AN EMPIRICAL STUDY OF THE RELATIONSHIPS BETWEEN FINANCIAL LEVERAGE AND CAPITAL COSTS FOR ELECTRIC UTILITIES

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WORKING PAPER

UNIVERSITY OF FLORIDA

1987

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CHAPTER I
INTRODUCTION

The Regulatory Process

Electric utilities are suppliers of an essential and indispensable service to society, and hence they are typically required to serve all customers in their market area at reasonable rates and without undue price discrimination. Further, for many years economies of scale in production and distribution made it possible for a single firm to provide lower cost service than several smaller firms. Thus, electric utilities are to a large extent natural monopoly providers of an essential service. This fact prompted governmental regulation at a very early stage in the development of the electric utility industry, with the primary purpose of regulation being to replicate the results that would have occurred under a competitive market system.[1] In a competitive market, the forces of competition hold prices down to the cost of production and distribution, including a return on invested capital. Over the long run, the return on capital will reflect the riskiness of the industry--the greater the risks confronted by the industry, the greater the required rate of return. Under regulation, regulators act as a substitute for the competitive market system by setting output prices and controlling entry and service standards.

Regulation of output prices involves two major tasks. First, regulators must determine the total revenues required to cover all operating expenses, including a fair rate of return on invested capital. Second, regulators must apportion this revenue requirement among the different customer classes and categories of service. (The latter task, often called rate design, is not relevant to this study, although rate structures certainly affect the volatility of sales and hence returns, capacity investment decisions, and incentives for customers to alter consumption patterns.) Overall revenue requirements for a firm are determined in the following manner:

$$R = O + (R - O - I)T + rB, \qquad (1\text{-}1)$$

where

R = total revenue requirements,

O = total operating expenses including depreciation,

I = embedded interest expense, or the interest on outstanding debt,

T = tax rate,

r = allowed rate of return, determined as a weighted average of the costs of debt and equity, and

B = rate base.

Total revenue requirements are thus set to cover all operating costs, including depreciation and taxes, plus provide a return to the firm's investors. The last term in

Equation 1-1, the allowed rate of return multiplied by the rate base, provides this return to investors. Normally, the rate base, B, is approximately equal to the net book value of that part of the firm's plant considered "used and useful" in providing service, plus an allowance for working capital requirements. The allowed rate of return, r, is calculated on the basis of the required rates of return of the investors providing the capital needed to acquire the assets used to provide service to consumers.

Rate of Return Regulation

A major element in utility regulation is the setting of just and reasonable allowed rates of return. The allowed rate of return is a blend, or weighted average, of the costs of the three types of capital used: debt, preferred stock, and common stock. It is estimated by the following equation:

$$r = w_d k_d + w_p k_p + w_s k_s,$$

where

w_d = proportion of debt in the capital structure,

k_d = embedded cost of debt,

w_p = proportion of preferred stock,

k_p = embedded cost of preferred stock,

w_s = proportion of common stock, and

k_s = marginal cost of common equity.

The embedded costs of debt and preferred stock are relatively easy to estimate, whereas the appropriate weights, w_i, and the marginal cost of common stock, k_s, present a much larger estimation problem.[2]

The weights should represent the proportions of debt, preferred stock, and common stock in the firm's target, or optimal, capital structure, which is that mix of capital components that minimizes the firm's marginal weighted average cost of capital. The estimation of a firm's target capital structure is complicated by the fact that the component costs (k_d, k_p, and k_s) are related to the amount of financial leverage, or fixed cost (debt and preferred stock) financing, used.[3] Further, the costs of debt and preferred stock are less than the cost of common stock.

The more financial leverage that is used, the higher the proportion of lower cost components, but at the same time, the higher the cost of each component. Thus, selecting the optimal amount of financial leverage (the optimal capital structure), like virtually all finance decisions, involves a risk/return trade-off. The information required to set the optimal capital structure includes the relationships between the component costs of capital (debt, preferred stock, and common stock) and the amount of financial leverage used. None of these relationships are easy to estimate, but establishing the relationship between financial leverage and common equity cost is especially difficult.

