variable representing firm
size was included in the regression model employed in the
study reported in this dissertation. In consonance with most
previous investigations, the specific measure of firm size
employed was the logarithm of total assets of the firm. The
logarithm of assets, rather than the value itself, was used
because it seems reasonable to believe that the sensitivity
of earnings-price ratio to firm size would decrease in an
approximate exponential manner.

It is possible that investors might be influenced in
their valuation of the firm by the way in which assets are
distributed between fixed assets and current assets. There-
fore, an additional variable in the form of the ratio of
current assets to total assets was also included.

Earning Power

Another factor which investors may take into account in their valuation of the firm is management ability. Graham, Dodd, and Cottle observed, "Picking a company with a good management is considered by many to be even more important than picking a company in a promising industry."[30] A similar sentiment is expressed by Christy and Clendenin in a contemporary investments text: "An unstable or poorly managed firm often does poorly under excellent conditions, even as a strong firm sometimes does well in a faltering industry."[31] It is true, of course, that good management is reflected in earnings performance of the company, and earnings data are already reflected in the regression model via the dependent variable. However, it is believed that, in addition to taking into account earnings, investors assign an independent premium for good management. On this point, Graham, Dodd, and Cottle noted:

> There is a strong tendency in the stock market to value the management factor twice in its calculations. Stock prices reflect the large earnings which the good management has produced, plus a substantial increment for "good management" considered separately.[32]

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[30]Benjamin Graham, David L. Dodd, and Sidney Cottle, Security Analysis: Principles and Technique, 4th ed. (New York, McGraw-Hill Book Company, 1962), p. 90.

[31]George A. Christy and John C. Clendenin, Introduction to Investments, 6th ed. (New York, McGraw-Hill Book Company, 1974), p. 303.

[32]Graham, Dodd, and Cottle, Security Analysis, p. 90.

Therefore, the regression model should include a variable to act as proxy for investors' assessment of the quality of management. The question then arises as to how the investor formulates a judgment of management. Regarding this problem, Christy and Clendenin state,

> It is difficult for an investor to appraise a corporate management from published reports. The list of directors may be examined to note their other corporate connections, and the occasional public relations-inspired biographical letters "about our executives" may be read, but these are of limited value. More reliable impressions can often be obtained by personal observation of company employees and representatives. . . . Mostly, however, the investor must judge management by its ability to make profits.[33]

Therefore, a good measure of profitability should be a useful proxy for management ability. One of the best measures of profitability is earning power. Regarding this measure, Christy and Roden state,

> Perhaps the best measure of profitability is earning power. Indeed, this is the specific ratio that most people have in mind whenever they use the term profitability. . . . The advantage in using this measure to represent profitability is that it shows management's ability to use the firm's assets to generate earnings on its invested capital.[34]

As the result of a consideration of the factors discussed above, earning power was included in the regression model employed in this research. The defining equation for earning

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[33]Christy and Clendenin, Introduction to Investments, p. 309.

[34]George A. Christy and Peyton Foster Roden, Finance: Environment and Decisions, 2nd ed. (New York, Canfield Press, 1976), p. 228.

power E utilized in this study was

$$E = \frac{\text{operating income before depreciation - depreciation}}{\text{net plant + current assets}}$$

Thus, intangible assets and investments are omitted from the denominator and income derived from investments is omitted from the numerator. Only assets under direct control of company management and income derived from them is considered in the measure of profitability.

Earnings Growth

As early as 1938, Williams recognized growth as a factor which should properly be taken into account in stock valuation models.[35] In 1956, Walter[36] as well as Gordon and Shapiro[37] extended Williams' work and introduced simple stock valuation models based on the concept of capitalizing a growing stream of dividends. Following this introduction, various similar models were developed and utilized by professional securities analysts.[38] A number of investigators have conducted

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[35]John Burr Williams, The Theory of Investment Value (Amsterdam, North Holland Publishing Company, 1938), pp. 87-96.

[36]James E. Walter, "Dividend Policies and Common Stock Prices," Journal of Finance, XI (March, 1956), 29-41.

[37]Myron J. Gordon and Eli Shapiro, "Capital Equipment Analysis: The Required Rate of Profit," Management Science, III (October, 1956), 102-110.

[38]For example, see Paul F. Wendy, "Current Growth Stock Valuation Methods," Financial Analysts Journal, XXI (March-April, 1965), 91-103; and Nicholas Molodovsky, Catherine May, and Sherman Chottiner, "Common Stock Valuation," Financial Analysts Journal, XXI (March-April, 1965), 104-123.

empirical studies based on cross-sectional regression analysis and have concluded that historical growth measures had significant influence on equity capitalization rates.[39] There is, therefore, ample reason for including a measure of growth in the regression model reported in this dissertation.

The question remains as to what type of growth measure should be used. The only extensive investigation of the effectiveness of various types of growth measures in explaining earnings-price ratios for stocks outside the electric utility industry was conducted by Malkiel and Cragg.[40] In a regression study of 178 corporations for the years 1961 through 1965, they found the ten-year growth rate of earnings per share or the ten-year growth rate of cash earnings per share to be superior measures of growth of about equal merit. The ten-year growth rate of earnings per share was therefore selected as a measure of growth for the study reported in this dissertation.

There is reason to believe that the horizon to which investors project future growth rates varies over time. On this point Malkiel stated,

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[39]For example, see J. Fred Weston, "A Test of Cost of Capital Propositions," _Southern Economic Journal_, XXX (October, 1963), 105-112; Ronald F. Wippern, "Financial Structure and the Value of the Firm," _Journal of Finance_, XXI (December, 1966), 615-633; and Eugene F. Brigham and Myron J. Gordon, "Leverage, Dividend Policy, and the Cost of Capital," _Journal of Finance_, XXIII (March, 1968), 85-103.

[40]Burton G. Malkiel and John G. Cragg, "Expectations and the Structure of Share Prices," _American Economic Review_, LX (September, 1970), 605.

> There is no self-evident appropriate horizon for the projection of growth rates, only a putatively reasonable one. The history of share-price behavior demonstrates ineluctably that investors are at some times willing to take a much longer view than at others. At the beginning of the present decade of the "soaring sixties" it did not seem unreasonable to anticipate with some degree of confidence a decade of substantial growth. At the 1962 market trough investors were unwilling to pay a substantial premium for any growth that was not expected to occur over the fairly immediate future.[41]

It seems reasonable, then, to believe that there may, at times, be similar shifts in the historical horizon to which investors look in assessing the growth record of firms. No reports of empirical investigations of this phenomenon could be found. However, it is to be noted that The Value Line Investment Survey regularly reports both five-year and ten-year growth rates. This approach would allow for a shifting investor horizon in assessing growth records. Therefore, it was decided to include both five-year and ten-year earnings growth rates in the regression model. The method used by The Value Line Investment Survey in calculating growth rates was also adopted. According to this method, the n-year growth rate G is the compounded annual rate of change in earnings defined by the following relation:

$$\frac{e_n + e_{n-1} + e_{n-2}}{3} = \left(\frac{e_0 + e_{-1} + e_{-2}}{3}\right)\left(1 + G\right)^n$$

where e_i represents earnings in the ith year.

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[41]Burton G. Malkiel, "Equity Yields, Growth, and the Structure of Share Prices," American Economic Review, LIII (December, 1963), 1026-1027.

It is to be expected that the two growth rates calculated in this way would be highly correlated with each other. To avoid this undesirable feature, the five-year growth rate was transformed by subtracting from it the ten-year growth rate. Thus, the final growth variables used were G_1, the ten-year growth rate, and G_2, the excess of the five-year growth rate over the ten-year growth rate.

Dividend Payout Rate

There is considerable controversy about whether or not investor valuation of stock shares is influenced by the dividend policy of the firm. Miller and Modigliani have advanced the hypothesis that investors are indifferent between dividends and retained earnings and that the dividend policy of the firm is economically irrelevant.[42] On the other hand, researchers such as Gordon[43] and Walter[44] have provided strong theoretical arguments in favor of the position that investors do take the dividend policy of the firm into account in evaluating common shares of the firm. Empirical tests have not settled the question, evidence being available on both

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[42]Merton H. Miller and Franco Modigliani, "Dividend Policy, Growth, and the Valuation of Shares," _Journal of Business_, XXXIV (October, 1961), 411-433.

[43]M. J. Gordon, "Dividends, Earnings, and Stock Prices," _Review of Economics and Statistics_, XLI (May, 1959), 99-105.

[44]James E. Walter, "Dividend Policy: Its Influence on the Value of the Enterprise," _Journal of Finance_, XVIII (May, 1963), 280-291.

sides of the issue.[45] The conflicting evidence is perhaps

not surprising since it seems reasonable to expect that the

significance that the investor attaches to the dividend pay-

out rate would vary over time.

To complicate the issue further, there is the problem

of what has been called in finance literature the "informa-

tional content" of dividends. It has been argued that divi-

dend rates convey information about future earnings. If this

is the case, then stock valuations could be affected by divi-

dend rates even though investors are indifferent between

dividends and retained earnings. This question was empiri-

cally investigated by Pettit.[46] He concluded that the results

of his investigation "clearly support the proposition that

the market makes use of announcements of changes in dividend

payments in assessing the value of a security."[47] The

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[45]For empirical evidence in support of the dividend
irrelevance hypothesis, see Merton H. Miller and Franco
Modigliani, "Some Estimates of the Cost of Capital to the
Electric Utility Industry, 1954-1957," American Economic
Review, LVI (June, 1966), 333-391; and Robert C. Higgins,
"Growth, Dividend Policy and Capital Costs in the Electric
Utility Industry," Journal of Finance, XXIX (September,
1974), 1189-1201. For empirical evidence in support of the
hypothesis that dividends are relevant, see Eugene F. Brig-
ham and Myron J. Gordon, "Leverage, Dividend Policy, and
the Cost of Capital," Journal of Finance, XXIII (March,
1968), 85-103; and James C. Van Horne and John G. McDonald,
"Dividend Policy and New Equity Financing," Journal of
Finance, XXVI (May, 1971), 507-519.

[46]R. Richardson Pettit, "Dividend Announcements,
Security Performance, and Capital Market Efficiency,"
Journal of Finance, XXVII (December, 1972), 993-1007.

[47]Ibid., p. 1006.

question was also investigated empirically by Watts.[48] Like

Pettit, he found that the results of his tests were consistent

with the hypothesis that dividends do convey information about

future earnings. However, unlike Pettit, he concluded that

> . . . in general, the information content of dividends
> can only be trivial. This conclusion is reinforced
> when one remembers that the results were obtained de-
> spite the selection of specifications of both the
> dividend expectations model and the dividend period
> which were most favorable to the information hypothesis.[49]

As a result of Watts' finding, Pettit reexamined the ques-

tion.[50] He found methodological errors in both his own and

Watts' work. After making corrections for these methodologi-

cal errors, he maintained that his and Watts' results were

consistent and supported the contention that dividend announce-

ments convey relevant information.

It is clear that the issue of investor attitudes toward

dividend rates has not been settled. However, the weight of

the evidence suggests that, for whatever reason, dividend

rates do influence market valuations of common shares. There-

fore, dividend payout rate was included as an independent

variable in the regression model used in the study reported

in this dissertation. For this purpose, the payout rate was

calculated as the ratio of the indicated annual dividend per

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[48]Ross Watts, "The Information Content of Dividends,"
Journal of Business, XLVI (April, 1973), 191-211.

[49]*Ibid.*, p. 211.

[50]R. Richardson Pettit, "The Impact of Dividend and
Earnings Announcements: A Reconciliation," *Journal of
Business*, XLIX (January, 1976), 86-96.

share to the earnings per share at the end of the cross-section year.

Dummy Variables

It was believed that there might be shifts in the earnings-price ratio function, as specified by the independent variables thus far introduced into the regression model, between certain sub-industry groupings of companies within the food industry. Dummy variables were included in the regression model to capture such possible shifts. Sub-industry groupings for which dummy variables were included are soft-drink companies, breweries, and meat-packing companies.[51]

The Regression Model

The dependent and independent variables having been specified, the regression model may be summarized in the form of the following equation:

$$Y_i = a_0 + a_1 H_i + a_2 B_i + a_3 S_i + a_4 C_i + a_5 E_i + a_6 G_{1i} +$$
$$a_7 G_{2i} + a_8 P_i + a_9 D_{1i} + a_{10} D_{2i} + a_{11} D_{3i} + u_i$$

where

$i = 1, \ldots, n$

n = number of firms for which data are available

---

[51]A dummy variable is a binary variable which may be used to indicate the presence or absence of some characteristic. For example, the brewery dummy variable would be assigned a value of one if the company under consideration were a brewery and a value of zero if not.

Y   = earnings-price ratio

H   = debt-equity ratio

B   = business risk variable

S   = natural logarithm of total assets

C   = ratio of current assets to total assets

E   = earning power

G_1 = ten-year growth rate of earnings

G_2 = five-year growth rate of earnings less G_1

P   = dividend payout rate

D_1 = soft-drink dummy variable

D_2 = brewery dummy variable

D_3 = meat-packing dummy variable

u   = disturbance term

The quantities a_j (j = 0,1, . . . , 11) are unknown parameters to be estimated by the regression process. The model was used in a test of the Modigliani-Miller hypothesis as discussed in the next chapter.

CHAPTER IV

RESEARCH RESULTS

As stated in Chapter I, the purpose of the research re-
ported in this dissertation is to conduct an empirical test
of the Modigliani-Miller hypothesis by making use of single-
stage, least-squares, multiple regression analysis. The
input data set and the results obtained are discussed in
this chapter.

The Input Data Set

The input data set consisted of financial data for fifty-
two companies in the food industry for the years 1972 through
1975. The list of companies included in this study is given
in Appendix B. A sub-industry classification of soft-drink
company, brewery, or meat-packing company is noted in paren-
thesis following the company name, where applicable. Major
statistical characteristics of the input data set are con-
tained in Table II.

The fifty-two companies included in this study consist
basically of companies in the food processing and beverage
groups of The Value Line Investment Survey. Criteria for
inclusion in the study were as follows. Firms that are
foreign-based, firms that have recently radically altered
their character, and firms that have a public historical

TABLE II

STATISTICAL CHARACTERISTICS OF INPUT VARIABLES

Cross-Section Year	Measure	Dependent Variable Y	H	B
1972	Mean Standard Deviation Coefficient of Variation	0.0659 0.0277 0.4203	0.6968 0.6187 0.8879	0.1687 0.1358 0.8050
1973	Mean Standard Deviation Coefficient of Variation	0.1032 0.0511 0.4952	0.7169 0.5238 0.7306	0.1642 0.1245 0.7582
1974	Mean Standard Deviation Coefficient of Variation	0.1571 0.0824 0.5245	0.7993 0.5071 0.6344	0.1818 0.1366 0.7514
1975	Mean Standard Deviation Coefficient of Variation	0.1138 0.0593 0.5211	0.6871 0.4880 0.7102	0.2035 0.1618 0.7951

TABLE II--<u>Continued</u>

Independent Variables					
S	C	E	G_1	G_2	P
5.603	0.5214	0.1822	0.0896	-0.0156	0.4350
1.163	0.1093	0.0820	0.0580	0.0467	0.1635
0.2076	0.2096	0.4501	0.6473	NMF*	0.3759
5.722	0.5331	0.1797	0.0930	-0.0157	0.4197
1.167	0.1061	0.0790	0.0553	0.0373	0.1733
0.2039	0.1990	0.4396	0.5946	NMF*	0.4129
5.850	0.5456	0.1776	0.0943	-0.0005	0.4212
1.188	0.1103	0.0751	0.0519	0.0426	0.2015
0.2031	0.2022	0.4229	0.5504	NMF*	0.4784
5.922	0.5478	0.1782	0.0943	0.0145	0.4244
1.185	0.1135	0.0723	0.0541	0.0540	0.2532
0.2001	0.2072	0.4057	0.5737	NMF*	0.5966

*No meaningful figure.

record that is too short to establish growth trends were excluded. Firms suffering deficits and apparently selling exclusively on the basis of turn-around prospects also had to be excluded, since there is no objective basis for measuring investor yield expectations in such cases. Finally, firms whose value might have been significantly affected by unusual circumstances, such as takeover battles, were excluded.

Data regarding firms included in the study were obtained from The Value Line Investment Survey, Standard and Poor's Stock Guide, Moody's Industrial Manual, and the COMPUSTAT data base. In case of conflict between the sources, Standard and Poor's Stock Guide or Moody's Industrial Manual was accepted as authoritative (no instances of conflicts between the latter two sources were noted).

A quick overview of the distribution of the input data may be obtained from Table II. However, a better understanding of the distribution of the data may be obtained from the frequency distributions shown in Tables III through XI. Of particular interest is the distribution of the debt-equity variable. This distribution is shown in Table IV. It is noteworthy that low debt-equity ratios are significantly represented in every cross-section year. Even at the bottom of the market trough in 1974, when the mean debt-equity ratio for the industry was at its highest, twelve of the companies (about 23 percent) had debt-equity ratios between zero and

TABLE III

FREQUENCY DISTRIBUTION OF EARNINGS-PRICE RATIOS
FOR COMPANIES IN THE TEST GROUP

Earnings-Price Ratio	Number of Companies			
	1972	1973	1974	1975
0 and less than 0.02	1	0	0	0
0.02 and less than 0.04	10	3	0	0
0.04 and less than 0.06	12	7	1	7
0.06 and less than 0.08	12	9	7	11
0.08 and less than 0.10	11	9	4	9
0.10 and less than 0.12	5	8	8	9
0.12 and less than 0.14	0	5	5	3
0.14 and less than 0.16	1	5	8	4
0.16 and less than 0.18	0	2	2	4
0.18 and less than 0.20	0	1	4	1
0.20 and less than 0.50	0	3	13	4

four-tenths. In 1972, when the mean debt-equity ratio for
the industry was at its lowest, there were twenty companies
(about 38 percent) in this bracket. On the other hand, in
the same year, twenty-one companies (about 40 percent) had
debt-equity ratios of eight-tenths or more. The number of
companies in this bracket rose to twenty-six (50 percent) in
1974. It can be seen, therefore, from an inspection of
Table IV, that the group of companies included in this study
provides a reasonably good distribution of debt-equity ratios
over a fairly broad range. This fact is important in estab-
lishing the validity of this study since the objective is

TABLE IV

FREQUENCY DISTRIBUTION OF DEBT-EQUITY RATIOS
FOR COMPANIES IN THE TEST GROUP

Debt-Equity Ratio	Number of Companies			
	1972	1973	1974	1975
0.0 and less than 0.2	11	10	6	10
0.2 and less than 0.4	9	6	6	3
0.4 and less than 0.6	5	10	12	13
0.6 and less than 0.8	6	4	2	4
0.8 and less than 1.0	11	6	8	9
1.0 and less than 1.5	6	12	12	8
1.5 and less than 2.0	2	2	5	5
2.0 and less than 3.0	2	2	1	0

TABLE V

FREQUENCY DISTRIBUTION OF BUSINESS RISK VARIABLE
(COEFFICIENT OF VARIATION OF EARNING POWER)
FOR COMPANIES IN THE TEST GROUP

Business Risk	Number of Companies			
	1972	1973	1974	1975
0.0 and less than 0.1	15	16	14	13
0.1 and less than 0.2	22	23	21	22
0.2 and less than 0.3	8	6	10	7
0.3 and less than 0.4	3	2	2	7
0.4 and less than 0.5	3	3	3	2
0.5 and less than 0.8	1	2	2	1

TABLE VI

FREQUENCY DISTRIBUTION OF SIZE OF
COMPANIES IN THE TEST GROUP

Total Assets ($ million)	Number of Companies			
	1972	1973	1974	1975
25 and less than 100	10	10	7	7
100 and less than 200	11	11	11	9
200 and less than 300	5	4	5	6
300 and less than 400	2	3	3	3
400 and less than 500	4	4	3	4
500 and less than 600	2	1	2	0
600 and less than 700	3	1	2	3
700 and less than 800	2	3	1	2
800 and less than 900	3	3	1	1
900 and less than 1000	5	1	4	1
1000 and less than 2000	5	11	13	16

TABLE VII

FREQUENCY DISTRIBUTION OF
CURRENT-ASSET/TOTAL-ASSET RATIOS
FOR COMPANIES IN THE TEST GROUP

Ratio of Current Assets to Total Assets	Number of Companies			
	1972	1973	1974	1975
0.1 and less than 0.3	1	1	3	2
0.3 and less than 0.4	4	5	1	3
0.4 and less than 0.5	20	12	10	10
0.5 and less than 0.6	13	20	22	19
0.6 and less than 0.7	10	10	13	15
0.7 and less than 0.8	4	4	3	3

TABLE VIII

FREQUENCY DISTRIBUTION OF EARNING POWER
FOR COMPANIES IN THE TEST GROUP

Earning Power	Number of Companies			
	1972	1973	1974	1975
0.00 and less than 0.05	1	1	1	0
0.05 and less than 0.10	4	5	5	3
0.10 and less than 0.15	15	14	13	12
0.15 and less than 0.20	14	17	18	22
0.20 and less than 0.25	7	6	8	10
0.25 and less than 0.30	5	4	3	1
0.30 and less than 0.35	3	2	1	2
0.35 and less than 0.40	2	2	2	1
0.40 and less than 0.45	1	1	1	1

TABLE IX

FREQUENCY DISTRIBUTION OF TEN-YEAR EARNINGS GROWTH
RATES FOR COMPANIES IN THE TEST GROUP

Ten-Year Earnings Growth Rate	Number of Companies			
	1972	1973	1974	1975
-0.05 and less than 0.00	3	2	2	3
0.00 and less than 0.05	12	9	9	7
0.05 and less than 0.10	17	20	13	18
0.10 and less than 0.15	13	13	21	7
0.15 and less than 0.20	4	5	7	4
0.20 and less than 0.25	3	3	0	3

TABLE X

FREQUENCY DISTRIBUTION OF FIVE-YEAR EARNINGS GROWTH
RATES FOR COMPANIES IN THE TEST GROUP

Five-Year Earnings Growth Rate	Number of Companies			
	1972	1973	1974	1975
-0.10 and less than -0.05	3	2	0	0
-0.05 and less than 0.00	6	3	1	1
0.00 and less than 0.05	11	15	14	8
0.05 and less than 0.10	15	16	14	16
0.10 and less than 0.15	8	9	13	17
0.15 and less than 0.20	5	3	7	3
0.20 and less than 0.25	2	4	2	3
0.25 and less than 0.40	2	0	1	4

TABLE XI

FREQUENCY DISTRIBUTION OF DIVIDEND
PAYOUT RATIOS

Payout Ratio	Number of Companies			
	1972	1973	1974	1975
0.0 and less than 0.1	3	2	2	2
0.1 and less than 0.2	0	3	4	4
0.2 and less than 0.3	6	5	8	5
0.3 and less than 0.4	13	14	12	15
0.4 and less than 0.5	11	14	10	12
0.5 and less than 0.6	12	6	7	8
0.6 and less than 0.7	6	5	5	2
0.7 and less than 0.8	0	1	1	2
0.8 and less than 0.9	0	1	1	1
0.9 and less than 1.0	1	1	2	0
1.0 and less than 2.0	0	0	0	1

to investigate the effect of variation in debt-equity ratio
on the cost of capital. Any conclusions reached in such a
study are of doubtful validity if the debt-equity ratios are
concentrated in a very narrow range, as they tend to be in
the electric utility industry.