Relevance of the Study

Until recently, the optimal capital structure played a minor role in electric utility management and regulation. The industry was under great stress during the 1970s and early 1980s as a result of record inflation, huge oil price increases which necessitated conversion from oil generating plants to coal or nuclear fuel, escalating costs and regulatory delays for nuclear plants, and, for some companies, dramatic growth in their service areas. These factors combined to depress profits and drive down stock and bond prices at the very time that the industry needed to raise huge amounts of cash to finance construction programs. Under such conditions, not much attention could be given to financing according to an optimal capital structure--firms had to raise capital any way they could, and that normally meant using first mortgage bonds to a very large extent. As a result, the financial leverage of most firms, measured in either book or market values, rose to all-time highs. Concurrently, regulatory agencies did not pay much attention to optimal capital structure in rate cases: The companies financed as best they could, and the allowed rate of return was generally based on the actual capital structure at the time the rate case was decided.

This lack of attention to capital structure issues also created little incentive for capital structure research. Thus, no conclusive empirical work has been conducted using data beyond the early 1970s.

Today, however, many companies have significantly improved their financial positions--profits are higher, capital expenditures are down sharply, and large depreciation cash flows are coming in from newly completed plants. These changes are giving companies the flexibility to adjust their capital structures, so the question of optimal capital structure, and the related question of the effect of capital structure on capital costs, is becoming a major issue for both regulators and managers.

Study Objectives

The primary objective of this study is to estimate empirically the relationships between financial leverage and the costs of common equity and debt. The study has two secondary objectives: (1) To determine if the relationships between leverage and the costs of debt and equity are affected by the financial leverage measure used, and (2) to determine if the empirical relationships between capital costs and financial leverage exhibit significant nonlinearities. Finally, there is one tertiary objective: to identify the business risk factors which influence an electric utility's cost of capital.

Preferred stock typically plays only a minor role in the capital structure of electric utilities, and hence the preferred stock/leverage relationship will not be addressed in this study.

Basic Methodology

The empirical portion of the study consisted of two models. First, an econometric model based on multiple regression techniques was used to estimate the relationships between leverage and capital (debt and common equity) costs:

$$k_s \text{ or } k_d = b_0 + b_1(\text{Leverage}) + b_2F_2 + \ldots + b_nF_n + e.$$

Here either the cost of common equity or the cost of debt is the dependent variable, and financial leverage is one of the independent variables. Additional independent variables (the F_i's) are included in the regression to account for other factors which might affect k_s or k_d and which may be correlated with financial leverage. The econometric model was also used to (1) assess the impact of the leverage measure used, and (2) test for nonlinear relationships.

Second, a bond rating guidelines model was developed to estimate the relationship between debt cost and financial leverage. This model uses Standard & Poor's Corporation (S&P) published guidelines, along with yields on bonds with different ratings, to estimate the leverage/debt cost relationship. To illustrate, S&P might state that a 43.5 percent debt ratio is average for AA-rated electric utilities, while a 49.0 percent debt ratio is representative of firms rated single A. Thus, a debt ratio difference of 5.5 percentage points leads to a full step difference in ratings. The yields on issues with different ratings can also be estimated, and the leverage differential and yield differential was then used to estimate the cost of debt/leverage relationship.

Summary of Results

The results show strong positive relationships between financial leverage and both debt and equity costs. Table 1-1 summarizes these relationships. The results indicate

Table 1-1
Summary of Results

Change in Debt Ratio	Basis Point Change in Debt Cost		Basis Point Change in Equity Cost	
	Econometric Model	Rating Guidelines Model	Econometric Model	Rating Guidelines Model
40% to 50%	28	56	74	111
50% to 60%	42	120	113	240

a much stronger relationship between financial leverage and equity costs than reported in previous studies. Further, the capital costs/leverage relationship was strongest when leverage is measured by market value debt-to-equity ratios--book value ratios were inferior measures of financial leverage for estimating its impact on capital costs. There was no evidence that the leverage/capital costs relationships were nonlinear when leverage is measured by debt-to-equity ratios.