The intercorrelation matrices of input variables for the
four cross-section years are shown in Tables XII through XV.
These matrices show the partial correlation coefficients of
each variable with every other variable. Such displays are
useful for gaining insight into some relationships. However,
they should be interpreted with caution because partial cor-
relation coefficients do not necessarily reflect important
multiple correlation relationships.

Of particular interest are the partial correlation co-
efficients between the debt-equity ratio and other variables
in the model. The most noteworthy of these is the one in-
volving earning power. It may be conjectured that the con-
sistently strong negative correlation between the debt-equity
ratio and earning power exists because a company with strong
earning power is able to generate more of its required funds
internally and thus has less need to utilize borrowed funds.
Another relationship that is fairly strong and consistent is
the positive correlation between firm size and the debt-
equity ratio. This relationship may reflect the tendency
for a large firm--generally representing an older, well-
established firm--to have better access to borrowed funds

TABLE XII

INTERCORRELATION MATRIX OF INPUT VARIABLES
FOR 1972

Variable	Y	H	B	S	C	E	G_1	G_2	P
Y	1.000								
H	.226	1.000							
B	.409	.101	1.000						
S	-.241	.260	-.201	1.000					
C	-.035	-.181	.104	-.098	1.000				
E	-.445	-.497	-.350	-.387	.055	1.000			
G_1	-.472	-.108	-.196	-.176	.051	.516	1.000		
G_2	.053	.155	.195	.203	-.111	-.264	.110	1.000	
P	.048	-.188	-.345	.006	-.142	.190	-.447	-.252	1.000

TABLE XIII

INTERCORRELATION MATRIX OF INPUT VARIABLES
FOR 1973

Variable	Y	H	B	S	C	E	G_1	G_2	P
Y	1.000								
H	.316	1.000							
B	.642	.209	1.000						
S	-.245	.314	-.259	1.000					
C	.076	.020	.128	.044	1.000				
E	-.475	-.554	-.454	-.350	-.109	1.000			
G_1	-.165	-.146	-.008	-.141	.117	.435	1.000		
G_2	.028	.168	.329	.249	.052	-.270	.031	1.000	
P	-.314	-.240	-.438	-.038	-.296	.332	-.513	-.348	1.000

TABLE XIV

INTERCORRELATION MATRIX OF INPUT VARIABLES
FOR 1974

Variable	Y	H	B	S	C	E	G_1	G_2	P
Y	1.000								
H	.174	1.000							
B	.611	-.049	1.000						
S	-.346	.355	-.305	1.000					
C	.169	.071	.066	.120	1.000				
E	-.415	-.548	-.382	-.343	-.254	1.000			
G_1	.142	-.098	.180	-.054	.062	.257	1.000		
G_2	.109	.151	.415	.123	.183	-.386	-.051	1.000	
P	-.528	-.204	-.398	-.093	-.262	.515	-.441	-.441	1.000

TABLE XV

INTERCORRELATION MATRIX OF INPUT VARIABLES
FOR 1975

Variable	Y	H	B	S	C	E	G_1	G_2	P
Y	1.000								
H	.118	1.000							
B	.578	-.195	1.000						
S	-.299	.303	-.328	1.000					
C	.093	-.015	-.070	.050	1.000				
E	-.341	-.534	-.370	-.314	-.089	1.000			
G_1	.157	-.076	.195	.070	.153	.159	1.000		
G_2	.551	.009	.530	-.035	.239	-.409	.058	1.000	
P	-.452	-.175	-.198	-.269	-.251	.211	-.572	-.236	1.000

than does the smaller firm. The latter, as a result, is forced to rely more heavily on equity funds. Another weaker, but still consistent relationship is the negative correlation between the debt-equity ratio and the dividend payout rate. This relationship also appears to be reasonable since a firm may reduce its reliance on borrowed funds by increasing its retention rate.

Regression Results

The estimates of the regression coefficients obtained by exercising the regression model described in Chapter III with the input data set described above are shown in Table XVI. Immediately below each coefficient is shown the associated standard error. Also shown is the t-value pertinent to the test of the null hypothesis that the coefficient is equal to zero. Since fifty-two observations were available and eleven coefficients were estimated, the t-value was subject to forty degrees of freedom. Coefficients which were found to differ from zero at the 5 percent level of significance are marked with an asterisk. The estimated constant terms are also listed, although they are not of much interest. They represent the estimated earnings-price ratios that would pertain to the firm for which all of the variables assume a value of zero, a highly unrealistic situation.

It will be noted that the estimated coefficient of the debt-equity variable is not significant at the 5 percent level in any of the cross-section years. In fact, an examination

TABLE XVI--Continued

Independent Variables

$a_5(E)$	$a_6(G_1)$	$a_7(G_2)$	$a_8(P)$	$a_9(D_1)$	$a_{10}(D_2)$	$a_{11}(D_3)$
-.1824* .0159 -11.5	-.1349 .0677 -1.99	.0245 .0589 .416	.0394 .0221 1.78	-.0085 .0099 -.859	.0358* .0136 2.63	.0145 .0108 1.34
-.3662* .0266 -13.7	-.0734 .1420 -.517	-.2057 .1485 -1.39	-.0022 .0429 -.051	-.0005 .0187 -.026	.0210 .0287 .731	.0424 .0211 2.01
-.4902* .0321 -15.3	.1829 .1950 .938	-.4910* .1982 -2.47	-.0542 .0526 -1.03	-.0274 .0282 -.972	-.0703 .0412 -1.71	.0713* .0279 2.56
-.3567* .0283 -12.6	-.1745 .1150 -1.52	.1967 .1212 1.62	-.1042* .0243 -4.29	.0036 .0167 .216	.0152 .0239 .636	.0687* .0170 4.04

*Significant at .05 level (40 degrees of freedom)

of the t-values will show that the null hypothesis of a zero
value for the coefficient is accepted at the 10 percent level
of significance, or better, in each year. Thus the results
are consistent with the conventional view of the effect of
financial leverage on the cost of capital. However, it does
not necessarily follow that the results are inconsistent with
the Modigliani-Miller hypothesis. This subject will be con-
sidered in greater detail later.

As far as other coefficients are concerned, the most
striking result is that obtained for the coefficient of earn-
ing power. It will be recalled that earning power was intro-
duced as a proxy for the quality of management. Therefore,
the a priori expectation was that the sign of the coefficient
would be negative. This expectation was realized. The esti-
mated coefficient was negative and highly significant in each
of the four cross-section years. This is particularly impor-
tant in light of the strong negative partial correlation
previously noted between earning power and the debt-equity
ratio. If earning power had been omitted from the regression
model, the debt-equity variable would have been forced to act
as a proxy for earning power. Therefore, the coefficient of
the debt-equity variable would have been biased upward making
it appear that investors were, indeed, reacting adversely to
increasing debt-equity ratio.

The estimated coefficient of the size variable is also
consistently negative and highly significant. The null

hypothesis of a zero coefficient is rejected at better than
the 0.5 percent level of significance in every cross-section
year. Thus the contention that the large firm tends to have
lower cost of equity capital than the small firm is strongly
supported by these results. Moreover, there is some indica-
tion that the premium which the small firm had to pay increased
at the market bottom in 1974 and continued at a higher level
in the recovery year of 1975.

The estimated coefficient of the business risk variable
is consistently positive, in accord with a priori expecta-
tions. However, the coefficient is significant at better than
the 5 percent level only in 1974. This behavior may reflect
heightened investor awareness of business risk near the market
bottom.

The lack of significance of any of the estimated growth
variable coefficients, except one, may seem noteworthy. How-
ever, the use of two variables to represent the growth obscures
the true influence of this factor. Therefore, the interpre-
tation of the results in terms of the influence of growth on
earnings-price ratio is unclear. It should be recalled that
the regression model was designed to facilitate delineation
of the influence of financial structure on the cost of capital.
Other variables were included only in support of this primary
objective.

The dividend payout ratio has an estimated coefficient
that is significant at better than the 5 percent level in only

one cross-section year. However, as discussed in Chapter III,
the interpretation to be placed on the significance or lack of
significance of the estimated coefficient of this variable is
not clear. Again, the inclusion of this variable in the re-
gression model was to facilitate the delineation of the in-
fluence of financial leverage on the cost of equity capital.

Overall regression statistics are shown in Table XVII.
It will be noted that the standard error of the estimate is
lowest in 1972 and highest in 1974. At first glance, this
behavior appears puzzling in light of the fact that the co-
efficient of multiple determination is significantly better
in 1974 than in 1972. However, examination of the data in
Table II or Table III suggests the reason for it: the dis-
persion of earnings-price ratios was much lower in 1972 than
in 1974. Therefore, although a greater portion of the varia-
tion in earnings-price ratios for the year 1974 was explained
by the regression model, the remaining unexplained variation
was still larger than the unexplained residue in 1972.

Tests of Validity of the Model

Before the regression results discussed above were used
in a test of the Modigliani-Miller hypothesis, some prelimi-
nary statistical tests were performed on the data to establish
the validity of the model. The results of these tests are
reported below.

TABLE XVII

REGRESSION STATISTICS

Statistic	1972	1973	1974	1975
Coefficient of Multiple Determination	.676	.660	.758	.782
Standard Error of the Estimate	.018	.034	.045	.031
F-Statistic (11 and 40 d.f.)*	7.58	7.07	11.4	13.1

*Critical value at .01 level of significance is 2.73.

Normality of Disturbance Terms

The t-tests of significance used in assessing the significance of the estimated partial regression coefficients are based on the assumption that the disturbance terms are normally distributed. The disturbance terms are, of course, not directly observable. However, the residuals from the regression process are estimates of the disturbance terms and the test of normality may be applied to these residuals.[1] The chi-squared test of goodness of fit was used for this purpose.[2] The results obtained are shown in Table XVIII. Six classes were used, with the result that, under the

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[1] Carl F. Christ, Econometric Models and Methods (New York, John Wiley and Sons, Inc., 1966), 521-522.

[2] Robert Parsons, Statistical Analysis: A Decision-Making Approach (New York, Harper and Row, Publishers, 1974), 459-461.

TABLE XVIII

CHI-SQUARED TEST OF RESIDUALS

Cross-Section Year	Chi-Squared* Statistic
1972	4.10
1973	5.50
1974	.35
1975	.95

*Four degrees of freedom.

Critical value at 0.05 level of significance is 9.49.

assumption that the null hypothesis was true, the test statistic has a chi-squared distribution with four degrees of freedom. It can be seen from the table that the null hypothesis of normally distributed residuals is accepted by a wide margin at the 5 percent significance level in each of the cross-section years.

Homoscedasticity of Disturbance Terms

Another basic assumption in the least-squares regression process is that of homoscedasticity[3] of the disturbance terms. If this assumption is violated, the estimates of the partial regression coefficients are still unbiased, but the efficiency of the estimation process is reduced.[4] While such inefficiency

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[3]Homoscedasticity is the property of having constant variance.

[4]That is, the precision with which the regression coefficients are estimated is reduced and the variances of

is undesirable, it does not lead to incorrect results. A more fundamental problem is that the estimates of the variances of the partial correlation coefficients are biased. As a result, the possibility of the presence of heteroscedasticity brings into question the validity of tests of significance of the coefficients.[5] Work by Theil[6] as well as by Prais and Houthakker[7] on consumer budgets indicates that the standard estimation algorithms are reasonably robust under moderate departures from homoscedasticity.[8] Nevertheless, it is a potential problem that should be considered.

Very little empirical work on heteroscedasticity in financial data of firms has been done. Lancaster investigated heteroscedasticity of dividends as a function of profits.[9] Morgan studied heteroscedasticity of stock prices as a function

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the estimates are increased over what they would be if the disturbance terms were homoscedastic.

[5]E. Malinvaud, _Statistical Methods of Econometrics_, translated by Mrs. A. Silvey (Chicago, Rand McNally and Company, 1966), 254-256.

[6]H. Theil, "Estimates and Their Sampling Variance of Parameters of Certain Heteroscedastic Distributions," _Revue de l'Institut International de Statistique_, XIX (1951), 146-147.

[7]S. J. Prais and H. S. Houthakker, _The Analysis of Family Budgets_ (London, Cambridge University Press, 1955), p. 58.

[8]That is, the accuracy with which variances of the partial correlation coefficients are estimated by the standard estimation algorithms is not very sensitive to departures from homoscedasticity.

[9]Tony Lancaster, "Grouping Estimators on Heteroscedastic Data," _Journal of American Statistical Association_, LXIII (March, 1968), 190-191.

of trading volume.[10] However, these studies are only sugges-
tive and not very helpful for the problem under consideration
here.

Because of the lack of existing empirical evidence on
the subject, it was decided to test the regression residuals
for heteroscedasticity as a function of each of the indepen-
dent variables in the regression model. To test for hetero-
scedasticity as a function of the primary independent variables
(i.e., excluding the dummy variables), a test based on the
Spearman rank correlation coefficient was used since the lim-
ited empirical work done in this area suggests that such a
test is more powerful[11] than alternative available tests.[12]

To implement the test for a particular variable, the
residuals and the observed values of the variable are ordered
and the Spearman rank correlation coefficient between the two
series is computed.[13] The correlation coefficient r_s is
given by

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[10]I. G. Morgan, "Stock Prices and Heteroscedasticity,"
Journal of Business, XLIX (October, 1976), 496-508.

[11]The power of a statistical test is the probability
that the null hypothesis will be rejected given that it is
false.

[12]J. Johnston, Econometric Methods (New York, McGraw-
Hill Book Company, 1972), 218-221.

[13]For a discussion of the Spearman rank correlation co-
efficient and associated tests of significance, see Sidney
Siegel, Nonparametric Statistics for the Behavioral Sciences
(New York, McGraw-Hill Book Company, 1956), 202-213.

$$r_s = 1 - \frac{6 \sum\limits_{i=1}^{N} d_i^2}{N^3 - N} \qquad (1)$$

where

d_i = difference in rank between the items of the ith pair

N = number of observations

The significance of the correlation coefficient, under the null hypothesis of zero correlation (implying homoscedastic disturbance terms), may be tested by forming the following statistic:

$$t = r_s \sqrt{\frac{m}{1 - r_s^2}} \qquad (2)$$

where m is the number of degrees of freedom of the series. The statistic t is distributed as Student's t with m degrees of freedom.

The rank correlation coefficients and associated t-values obtained by using this procedure are shown in Table XIX. Since fifty-two observations of each variable were available for input to the regression model and eleven coefficients were estimated, the series of disturbance terms had forty degrees of freedom. The critical t-value for forty degrees of freedom at the 5 percent level of significance is 2.02. The t-values which exceed this critical value, thus causing rejection of the null hypothesis that disturbance terms are

TABLE XIX

TEST BASED ON SPEARMAN RANK
CORRELATION COEFFICIENTS

Variable	1972		1973	
	Correlation Coefficient	t-value*	Correlation Coefficient	t-value*
H	-.0615	-0.39	.0289	0.18
B	-.0457	-0.29	.1375	0.88
S	-.0956	-0.61	-.1080	-0.69
C	-.3161	-1.88	-.0945	-0.60
E	.0601	0.38	-.0748	-0.47
G_1	.1429	0.91	-.2230	-1.45
G_2	.3843	2.63**	-.0467	-0.30
P	-.0410	-0.26	-.1451	-0.93

*Forty degrees of freedom

 Critical values at .01 level of significance are $\pm$ 2.70

 Critical values at .05 level of significance are $\pm$ 2.02

**Significant at .05 level

TABLE XIX--<u>Continued</u>

1974		1975	
Correlation Coefficient	t-value*	Correlation Coefficient	t-value*
.1458	0.93	.2678	1.76
.2503	1.64	.2279	1.48
.0008	0.00	.0520	0.33
.1201	0.77	.0593	0.38
-.1388	-0.89	-.2409	-1.56
-.2939	-1.94	.2967	1.96
-.0074	-0.05	.0481	0.30
-.3872	-2.66**	-.3690	-2.51**

homoscedastic, are indicated in the table with a double

asterisk. It will be noted that no heteroscedasticity is

indicated for the cross-section year 1973. In the year 1972,

the null hypothesis is rejected for the variable G_2 (five-

year growth rate less the ten-year growth rate). In each of

the years 1974 and 1975, the null hypothesis is rejected for

the variable P (dividend payout rate). It is to be noted

that in no case does the t-value exceed the critical value

of 2.70 at the 1 percent significance level. This latter

fact may be taken as an indication that existing heterosce-

dasticity is of moderate proportions. The importance of

this heteroscedasticity to the regression results will be

considered in connection with the discussion of the test of

the Modigliani-Miller hypothesis.

The test based on the Spearman rank correlation coeffi-

cient could obviously not be used to test for heteroscedasti-

city relative to the dummy variables. Therefore, another

test had to be considered for this purpose. The test chosen

for this purpose was the Kruskal-Wallis test.[14] To implement

this test, the residuals are replaced by their ranks. They

are then segregated into four classes, one corresponding to

each of the three dummy variables and one corresponding to

the basic food companies. On the basis of this data, the

statistic H is formed as follows:

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[14]For a discussion of the Kruskal-Wallis test, see
Siegel, Nonparametric Statistics, pp. 184-194.

$$H = \frac{12}{N(N + 1)} \sum_{j = 1}^{k} \frac{R_j^2}{n_j} - 3(N + 1) \qquad (3)$$

where

k = number of classes

n_j = number of cases in jth sample

N = number of cases in all classes combined

R_j = sum of ranks in jth class

Under the null hypothesis of homogeneous populations in the K classes, the statistic H has the chi-squared distribution with (k - 1) degrees of freedom. The statistics derived in accordance with equation (3) are shown in Table XX. Statistics which exceed the critical value of 7.8 at the 5 percent significance level, thus causing rejection of the null hypothesis, are marked with a double asterisk. It will be noted that the null hypothesis is rejected at the 5 percent level in 1972 and 1975, thus indicating that the disturbance terms are heteroscedastic.

The results of the Kruskal-Wallis test indicate the presence of heteroscedasticity in the cross-section years 1972 and 1975. However, the test does not indicate the nature of the heteroscedasticity. For example, it may be that three of the four classes are homogeneous with only one class departing from the norm. Therefore, to shed further light on this subject, the Mann-Whitney U test was performed on the data for the two years in which heteroscedasticity is

TABLE XX

KRUSKAL-WALLIS TEST

Cross-Section Year	Kruskal-Wallis* Statistic
1972	10.1**
1973	5.0
1974	5.1
1975	8.2**

*Chi-squared distribution with three degrees of freedom.

Critical value at .05 level of significance is 7.8.

**Significant at .05 level.

indicated.[15] To implement the test, the residuals are ranked and divided into two classes, class number one containing the residuals corresponding to one of the dummy variables and class number two containing the remaining residuals. The statistic U is then formed as follows:

$$U = n_1 n_2 + \frac{n_1 (n_1 + 1)}{2} - R_1 \qquad (4)$$

where

n_1 = number of items in class number one

n_2 = number of items in class number two

R_1 = sum of the ranks assigned to class number one.

It can be shown that, under the null hypothesis of homogeneous

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[15]For a discussion of the Mann-Whitney U test, see Siegel, <u>Nonparametric Statistics</u>, pp. 116-126.

classes, the distribution of the statistic U is well approximated by a normal distribution with

$$\text{mean} = \frac{n_1 n_2}{2} \tag{5}$$

and

$$\text{standard deviation} = \frac{(n_1)(n_2)(n_1 + n_2 + 1)}{12} \tag{6}$$

when one of the classes has more than twenty items. Thus, under these conditions, the significance of an observed value of the statistic U can be assessed on the basis of a normal distribution. The test was repeated three times for each cross-section year, with class number one successively containing the residuals corresponding to the dummy variables D_1 (soft drinks), D_2 (breweries), and D_3 (meat-packing companies). Class number two then contained a minimum of forty-six items and a normal distribution was clearly applicable. The statistics calculated on the basis of equation (4) are shown in Table XXI. Statistics which lie outside the acceptance region, and thus result in rejection of the null hypothesis at the 5 percent level of significance, are indicated with the superscript "d." It will be noted that the null hypothesis is rejected for breweries in the year 1972 and for meat-packing companies in the year 1975 as the result of significant negative z-values. The Mann-Whitney U statistics were calculated in such a way that negative z-values

TABLE XXI

MANN-WHITNEY U TEST

Class 1	1972		1975	
	U-Statistic	Z-Value[c]	U-Statistic	Z-Value[c]
Soft Drinks (D_1)[a]	145	0.20	149	0.31
Breweries (D_2)[b]	15	-3.18[d]	131	0.42
Meat Packers (D_3)[a]	158	.57	38	-2.86[d]

[a]Class 1 contains six items.

[b]Class 1 contains five items.

[c]Critical values at 5 percent level of significance are ± 1.96.

[d]Significant at 5 percent level.

indicate a tendency for larger ranks to occur in class number one. Therefore, the results of this test indicate that the variance of the disturbance terms is higher for breweries than other firms in 1972 and higher for meat packers than for other firms in 1975. The hypothesis of homoscedastic disturbance terms is accepted for all other groups. The importance of this heteroscedasticity to the regression results will be considered in connection with the discussion of the test of the Modigliani-Miller hypothesis.

Autocorrelation of Disturbance Terms

As discussed in Chapter III, the possible omission of an independent variable which is correlated with the debt-equity ratio is a matter of some concern, since such omission may lead to bias in the estimate of the coefficient of the debt-equity variable. To test for this possibility, an adaptation of a test often applied in studies of temporal data was used.

In temporal regressions, omission of variables with serial correlation tends to cause serial correlation in the disturbance terms. Other forms of misspecification may lead to the same result. However, in a properly specified regression model, the disturbance terms are serially independent.[16]

Tests for serial correlation are commonly applied and reported in connection with temporal regression studies.[17] However, the same technique can be applied to cross-section studies, if the residuals are first arranged in an order that is suspected of being autocorrelated.[18] In the case under consideration in this dissertation, concern is concentrated on the possibility of omission of a variable significantly correlated with the debt-equity ratio. Therefore, the test

[16]J. Johnston, _Econometric Methods_ (New York, McGraw-Hill Book Company, 1972), pp. 243-244.