The two dominant risk business factors, to both debt and equity investors, were nuclear construction programs and reserve margins. In contrast to previous studies, regulatory climate did not affect equity or debt costs during the study period.

Report Organization

The remainder of this study is divided into five parts. Chapter II contains a review of the relevant literature. Both theoretical and empirical work are discussed. Chapter III describes the econometric model and provides the rationale for the particular specifications selected, while Chapter IV contains the results of the regression runs. Chapter V then describes the bond rating guidelines model and results, and, finally, Chapter VI summarizes and compares the results of the two models and presents the final conclusions.

Notes

[1]For an in-depth discussion of the regulatory process, including rate of return regulation, see Phillips (1984).

[2]The costs of debt and preferred stock consist primarily of the fixed historic costs of the securities already issued, which are known at the time the allowed rate of return is set. The costs of debt and preferred stock anticipated to be issued during the effective period of the rate decision may also be included. These marginal costs are somewhat more difficult to estimate, but they represent only a small fraction of the total debt and preferred stock outstanding.

[3]Finance theorists hypothesize a positive relationship between financial leverage and component costs--the higher the proportion of debt and preferred stock in the capital structure, the higher the costs of debt, preferred stock, and common equity. Empirical studies have tended to support this relationship, although the exact form of the relationship has not been established. Chapter II discusses the supporting theoretical and empirical studies in detail.

CHAPTER II
REVIEW OF PRIOR STUDIES

A number of theoretical studies have set forth hypothesized relationships between financial leverage and the cost of various types of capital. Further, several empirical studies have been conducted to estimate these relationships for electric utilities. This chapter summarizes these studies.

Theoretical Studies

Cost of Equity Studies

The theoretical studies addressing the cost of equity/leverage relationship fall into three broad classifications: (1) the classics, (2) extensions of the classics, and (3) studies which incorporate in the impact of regulation. The studies are discussed in that order.

The classics. The theoretical relationships between a firm's use of financial leverage and its equity cost have evolved from the classic articles by Modigliani and Miller (MM) (1958 and 1963). They prove, under a well-known set of restrictive assumptions, that a levered firm's cost of common equity, k_s, is related to financial leverage in the following way:[1]

$$k_s = k_u + (k_u - k_{RF})(1 - T)(\frac{D}{S}), \qquad (2\text{-}1)$$

where

k_u = cost of common equity to an unlevered firm with the same business risk as the levered firm,

k_{RF} = cost of risk-free debt,

T = tax rate of the levered firm,

D = market value of the levered firm's debt, and

S = market value of the levered firm's common equity.

In their original work, MM assumed that corporate debt is risk free. Under this assumption, the cost of equity is linearly related to the market value debt-to-equity ratio.

<u>Extensions to the classics</u>. Finance theorists and practitioners alike doubt that Equation 2-1 holds when MM's restrictive assumptions are relaxed. Stiglitz (1969) and Rubinstein (1973) went on to show that the introduction of risky corporate debt does not alter the basic MM relationship, which can be rewritten as

$$k_s = k_u + (k_u - k_d)(1 - T)(\frac{D}{S}) \qquad (2\text{-}2)$$

where k_d is the levered firm's cost of risky debt. Equation 2-2 again shows that common equity costs increase with the use of financial leverage. However, the addition of risky debt results in k_d being a function of financial leverage, and hence the cost of equity is no longer linearly related to the market value debt-to-equity ratio.

Perhaps the two most important of MM's restrictive assumptions are (1) the absence of personal taxes and (2) the absence of financial distress and agency costs. Miller

(1977) and DeAngelo and Masulis (1980) argued that the addition of personal taxes increases the levered firm's cost of common equity above that given by Equation 2-2. Under Miller's assumptions, the addition of personal taxes results in this relationship:

$$k_s = k_u + (k_u - (1 - T)k_d)\frac{D}{S}. \qquad (2\text{-}3)$$

Under Miller, the leverage risk premium (the last term in Equation 2-3) is larger than hypothesized by MM and hence leverage has a greater impact on equity cost.