[17]E. Malinvaud, _Statistical Methods of Econometrics_ (Chicago, Rand McNally and Company, 1966), p. 424.

[18]Carl F. Christ, _Econometric Models and Methods_ (New York, John Wiley and Sons, Inc., 1966), p. 527.

for serial correlation was applied after first ordering the residuals according to the associated debt-equity ratios.

A method which may be applied to residuals of a regression model to test for serial correlation has been developed by Durbin and Watson.[19] To apply this test, a variant of the von Neumann statistic is used. The statistic d is defined as follows:

$$d = \frac{(e_{n+1} - e_n)^2}{e_n^{\;2}} \qquad (7)$$

where

e_i = the ith residual

N = the total number of residuals.

A value near two indicates absence of autocorrelation. The exact distribution of the statistic is not known. However, Durbin and Watson have established lower and upper bounds (d_L and d_U, respectively) for the statistic at various levels of significance. If d is greater than d_U, the null hypothesis of zero autocorrelation is accepted. If d is less than d_L, the alternate hypothesis of positive autocorrelation is accepted. If d lies between d_L and d_U, the test is indeterminate. To test for negative autocorrelation, the statistic

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[19]J. Durbin and G. S. Watson, "Testing for Serial Correlation in Least Squares Regression. I," Biometrika, XXXVII (December, 1950), 409-428; "Testing for Serial Correlation in Least Squares Regression. II," Biometrika, XXXVIII (June, 1951), 159-178.

(4 - d) is compared to the same limits with comparable decision criteria, except that a value of the statistic below d_L results in acceptance of the alternate hypothesis of negative autocorrelation. The existence of an indeterminate range, as noted above, is a major weakness of the test. As Klein states, "In principle, the Durbin-Watson test makes superior use of the von Neumann statistic for application to the specific problem of error independence in regression analysis, but in practice it is often an inconclusive test."[20]

The Durbin-Watson statistics calculated in accordance with equation (7) are shown in Table XXII. The upper and lower limits applicable to this situation are also shown in the table. They were obtained from tabulated values published by Durbin and Watson.[21] The limits are a function of the significance level, the number of observations in the regression, and the number of slope variables in the model. Unfortunately, the published tabulation covers a maximum of five slope variables. The model used in the study under consideration used eight slope variables. To overcome this problem, extrapolation was performed on the conservative assumption that each additional slope variable would result in the addition of the same size increment to the limits, although at some point the increments must begin to diminish. Comparison

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[20]Lawrence R. Klein, A Textbook of Econometrics, 2nd ed. (Englewood Cliffs, Prentice-Hall, Inc., 1974), p. 96.

[21]Durbin and Watson, "Testing for Serial Correlation. II," p. 174.

TABLE XXII

DURBIN-WATSON STATISTICS

Cross-Section Year	Durbin-Watson* Statistic		Test Result
	d	4 - d	
1972	1.875	. .	H_o accepted
1973	2.087	1.913	H_o accepted
1974	2.671	1.329	Indeterminate
1975	2.306	1.694	Indeterminate

*Limits at 5 percent level of significance:

$$d_L = 1.18$$

$$d_U = 1.84$$

of the Durbin-Watson statistics with the limits shown results in acceptance of the null hypothesis of zero autocorrelation in the cross-section years 1972 and 1973. In the other two years, unfortunately, as often occurs with the Durbin-Watson test, no conclusion can be reached.

Since the hypothesis of zero autocorrelation was accepted in two of the cross-section years and the test was inconclusive in the other two, the focus shifted to examining the relationship between the debt-equity coefficient estimates in the four cross-section years. Specifically, it was desired to see whether any inferences could be drawn regarding homogeneity of populations from which the estimates were drawn.

Consideration of the stock market environment during the time under study suggests that the four years may be divided into two periods of quite different character. The first period consists of the year 1972. It began in the aura of the Smithsonian currency accord, included the landslide re-election of Richard Nixon as President, and culminated in expectations of imminent Vietnam peace. A bull market peak was reached at the end of that year. The second period was much more chaotic. The bear market years of 1973 and 1974 brought the Arab oil embargoes, saw the price of gold reach a peak at $195 per ounce, and encompassed the ever-escalating Watergate scandals which culminated in President Nixon's resignation. The recovery year of 1975 remained relatively chaotic with a business recession bottom in the first quarter and the New York City problem reaching a crisis stage in the last quarter.

The division into two periods suggested above is rather clearly visible in the data compiled in Table XVI. The variances of the coefficients are substantially larger in the years 1973, 1974, and 1975 than they are in 1972, apparently reflecting the more chaotic market environment of the latter period.

As a result of the considerations above, tests for homogeneity of populations were restricted to the years 1973, 1974, and 1975. The tests used for this purpose are discussed below.

The first step was to test for homogeneity of variances. For this purpose, Bartlett's test was used.[22] In describing this test, it is helpful to define the quantity y as follows:

$$y = \prod_{i=1}^{T} \left(\frac{s_i^2}{s^2} \right)^{m_i/2} \tag{8}$$

where

s_i^2 = ith variance

m_i = number of degrees of freedom associated with the ith variance

T = number of variances being tested

and

$$s^2 = \frac{\sum_{i=1}^{T} m_i s_i^2}{\sum_{i=1}^{T} m_i} \tag{9}$$

Then, to perform Bartlett's test, the statistic U is formed as follows:

$$U = \frac{-2 \ln y}{1 + \frac{1}{3(t-1)} \left(\sum_{i=1}^{T} \frac{1}{m_i} - \frac{1}{\sum_{i=1}^{T} m_i} \right)} \tag{10}$$

Under the null hypothesis of homogeneous variances, the distribution of the statistic U is closely approximated by a chi-squared distribution with t - 1 degrees of freedom.

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[22]For a discussion of Bartlett's test, see H. C. Fryer, Concepts and Methods of Experimental Statistics (Boston, Allyn and Bacon, 1966), pp. 242-247.

Using the values of the variances of the partial regression coefficients for the debt-equity variable in the years 1973, 1974, and 1975, from Table XVI in equations (8), (9), and (10), a value for U of 5.52 is obtained. The critical value, at the 5 percent level of significance, of the chi-squared distribution with two degrees of freedom is 5.99. Therefore, the null hypothesis of homogeneous variances is accepted at the 5 percent level.

With the variances having been established as homogeneous, a test for equality of the coefficients may be performed. A test that is suitable for this purpose was introduced by Fisher.[23] In fact, as he introduced the test, it was used as a test of the hypothesis that partial regression coefficients were estimates from the same population. However, preceding the Fisher test with a test for homogeneity of variances results in a more powerful composite test of population homogeneity than could be achieved with the Fisher test alone.

In describing Fisher's test, it is convenient to define the quantity b' as follows:

$$b' = \frac{\sum_{i=1}^{T} b_i / s_i^2}{\sum_{i=1}^{T} 1 / s_i^2} \qquad (11)$$

[23]Lawrence Fisher, "Determinants of Risk Premiums on Corporate Bonds," The Journal of Political Economy, LXVII (June, 1959), 230.

where

b_i = ith estimated partial regression coefficient

s_i = standard error of b_i

T = number of estimated partial regression coefficients being tested

To perform the test, the statistic z is formed as follows:

$$z = \sum_{i=1}^{T} \frac{(b_i - b')^2}{s_i^2} \qquad (12)$$

Under the null hypothesis of equality of partial regression coefficients, the statistic z has a chi-squared distribution with T - 1 degrees of freedom. Using the values of the estimated partial regression coefficients for the years 1973, 1974, and 1975, from Table XVI in equations (11) and (12), a value for z of 1.40 is obtained. As in the preceding test, the critical value at the 5 percent level of significance is 5.99. Therefore, the null hypothesis is accepted. Thus the composite test (Bartlett's plus Fisher's) results in acceptance, by a wide margin at the 5 percent level of significance, that the partial regression coefficients from the years 1973, 1974, and 1975, are samples from the same population.

Test of the Modigliani-Miller Hypothesis

With tests designed to establish the validity of the regression model having been performed, the results obtained through use of the model were employed in a test of the Modigliani-Miller hypothesis. As stated in Chapter III,

Modigliani and Miller's Proposition II was used as the basis
of the test. According to this proposition (see equation
III-2),

$$k_e = k_o + (1 - T)(k_o - r) H \qquad (13)$$

The test consists of comparing the theoretical coefficient
of H in equation (13) with the empirical estimates of the
coefficient of H derived from exercising the regression model.
It will be noted that the coefficient of H in equation (13)
involves the leverage-free equity yield k_o. Therefore, the
leverage-free equity yield must also be estimated from the
regression results.

The constant term $\hat{a}_o$ obtained from the regression model
and listed in Table XVI for each cross-section year is an
estimate of the earnings yield with the primary debt-equity
variable as well as the auxiliary variables set equal to zero.
This condition is highly unrealistic. Furthermore, since it
is one that lies outside the range of observed values, accur-
ate estimation cannot be expected. The most accurate estimates
of the leverage-free earnings yield should be obtained for
values of the auxiliary variables near the industry average.
Therefore, industry average values were assigned to these
variables with certain exceptions. The dummy variables were
assigned values of zero. Thus the earnings-yield estimates
finally obtained are for a basic food company. The growth
variable G_2 was also set equal to zero. Since the average
value of G_2 was, in every cross-section year, very close to

zero, no significant deviation from industry average conditions is involved. However, interpretation of the results is facilitated by this assignment of value. Since G_2 is a measure of the excess of the five-year growth rate over the ten-year growth rate, assignment of a value of zero to G_2 has the result that the ultimate earnings yield estimate is for a company with uniform five- and ten-year growth rates.

With values assigned as described above, the estimated leverage-free earnings yield Y_o is given by

$$\hat{Y}_o = \hat{a}_o + \hat{a}_2\bar{B} + \hat{a}_3\bar{S} + \hat{a}_4\bar{C} + \hat{a}_5\bar{E} + \hat{a}_6\bar{G}_1 + \hat{a}_8\bar{P}. \quad (14)$$

In this equation, a caret is used to indicate the estimate of a partial regression coefficient and a macron is used to indicate the industry average of a variable. For a test of statistical significance, the variance of $\hat{Y}_o$ is also needed. It is, of course, a function of the variances and covariances of all the estimated partial regression coefficients in equation (14). Therefore, as a computational device for estimating the leverage-free earnings yield as well as its variance, a transformation of variables in the basic regression model was made for each cross-section year and the model was then reexercised. The transformed model can be represented by the following equation:

$$Y_i = b_o + a_1H_i + a_2(B_i - \bar{B}) + a_3(S_i - \bar{S}) + a_4(C_i - \bar{C}) +$$
$$a_5(E_i - \bar{E}) + a_6(G_{1i} - \bar{G}) + a_7G_{2i} + a_8(P_i - \bar{P}) +$$
$$a_9D_{1i} + a_{10}D_{2i} + a_{11}D_{3i} + u_i \quad (15)$$

The estimate $\hat{b}_o$ of the constant term in this equation is then the desired estimate of the leverage-free earnings yield. The estimates of the partial regression coefficients are, of course, unchanged by this transformation.

As discussed in Chapter III, the measure of equity yield to be used is that derived from the Gordon-Shapiro model as expressed in equation III-(3). Since the dividend yield for a stock is related to the earnings yield by the payout ratio, the estimate of leverage-free equity yield $\hat{k}_o$ is given by

$$\hat{k}_o = \bar{P}\hat{b}_o + \bar{G}_1 \qquad (16)$$

and the rate of change $\hat{A}_1$ of equity yield per unit change in debt-equity ratio is given by

$$\hat{A}_1 = \bar{P}\hat{a}_1. \qquad (17)$$

As can be seen by referring to equation (13), if the Modigliani-Miller hypothesis is valid,

$$A_1 = (1 - T)(k_o - r). \qquad (18)$$

A test of the hypothesis can, therefore, be conducted by comparing the regression estimate of A_1 with the right-hand side of equation (18). For this purpose, the value of the right-hand side of equation (18) for a particular cross-section year is calculated by using the estimated leverage-free equity yield for that cross-section year for k_o, a marginal income tax rate of 0.48 for t, and an interest rate appropriate to the cross-section year for r. Let

$$k' = (1 - T)(\hat{k}_o - r). \qquad (19)$$

Then the statistic t defined as

$$t = \frac{k' - \hat{A}_1}{s_o} \qquad (20)$$

where

$$s_o = \text{standard error of } (k' - \hat{A}_1)$$

may be used in implementing the test. Under the assumption
that the Modigliani-Miller hypothesis is valid, the statistic
t has the Student's t-distribution with 40 degrees of freedom.

In calculating values of s_o, the following relations
were utilized:

$$\text{var}(cx + d) = c^2\text{var}(x) \qquad (21)$$

$$\text{var}(x - y) = \text{var}(x) - 2\text{cov}(x,y) + \text{var}(y) \qquad (22)$$

and

$$\text{cov}\,[(cx + d), (ey + f)] = ce\,[\text{cov}(x,y)] \qquad (23)$$

where x and y are variables and c, d, e, and f are constants.
Using these relations, the following equation is obtained
for the variance of $(k' - \hat{A}_1)$:

$$\text{var}(k' - \hat{A}_1) = (1 - T)^2\bar{P}^2\text{var}(\hat{b}_o) - 2(1 - T)$$

$$\bar{P}^2\text{cov}(\hat{b}_o,\hat{a}_1) + \bar{P}^2\text{var}(\hat{a}_1). \qquad (24)$$

The standard error of $(k' - \hat{A}_1)$ is then given by

$$s_o = \sqrt{\text{var}(k' - \hat{A}_1)}. \qquad (25)$$

Results obtained by implementing the test of the
Modigliani-Miller hypothesis as described above are shown
in Table XXIII. In column (2) of this table are displayed
the estimated intercepts obtained by exercising the transformed

TABLE XXIII

TEST OF MODIGLIANI-MILLER HYPOTHESIS

Cross-Section Year	$\hat{b}_o$ [a]	$\hat{k}_o$ [b]	$\hat{A}_1$ [c]	r [d]	$k'-\hat{A}_1$ [e]	s_o [f]	t-value [g]
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1972	.0566	.1142	.0035	.0722	.0184	.0034	5.41
1973	.0855	.1289	.0044	.0784	.0219	.0074	2.95
1974	.1571	.1605	.0008	.0923	.0347	.0113	3.07
1975	.1046	.1387	-.0021	.0926	.0261	.0074	3.53

(a) Estimated leverage-free earnings-price ratio.

(b) Estimated leverage-free equity yield.

(c) Estimated rate of increase of equity yield per unit increase in debt-equity ratio.

(d) Interest rate based on Moody's Industrial Bond Yield Index from Moody's Investors Service, Inc., Moody's Bond Record, January, 1977, p. 165.

(e) Difference between theoretical and observed yield sensitivity to debt-equity ratio.

(f) Standard error of $(k'-\hat{A}_1)$.

(g) Critical value at 0.5 percent level of significance is 2.70.

regression model described by equation (15). These inter-
cepts represent estimates of the leverage-free earnings-price
ratios. The leverage-free equity yields derived from these
values by use of equation (16) are shown in column (3).
Column (4) contains a listing of the estimated rates of in-
crease of equity yield per unit increase in debt-equity ratio
derived from the estimated coefficient of the debt-equity
variable (displayed in Table XVI) by use of equation (17).
Column (5) contains a listing of interest rates based on the
value of Moody's Industrial Bond Yield Index for December of
each cross-section year.[24] In column (6) are shown values of
the difference between the sensitivity of equity yield to
debt-equity ratio predicted by the Modigliani-Miller hypothe-
sis (calculated by use of equation (19)) and the observed value
displayed in column (4). The associated standard errors,
calculated by use of equations (24) and (25), are shown in
column (7). Finally, the t-values calculated by means of
equation (20) are shown in column (8). These values may be
compared to the critical value of 2.71 at the 0.5 percent
level of significance. It will be noted that this critical
value is exceeded in every cross-section year. Thus the null
hypothesis that the coefficient of the debt-equity ratio is
equal to $(1 - T)(k_o - r)$ (see equation III-2) is strongly

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[24]Moody's Investors Service, Inc., Moody's Bond Record
(New York, n.p., January, 1977), p. 165.

rejected in every cross-section year and the results of this research do not support the Modigliani-Miller hypothesis.

The test was performed for the Miller-amended version of the Modigliani-Miller hypothesis by executing the same procedure except that the term (1 - T) was dropped from equations (13), (18), (19), and (24). The results of this test are shown in Table XXIV. It will be noted that the margins by which the hypothesis is rejected are even wider for the Miller-amended version.

As discussed earlier in this chapter, tests indicated the existence of some heteroscedasticity of residuals in three of the cross-section years. It was pointed out there that the primary reason for concern about the existence of heteroscedasticity is that biased estimates of variances may result. Therefore, the possible impact of the heteroscedasticity noted will be discussed below.

In the cross-section year 1972, heteroscedasticity was found to be associated with the variable G_2. Reference to Table XIX reveals that residuals are positively correlated with G_2. Therefore, the variance of the leverage-free yield is an increasing function of this variable. Since the leverage-free yield was estimated under the condition of a zero value for G_2, any bias in estimating the variance is in the conservative direction; i.e., the estimated value of the variance will actually be larger than it should be.

TABLE XXIV

TEST OF MODIGLIANI-MILLER HYPOTHESIS
(MILLER AMENDMENT)

Cross-Section Year (1)	$\hat{b}_o$ (a) (2)	$\hat{k}_o$ (b) (3)	$\hat{A}_1$ (c) (4)	r (d) (5)	$k' - \hat{A}_1$ (e) (6)	s_o (f) (7)	t-value (g) (8)
1972	.0566	.1142	.0035	.0722	.0385	.0045	8.55
1973	.0855	.1289	.0044	.0784	.0461	.0099	4.66
1974	.1571	.1605	.0008	.0923	.0674	.0157	4.29
1975	.1046	.1387	-.0021	.0926	.0482	.0100	4.82

(a) Estimated leverage-free earnings-price ratio.

(b) Estimated leverage-free equity yield.

(c) Estimated rate of increase of equity yield per unit increase in debt-equity ratio.

(d) Interest rate based on Moody's Industrial Bond Yield Index from Moody's Investors Service, Inc., Moody's Bond Record, January, 1977, p. 165.

(e) Difference between theoretical and observed yield sensitivity to debt-equity ratio.

(f) Standard error of $(k' - \hat{A}_1)$.

(g) Critical value at 0.5 percent level of significance is 2.70.

In the cross-section years 1974 and 1975, heteroscedasticity was found to be associated with the variable P. Therefore, the variance of the leverage-free equity yield is a function of P. It will be recalled that moderate heteroscedasticity was indicated and that limited existing empirical evidence indicates that the standard algorithm for estimating variance is relatively robust under moderate departures from homoscedasticity. Furthermore, in this case, the leverage-free yield was estimated for a value of P equal to the industry average. Therefore, any error in estimating the variance should be still further ameliorated.

Two other instances of heteroscedasticity were noted, both involving dummy variables. For the cross-section year 1972, tests indicated that the variance was significantly greater for breweries than for other companies. For the cross-section year 1975, tests indicated that the variance was significantly greater for meat-packing companies than for other companies. These instances of heteroscedasticity are not considered serious. In the first place, only five or six companies out of the total of fifty-two are involved in a cross-section year. In the second place, estimates of the leverage-free yields were made using zero values for the dummy variables. Therefore, any errors in estimates of variances of leverage-free yields are in the conservative direction.

As a result of the considerations discussed above, it is believed that the tests are not seriously compromised by the existence of heteroscedasticity.

CHAPTER V

SUMMARY AND CONCLUSIONS

This chapter contains a summary of the study reported
in this dissertation as well as some comments on the results
of that study.

Summary

The objective of the research reported in this disserta-
tion is to conduct an empirical test of the hypothesis that,
excluding income tax effects, the cost of capital to a firm
is independent of the degree of financial leverage employed
by the firm. This hypothesis represents a challenge to the
traditional view on the subject, a challenge which carries
implications of considerable importance in the field of fi-
nance. The challenge has led to a lengthy controversy which
can ultimately be resolved only by subjecting the hypothesis
to empirical test.

The Divergent Views

Two divergent views on the effect of financial leverage
on the cost of capital have developed: the traditional view
and a view primarily associated with Modigliani and Miller.

The traditional view of the financial structure of the
firm is that the cost of capital may be minimized by select-
ing an optimum degree of financial leverage. It is contended

that, if an unleveraged firm adds small amounts of debt to its capital structure, investors in the firm's securities will not perceive a commensurate rise in risk and will, therefore, demand no significant risk premium. Since the return required by debt holders is less than that required by equity holders, the average cost of capital will decline. However, if the debt-equity ratio is increased excessively, investor reaction will be adverse, substantial risk premiums will be required, and the average cost of capital will rise.

In contrast to the traditional view, Modigliani and Miller contend that, in the absence of income taxes, the degree of financial leverage employed by a firm is a matter of indifference. They predicate their contention on an assumption of perfect capital markets and rational investors. With these assumptions, the amount of leverage may differ from that desired by equity investors, but this possibility has no bearing on the value of equity shares. If an investor prefers a different amount of leverage, he can adjust the leverage in his portfolio by purchasing bonds for cash or stock on margin, as required. As a result, they contend that the value of the firm is determined by capitalizing the stream of income derived from the assets possessed by the firm at a rate which is independent of the way in which the assets are financed. Market assessment of the firm must converge to the value so determined because any deviation from this value

will provide incentive for arbitrage action which will tend to eliminate the deviation.

After considering the effects of corporate income taxes, Modigliani and Miller revised their original proposition. According to the revised proposition, the average cost of capital will decline with increasing leverage due to the income-tax deductability of interest payments. This alteration in Modigliani and Miller's original proposition softens the difference between their view and the traditional view but by no means obliterates it.

Recently, Miller restudied the effect of income taxes. As the result of taking into account personal as well as corporate income taxes, he concluded that, even in a world in which interest payments are tax deductible, the value of the firm is independent of financial leverage employed by the firm. This conclusion appears to be the logical consequence of the fundamental assumptions underlying the Modigliani-Miller hypothesis. Therefore, this latest version is judged to be the proper one to subject to empirical test. Nevertheless, since Modigliani has not yet commented on the revision, the term "Modigliani-Miller hypothesis," as used in this dissertation, refers to the version existing before Miller's latest revision. Both versions were subjected to test in this study.