The biggest criticism of both the MM and Miller models stems from the assumption of a zero cost for financial distress. In bankruptcy, the value of the firm is reduced by payments made to third parties. Fees paid to trustees, lawyers, accountants, appraisers, and so on, reduce the value of the firm's assets, and hence the funds available for distribution to bondholders and stockholders. These are the direct costs of bankruptcy. Additionally, firms in financial distress may suffer indirect costs such as lost customers, managerial inefficiency due to pressing financial problems, job security demands, and so on. Warner (1977), in examining 11 railroad bankruptcies, concluded that direct bankruptcy costs are small, averaging about 2.5 percent of the market value of the firm 3 years prior to the bankruptcy. On the other hand, Altman (1984) estimated both direct and indirect bankruptcy costs for 26 firms, and he found these combined costs to average about 15 percent of total firm value. The results are mixed, but there is evidence to suggest that expected bankruptcy costs can be sufficiently high to influence the cost of common equity/leverage relationship.

In addition to bankruptcy costs, Jensen and Meckling (1976) and Barnea, Haugen, and Senbet (1985) argued that the use of leverage imposes costs associated with the restrictive covenants and monitoring actions that creditors take to protect themselves against unfavorable managerial actions. These costs, called agency costs, may increase as leverage increases. It is commonly argued (see Chen and Kim (1979) and Kim (1982)) that leverage-related agency and financial distress costs invalidate the theoretical relationships developed by MM and by Miller. With these costs added, the relationship becomes much more complex, and it is possible that the relationships between common equity cost and financial leverage expressed in Equations 2-2 and 2-3 require additional terms. For example, see Patterson (1984).

The impact of regulation. The process of regulation may affect the theoretical relationships between common equity costs and financial leverage. MM and Miller, in deriving Equations 2-2 and 2-3, assumed that the firm's earnings before interest and taxes (EBIT) is independent of financial leverage. However, the regulatory process seems to invalidate this assumption. Gordon (1967) and Gordon and McCallum (1972), argued that, for regulated firms, earnings before interest but after taxes, rather than EBIT, is the cash flow variable that is independent of leverage. They further argued that, under the remaining MM assumptions, the correct relationship between common equity costs and financial leverage for regulated firms is that prescribed by MM in a zero-tax world:

$$k_s = k_u + (k_u - k_d)\frac{D}{S}. \qquad (2\text{-}4)$$

Elton and Gruber (1971) made the same cash flow independency argument as Gordon and McCallum, but reached different conclusions. They argued that the proper leverage relationship for regulated firms is the same as for unregulated firms given by MM when corporate taxes are considered:

$$k_s = k_u + (k_u - k_d)(1 - T)\frac{D}{S}. \qquad (2\text{-}2)$$

Elton and Gruber (1972) then demonstrated that either Equation 2-2 or Equation 2-4 can be correct, depending upon what further assumptions are made about regulatory behavior. Equation 2-4 is correct if the allowed rate of return is uncertain over time, but once set the allowed rate is realized in each period. On the other hand, Equation 2-2 is correct if the allowed rate of return is fixed over time, but the earned rate of return may vary across periods. Of course, neither description of the process is correct since both allowed and realized rates of return are uncertain over time.

Finally, Jaffe and Mandelker (1976) argued that the relationship between leverage and equity cost for a regulated firm cannot be derived without specifying its supply and demand curves, because the regulated price is a function of financial leverage. Further, Equation 2-2 or Equation 2-4 can only be correct for special cases of supply and demand conditions that are not likely to hold for regulated firms. Instead, they argued that under more traditional demand assumptions, the cost of equity rises even less with leverage than indicated by Equation 2-2.

In summary, finance theory provides many different models of the relationship between equity cost and leverage. The exact specification of the relationship depends on the underlying assumptions, and it is virtually impossible a priori to choose among the hypothesized relationships.