The realism of the world in which Modigliani and Miller have chosen to operate has been challenged on the basis of

various considerations. For example, it has been argued that when transactions costs are considered, there will be a net preference for equity shares of firms which employ substantial leverage. This preference arises from the fact that higher transactions costs are involved in constructing "homemade" leverage than in "undoing" corporate leverage. A number of investigators have contended that consideration of the possibility of financial embarrassment or bankruptcy of the firm results in the firm facing the problem of capital structure optimization.

Various market imperfections may have significant impact on the behavior of the cost of capital as a function of financial leverage. For example, Regulation T places very significant limitation on the use of margin. Furthermore, many instiutions use no margin at all due either to legal restrictions or practice of the prudent man rule. As another example, significant market imperfection arises from the fact that the individual borrower must usually pay higher interest rates than the corporate borrower and that he does not enjoy the advantage of limited liability as does the corporate borrower. As a final example, in segmented markets in which equity and debt holders differ in their expectations and risk aversion, the equilibrium value of the firm can depend on the debt-equity ratio even with otherwise perfect capital markets and rational investors.

Granted their assumptions, Modigliani and Miller's conclusions have not been questioned. The crucial question is whether the effects of market imperfections and institutional rigidities are sufficiently significant to destroy the usefulness of the Modigliani-Miller proposition in the real world. To shed light on this question, it is necessary to submit their hypothesis to empirical test.

Significance of the Study

Assuming that the objective of the firm is to maximize shareholder wealth, the cost of capital becomes a basic criterion in the firm's investment decisions. Therefore, any factor which may impinge on the cost of capital deserves attention. As indicated above, the traditional view is that the cost of capital is a convex function of financial leverage. In consonance with this view, the selection of an optimum debt-equity ratio is a matter of high corporate policy. In contrast to the traditional view, the Modigliani-Miller position is that, fundamentally, the cost of capital is independent of the financing decision. It follows, then, that the selection of a debt-equity ratio, far from being a matter of crucial policy decision, is one of indifference. Therefore, resolution of these divergent views is a matter of importance to the financial management of the firm.

In addition to its significance at the microeconomic level, the Modigliani-Miller hypothesis has implications at the macroeconomic level. If the Modigliani-Miller contention

that the financial policy of the firm does not affect its market value is valid, it follows that only the operating decisions of the firm are significant at the macroeconomic level. Therefore, studies of the real sector based on flow-of-funds analysis cannot be expected to be productive.

The Modigliani-Miller hypothesis may also be viewed as a defense of the capitalistic system. In the past, various economists have pointed out what they perceived to be weaknesses of the capitalistic system. Kalecki saw insurmountable obstacles to business democracy based on his principle of increasing risk. Robinson discussed the threat to entrepreneurs posed by the thrift of rentiers and the tendency of markets to come under domination by "old-established, powerful firms" partly due to the need for innovators to depend heavily on borrowed funds. The problems posed to the capitalist system by these factors are less serious if the Modigliani-Miller hypothesis is true.

Existing Empirical Evidence

Since the Modigliani-Miller hypothesis was announced in 1958, various tests of the hypothesis have been conducted and reported in the literature. A review of this literature has revealed that the tests were of three general types, as discussed in the following paragraphs.

One type of test that has been conducted is one designed to test for the existence of differing financial structures in different industries. Such tests were conducted by two

different investigators, both concluding that firms in a given industry tend to adopt similar financial structures. The implication, then, is that the financial structure toward which the companies in a given industry tend is an optimal structure. However, there is no proof that this implication is justified.

Another approach, adopted by one investigator, is to analyze time series of financial data from individual companies. The investigator analyzed data from several utilities in this manner and concluded that the results tended to support the traditional view. However, the results of such studies are very difficult to interpret because the range of debt-equity ratios encountered within one company over a period of time is extremely limited and the economic environment within which the company is operating is continually changing.

The most frequently reported type of test is one based on cross-sectional regression analysis of financial data for companies in some industry. The industry most often selected, and the one in which the only rigorous tests of the hypothesis have been conducted, is the electric utility industry. Unfortunately, the electric utility industry is a poor testing ground for the hypothesis. In the first place, examination of the capital structure of electric utility companies shows that the range of debt-equity ratios employed by them is very narrow. In the second place, the effect of government

regulation of utility rate structures is subject to debate. Opposite conclusions regarding the validity of the Modigliani-Miller hypothesis have been reached as the result of adopting a different way of introducing the effect of the regulatory process into the investigator's model. A recent study has concluded that the effect of leverage on the value of a regulated firm can only be estimated if specific supply and demand conditions of that firm are known. This conclusion, of course, means that any test of the Modigliani-Miller hypothesis based on a cross-sectional analysis of electric utility companies is of doubtful validity.

Design of the Regression Model

As a result of the review of the literature discussed above, the study reported in this dissertation was undertaken with the objective of conducting a rigorous test of the Modigliani-Miller hypothesis in a non-regulated industry by means of cross-sectional regression analysis. The food industry was chosen for this purpose.

In the article announcing their hypothesis, Modigliani and Miller set forth two propositions. In Proposition I they asserted that the value of the firm is independent of financial structure. This proposition implies that the average cost of capital is not affected by financial leverage. However, the crucial issue is contained in Proposition II, a corollary of Proposition I. This proposition specifies that the cost of equity capital rises linearly with increasing

debt-equity ratio at a rate equal to $(1 - T)(k_o - r)$. Either Proposition I or Proposition II may be used as the basis of a test of the Modigliani-Miller hypothesis. Modigliani and Miller used Proposition I as the basis of their tests. As a result, their work was concerned with the average cost of capital. In the research reported in this dissertation, Proposition II is used as the basis of the test. Thus, in this study, the focus is on the cost of equity capital.

The first problem to be faced, then, was the selection of a measure of equity yield. A number of stock valuation models (from each of which a measure of equity yield may be derived) have been developed for application to the dynamic situation of a growing firm. These models can be shown to be formally equivalent. However, the most convenient and widely used measure of equity yield is based on the Gordon-Shapiro model, and equates equity yield to dividend yield plus earnings growth. This measure of equity yield was adopted for use in the test of the Modigliani-Miller hypothesis in this study. However, for reasons detailed in Chapter III, it was concluded that the earnings yield is a more sensitive indicator of investor response to factors affecting stock valuation. Since the earnings yield is simply related to the dividend yield by the payout ratio, the earnings yield was used as the dependent variable in the regression model.

The primary independent variable in the regression model is the debt-equity ratio. Although the Modigliani-Miller

hypothesis was cast in terms of the market value of the debt-equity ratio, there are cogent reasons for considering the book value of debt-equity ratio to be a superior measure of financial leverage for the study reported in this dissertation. In the first place, if the market value of debt-equity ratio were used, both the dependent variable and the primary independent variable would have the market value of equity appearing in their denominators. Such a relationship may lead to spurious correlation and consequent positive bias in the estimated coefficient of the debt-equity variable. In the second place, the primary dependent variable should be a pure measure of financial risk. However, examination of the character of the market value of debt-equity ratio indicates that it incorporates elements of business risk as well as financial risk. In the third place, the market value of debt-equity ratio is an unstable quantity and its value at any given point in time is very difficult to establish. As a result, it seems unlikely that investors would use such an approach to evaluating financial risk as an element in the investment decision-making process. This belief is reinforced by the fact that stock analyses provided by leading investor service companies contain data on the book value of debt, while no consideration is given to the market value of debt. Finally, the market value of the debt-equity ratio is an inappropriate measure for management control. If a study such as the one reported in this dissertation is to have any value

in the field of financial management, the financial leverage
variable must be one that is useful for purposes of manage-
ment control.

In some previous studies of this subject, financial lev-
erage was defined so that it was concerned only with equity
and long-term debt. However, such a measure is a poor measure
of financial risk. Therefore, the debt-equity ratio used in
this study was defined to include short-term obligations.

The test of the Modigliani-Miller hypothesis could have
been conducted on the basis of the results of a simple re-
gression of the yield variable on the debt-equity variable.
In fact, this approach has been used by some previous inves-
tigators. However, investors are influenced by factors other
than the debt-equity ratio in establishing the market value
of equity yield. Should one of these factors be significantly
correlated with the debt-equity ratio, its omission could
result in biasing the estimate of the coefficient of the
debt-equity variable. Therefore, additional independent
variables which, on the basis of theoretical considerations
and previous empirical studies, can be expected to influence
the market value of earnings yield were included in the re-
gression model used in this study. The additional variables
included were measures of business risk, firm size, ratio of
current assets to total assets, earning power, earnings growth,
and dividend payout rate. In addition, dummy variables were
included to capture possible shifts in the earnings yield

function for three sub-industry groupings of companies: soft-drink companies, breweries, and meat-packing companies.

Use of the Regression Model

The regression model was used to generate data for the test of the Modigliani-Miller hypothesis, with input data from fifty-two food companies for the years 1972 through 1975. A characteristic of the input data that is of particular interest is the frequency distribution of debt-equity ratios. It is noteworthy that very significant representation is present in very low debt-equity ratios (see Table IV), a feature that is not encountered in the electric utility industry. Furthermore, reasonably good distribution is encountered for a fairly broad range of ratios. This fact is, of course, important in a study concerned with the effect of debt-equity ratios on the cost of capital.

Before using the results of the regression analysis in a test of the Modigliani-Miller hypothesis, preliminary statistical tests were performed on the regression residuals. The tests performed included tests for normality, homoscedasticity, and autocorrelation of the residuals. The latter two types of tests are the most significant.

Tests for homoscedasticity are important because significant heteroscedasticity may introduce bias into the estimates of the variances of the regression coefficients. The presence of such biases would bring into question the validity of statistical tests performed on the estimated regression

coefficients. The tests for homoscedasticity indicated that moderate heteroscedasticity exists as a function of a growth variable in the 1972 cross-section year and as a function of the dividend payout variable in the cross-section years 1974 and 1975. In addition, tests indicated that heteroscedasticity exists as a function of one of the dummy variables in each of the cross-section years 1972 and 1975. However, for reasons discussed in Chapter IV, it was concluded that the consequences of the indicated heteroscedasticity were not serious.

The Durbin-Watson test for autocorrelation of residuals was performed after the residuals were ordered on the basis of ascending values of debt-equity ratio. The test was performed because of concern over the possibility of omission from the regression model of a variable that was significantly correlated with the debt-equity ratio, and consequent bias in the estimated coefficient of the debt-equity variable. Acceptance in this test of the null hypothesis of zero auto-correlation indicates that remaining unexplained variations in the dependent variable are randomly distributed relative to the debt-equity ratio. The null hypothesis was accepted at the 5 percent significance level in the cross-section years 1972 and 1973. In the other two years, the test was inconclusive, as it very often is. However, tests for homogeneity of population resulted in acceptance, by a wide margin at the 5 percent level of significance, that the regression

coefficients for the debt-equity variable from the years 1973, 1974, and 1975 are samples from the same population.

The estimated regression coefficients together with standard errors and t-values are shown in Table XVI. The estimated coefficient for the debt-equity variable is not significant at the 5.0 percent level in any cross-section year. Thus the results are consistent with the traditional view of the effect of financial leverage on the cost of capital. However, it does not necessarily follow that the results are inconsistent with the Modigliani-Miller hypothesis. To test the validity of the Modigliani-Miller hypothesis, it is necessary to compare the theoretical coefficient of the debt-equity ratio predicted by Modigliani and Miller with the estimated regression coefficient, and to assess any difference in statistical terms. The results of this exercise are shown in Table XXIII. As the table shows, the null hypothesis of zero difference between the predicted and estimated coefficients is rejected at better than the 0.5 percent level of significance in every cross-section year.

The results obtained by performing the same test on the Miller-amended version of the Modigliani-Miller hypothesis are shown in Table XXIV. It can be seen that the margins by which the null hypothesis is rejected are larger in this table. Since the Miller-amended version is believed to be the proper version of the hypothesis to subject to test, the

values given in Table XXIV are a better measure of the margin by which rejection occurs than those in Table XXIII.

Examination of Table XVI shows another result of considerable interest. The estimated coefficient of the earning-power variable was negative and highly significant in every cross-section year. This result is particularly important in light of the fact that strong negative partial correlation exists between earning power and the debt-equity ratio (see Tables XII to XV). Omission of the earning power variable from the model would have introduced upward bias into the estimated coefficient of the debt-equity ratio.

Another interesting fact observable from Table XVI is that the estimated coefficient of the size variable is consistently negative and highly significant. Thus the contention that the large firm tends to have lower cost of equity capital than the small firm is strongly supported by these results. Moreover, there is some indication that the premium which the small firm had to pay increased at the market bottom in 1974 and continued at a higher level in the recovery year of 1975.

Conclusions

The objective of the research reported in this dissertation was to test the Modigliani-Miller hypothesis that, excluding income tax effects, the cost of capital to a firm is independent of the degree of financial leverage employed by the firm. The basis of the test was Modigliani and Miller's

Proposition II, a corollary of their fundamental hypothesis. Proposition II, in effect, states that equity investors fully discount any increase in risk due to financial leverage so that there is no possibility for the firm to reduce its cost of capital by employing financial leverage. The results of the research reported in this dissertation do not support that contention. The study indicates that, if equity investors require any increase in premium for increasing financial leverage, the premium required is significantly less than that predicted by the Modigliani-Miller Proposition II, over the range of debt-equity ratios covered by this study. The conclusion, then, is that it is possible for a firm to reduce its cost of capital by employing financial leverage.

The empirical investigation included in this study was limited to the food industry for the period 1972 to 1975. Therefore, the conclusions may not apply to other industries or other time periods. It is possible that special conditions existing within the industry and time period considered contributed to the results obtained. However, it should be noted that a particularly chaotic economic period was included in the total time period covered by this study. One would expect that a study covering such a period would be more likely to result in acceptance of the Modigliani-Miller hypothesis than one covering a more placid economic environment. If investors respond differently at different times to risk due to financial leverage, one would expect heightened awareness of

the risk in chaotic time periods. Furthermore, financial data input to the regression model tends to be more noisy in such periods, making it more difficult to achieve sufficient precision to establish significance of any differences between theoretical and estimated values. Therefore, rejection of the hypothesis under these conditions seems particularly convincing.

A secondary conclusion that may be drawn from this study is that previous investigators have paid inadequate attention to the question of whether the basic assumptions underlying the standard regression algorithms are justified for their particular circumstances. Homoscedasticity of the disturbance terms is one of the basic assumptions. Of all the investigations reviewed in Chapter II, the only one in which the subject was even addressed was the 1966 study by Miller and Modigliani. They deflated each of the variables in their valuation model by a variable representing total assets in the expectation that this procedure would result in homoscedasticity.[1] The remainder of the studies contained no mention of the subject. However, the results of the study reported in this dissertation indicate that the problem of possible heteroscedasticity needs to be addressed specifically in each particular situation. Even when using the same regression model with the same group of companies, it

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[1]Merton H. Miller and Franco Modigliani, "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-1957," American Economic Review, LVI (June, 1966), 334-391.

appears that demonstration of homoscedasticity in one cross-section year gives no assurance of homoscedasticity in another cross-section year.

Another secondary conclusion that can be drawn from this study is that earning power is an important variable to consider for inclusion in a regression model intended for use in investigating the effect of financial leverage on the cost of capital. As noted previously, the estimated coefficient of the earning-power variable was negative and highly significant in every cross-section year. Furthermore, earning power showed strong negative partial correlation with the debt-equity ratio. Therefore, omission of the earning-power variable from the regression model would have introduced upward bias into the estimated regression coefficient of the debt-equity ratio, making it appear that investors were reacting adversely to increasing debt-equity ratio. However, none of the tests of the Modigliani-Miller hypothesis discussed in Chapter II were based on a model including earning power.

Future Research

Further research in the area covered by this study seems justified. An obvious need is for more studies of a similar nature covering other industries and other years. In a study of the type reported here, there is always the possibility that special conditions existing in the industry or time period considered account for the results obtained.

Confidence in the generality of the results can grow only if similar results are obtained in other industries and other time periods.

Another area worthy of research is the effect of excluded companies on the results of the study. The most important of these exclusions is that of firms suffering deficits and apparently selling exclusively on the basis of turn-around prospects. Such exclusion is necessary at this time since there is no objective basis for measuring investor yield expectations in such cases. Yet the data from such companies may contain important evidence on the subject of investor attitudes toward debt in a firm's financial structure. Other important and potentially interesting exclusions are firms that have a public historical record too short to establish growth trends and firms whose value might have been affected by unusual circumstances, such as take-over battles.

Another interesting area for exploration is the exact nature of the relation between debt-equity ratio and earning power. Christy has observed that two possible managerial reactions to unfavorable company earnings may distort data used in studies of debt-equity ratios and give debt in the financial structure an undeservedly bad reputation: (1) management may try to increase shareholder earnings by employing financial leverage, and (2) in the face of declining stock price, management may feel impelled to use debt

financing to avoid dilution of current equity.[2] The find-ings in this study relevant to earning power are certainly consistent with this observation. However, detailed studies of the histories of individual companies over a period of time would probably be required to establish the hypothesized relationships.

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[2]This observation was made in private conversation be-tween the author and George A. Christy on April 6, 1977.

APPENDIX A

ELECTRIC UTILITY COMPANIES

Electric Utility Industry (Central)

1. Central and South West Corporation
2. Central Illinois Light Company
3. Central Illinois Public Service Company
4. Central Louisiana Electric Company
5. Cincinnati Gas and Electric Company
6. Cleveland Electric Illuminating Company
7. Columbus and Southern Ohio Electric Company
8. Commonwealth Edison Company
9. Consumers Power Company
10. Dayton Power and Light Company
11. Detroit Edison Company
12. El Paso Electric Company
13. Empire District Electric Company
14. Gulf States Utilities Company
15. Houston Industries
16. Illinois Power Company
17. Indianapolis Power and Light Company
18. Interstate Power Company
19. Iowa Electric Light and Power Company
20. Iowa-Illinois Gas and Electric Company
21. Iowa Power and Light Company

22. Iowa Public Service Company

23. Iowa Southern Utilities Company

24. Kansas City Power and Light Company

25. Kansas Gas and Electric Company

26. Kansas Power and Light Company

27. Kentucky Utilities Company

28. Louisville Gas and Electric Company

29. Middle South Utilities Company

30. Minnesota Power and Light Company

31. Missouri Public Service Company

32. Montana-Dakota Utilities Company

33. Northern Indiana Public Service Company

34. Northern States Power Company (Minnesota)

35. Ohio Edison Company

36. Oklahoma Gas and Electric Company

37. Otter Tail Power Company

38. Public Service Company of Indiana, Inc.

39. St. Joseph Light and Power Company

40. South Indiana Gas and Electric Company

41. Southwestern Public Service Company

42. Texas Utilities Company

43. Toledo Edison Company

44. Union Electric Company

45. Wisconsin Electric Power Company

46. Wisconsin Power and Light Company

47. Wisconsin Public Service Corporation

Electric Utility Industry (East)

1. Allegheny Power System
2. American Electric Power Company
3. Atlantic City Electric Company
4. Baltimore Gas and Electric Company
5. Boston Edison Company
6. Carolina Power and Light Company
7. Central Hudson Gas and Electric Company
8. Central Maine Power Company
9. Consolidated Edison Company of New York
10. Delmarva Power and Light Company
11. Duke Power Company
12. Duquesne Light Company
13. Eastern Utilities Association
14. Florida Power Corporation
15. Florida Power and Light Company
16. General Public Utilities Company
17. Long Island Lighting Company
18. New England Electric System
19. New England Gas and Electric Association
20. New York State Electric and Gas Corporation
21. Niagara Mohawk Power Corporation
22. Northeast Utilities Company
23. Orange and Rockland Utilities Company
24. Pennsylvania Power and Light Company
25. Philadelphia Electric Company

26. Potomac Electric Power Company

27. Public Service Electric and Gas Company

28. Public Service Company of New Hampshire

29. Rochester Gas and Electric Corporation

30. Savannah Electric and Power Company

31. South Carolina Electric and Gas Company

32. Southern Company

33. Tampa Electric Company

34. United Illuminating Company

35. Virginia Electric and Power Company

Electric Utility Industry (West)

1. Arizona Public Service Company

2. Citizens Utilities Company

3. Hawaiian Electric Company

4. Idaho Power Company

5. Montana Power Company

6. Nevada Power Company

7. Pacific Gas and Electric Company

8. Pacific Power and Light Company

9. Portland General Electric Company

10. Public Service Company of Colorado

11. Public Service Company of New Mexico

12. Puget Sound Power and Light Company

13. San Diego Gas and Electric Company

14. Sierra Pacific Power Company

15. Southern California Edison Company

16. Tucson Gas and Electric Company

17. Utah Power and Light Company

18. Washington Water Power Company

APPENDIX B

FOOD COMPANIES

1. American Maize-Products Company

2. Anderson Clayton and Company

3. Archer-Daniels-Midland Company

4. Beatrice Foods Company

5. Borden, Inc.

6. CPC International, Inc.

7. Campbell Soup Company

8. Carnation Company

9. Central Soya Company, Inc.

10. Consolidated Foods Corporation

11. Del Monte Corporation

12. Fairmont Foods

13. General Foods Corporation

14. General Mills, Inc.

15. Gerber Products

16. Green Giant

17. H. J. Heinz Company

18. Hershey Foods Corporation

19. Kellogg Company

20. Kraftco Corporation

21. Nabisco, Inc.

22. Norton Simon, Inc.

23. Pet, Inc.

24. The Pillsbury Company

25. The Quaker Oats Company

26. Ralston Purina

27. Riviana Foods, Inc.

28. Russell Stover Candies, Inc.

29. J. M. Smucker Company

30. A. E. Staley Manufacturing Company

31. Standard Brands

32. Stokely-Van Camp, Inc.

33. Tasty Baking Company

34. Tootsie Roll Industries, Inc.

35. Wm. Wrigley, Jr., Company

36. Coca-Cola Bottling Company of New York (soft drink company)

37. Coca-Cola Company (soft drink company)

38. Dr. Pepper Company (soft drink company)

39. Pepsico, Inc. (soft drink company)

40. Royal Crown Cola (soft drink company)

41. Seven-Up Company (soft drink company)

42. Anheuser-Busch, Inc. (brewery)

43. G. Heileman Brewing (brewery)

44. Lone Star Brewing (brewery)

45. Pabst Brewing Company (brewery)

46. Schlitz Brewing Company (brewery)

47. Esmark, Inc. (meat-packing company)

48. The Federal Company (meat-packing company)

49. George A. Hormel and Company (meat-packing company)

50. Iowa Beef Processors, Inc. (meat-packing company)

51. Kane-Miller Corporation (meat-packing company)

52. Oscar Mayer and Company (meat-packing company)

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