<u>Cost of Debt Studies</u>

The theoretical cost of debt/financial leverage relationship has not received as much attention as the cost of equity/financial leverage relationship. However, it is generally held that, like common equity, debt costs are positively related to the use of financial leverage--the greater the use of debt financing, the higher the cost of debt. This is because higher debt usage increases the fixed claims against a firm's earnings stream, and hence (1) increases the probability of financial distress and (2) increases the dollar value of claims against any liquidation proceeds.

Hsia (1981) combined the Option Pricing Model (OPM), the Capital Asset Pricing Model (CAPM), and the MM zero tax model to demonstrate consistency among the models. In this work, Hsia developed the following expression for the relationship between the cost of debt and financial leverage:

$$k_d = k_{RF} + (k_u - k_{RF})(1 - N(d_1))\frac{V}{D}. \qquad (2\text{-}5)$$

Here $N(d_1)$ is the cumulative probability for a unit normal variable, and hence must fall between 0 and 1, and $V = D + S$.[2] Thus, Equation 2-5 shows that the cost of debt is equal to the risk-free rate, k_{RF}, plus a risk premium that increases with financial leverage. If a firm used all debt financing, then $N(d_1) = 0$ and $V/D = 1$, and hence the cost of debt would equal the cost of equity to an unlevered firm. Note, though, that Hsia's result is based on the assumption that bankruptcy costs are zero.

Empirical Studies

Cost of Equity Studies

The number of theoretical models proposed supports the need for empirical studies which attempt to estimate the relationship between an electric utility's financial leverage and its cost of common equity. Numerous such studies have been conducted, and even more studies have examined the relationship for unregulated firms. In the following paragraphs, only the more prominent electric utility studies are discussed.

Virtually all empirical work has used the following specification:

$$k_s = b_0 + b_1(\text{Leverage}) + b_2F_2 + \ldots b_nF_n + e.$$

Here the firm's cost of common equity is the dependent variable, leverage is one of the independent variables, and other independent variables are included to account for cross-sectional differences in k not attributable to leverage. All studies of this nature have three major problems: (1) It is very difficult to estimate the dependent variable, and hence the early studies used proxies such as dividend yield in place of a direct estimate of the cost of common equity. (2) The specification must include all other risk factors that are correlated with financial leverage to avoid biasing the leverage coefficient.[3] (3) All of the variables in the specification should be measured in terms of investors' expectations, not historic data, and this presents a serious measurement problem.

The first major study to incorporate modern financial and statistical concepts was conducted by Brigham and Gordon (1968). They used the following model:

$$\begin{aligned}\text{Dividend yield} = {} & b_0 + b_1(\text{Growth rate}) \\ & + b_2(\text{Book value debt/equity ratio}) \\ & + b_3(\text{Earnings instability}) \\ & + b_4(\text{Corporate size}) \\ & + b_5(\text{Proportion of sales from electricity}) + e.\end{aligned}$$

Their sample consisted of 69 electric utilities during the years 1958 to 1962. They found, on average, that a unitary increase in the book debt-to-equity ratio raised the dividend yield by about 0.33 percentage points.[4]

Gordon (1974) expanded both the model and the sample used in the Brigham and Gordon study. Gordon used the following model:

$$\text{Dividend yield} = b_0 + b_1(\text{Market value debt/equity ratio}) + b_2(\text{Growth rate}) + b_3(\text{Proportion of sales from electricity}) + b_4(\text{Earnings quality}) + e,$$

and he found that over the 1958-1968 period, the coefficient of the leverage variable averaged about 0.5 when leverage was measured by the market value debt-to-equity ratio.[5] Robichek, Higgins, and Kinsman (1973) carried out a study over the 1962-1969 period, using the following model:

$$k_s = b_0 + b_1((\text{Debt} + \text{preferred})/\text{equity ratio}) + b_2(\text{Flow-through dummy}) + e.$$

They estimated k_s using several different discounted cash flow (DCF) models, and used both book and market value leverage ratios. They found that the effect of leverage on common equity costs was about 0.9 percentage points for each unit change in leverage as measured by the book value debt-to-equity ratio. Their results using market value debt-to-equity ratios were inconclusive.

Mehta et al. (1980) carried out a study based on 55 electrics during the 1968-1972 period using the following model:

$$\text{Dividend yield} = b_0 + b_1(\text{Growth rate}) + b_2(\text{Book value preferred/market value common equity ratio}) + b_3(\text{Book value debt/market value common equity ratio}) + e.$$

They found that dividend yield changed on average by about 1.01 percentage points for a unitary change in the preferred stock leverage variable, and by about 0.74 percentage points for a unitary change in the debt leverage variable. Mehta et al. also reached these related conclusions: First, the effect of preferred stock leverage on common equity costs is the same as the effect of debt leverage, except for the tax deductibility of interest expense. Second, if the leverage variable is defined as preferred leverage plus debt leverage multiplied by (1 - Tax rate), then a unitary increase in this combined leverage variable increases common equity costs by about 1.25 percentage points. If the combined leverage variable is measured merely by preferred leverage plus debt leverage, the effect of a unitary change is a 0.75 percentage point change in equity costs.

Finally, Patterson (1984) used a quadratic relationship between the cost of common equity and leverage, based on an assumed quadratic function for the value/leverage relationship. Although his study focused on the relationship between financial leverage and the value of the firm, using a sample of 114 utilities for the years 1975 to 1979, he did draw some conclusions about the effect of leverage on equity costs. He concluded that the relationship between leverage, as measured by the market value debt/equity ratio, and common equity costs is a nonlinear function whose slope rises as leverage increases. However, he did not attempt to attach numerical significance to the relationship.

It is very difficult to compare and contrast the results of the five studies just cited. The studies differ in model specification, variable measurement, and sample size, content, and period. However, the five studies are consistent with the theoretical hypothesis that equity costs increase with leverage.

Cost of Debt Studies

As with theoretical studies, there are few works which empirically estimate the relationship between financial leverage and debt cost. There has been little motivation in the electric utility industry to conduct such research, because the important variable in rate case work is the firm's embedded cost of debt, which can easily be measured. The relationship between debt costs and financial leverage only becomes important when capital structure is an issue.

However, Gordon (1974) did estimate the cost of debt/leverage relationship using 1963 and 1968 data. He found that an increase in the book value debt-to-equity ratio from 1.0 to 2.0 increased the cost of debt by 0.93 percentage points using 1963 data, and by 1.14 percentage points using 1968 data.

Notes

[1]Equation 2-1 is the final result of the MM work when corporate taxes are considered. MM's first article (1958) focused on a zero-tax world.

[2]$N(d_1)$ and d_1 stem from the Black-Scholes Option Pricing Model. See Black and Scholes (1972).

[3]If all of the factors affecting common equity costs were statistically independent, then the omission of independent variables would lower the R^2 of the regression but would not bias the coefficients. However, the omission of variables correlated with the leverage variable would result in a leverage coefficient that is too large and a standard error that is too small.

[4]The average coefficient over the five years of the study is 0.33. A unitary change in the book debt-to-equity ratio is when the ratio changes by plus or minus 1.0. For example, a change from 0.5 to 1.5 is a unitary change, and such a change would increase common equity costs by 0.33 percentage points. Finally, Brigham and Gordon argued that since market/book ratios were about 2 to 2.5 over the period, the coefficient for the leverage variable measured in market value terms would be approximately 0.8.

[5]The coefficient values ranged from 0.4 to 0.7, and were statistically significant in only 5 of the 11 years. The values of the market value debt-to-equity ratio ranged from 0.59 to 0.88.

CHAPTER III
THE ECONOMETRIC MODEL

Model Overview

In general, a firm's capital costs are a function of the risk-free rate, the firm's business risk, its financial risk, and possible other factors such as its dividend policy. Thus,

$$k_s \text{ or } k_d = f(k_{RF}, \text{ business risk, financial risk, other factors}).$$

The specific relationships can be estimated using the classical linear multiple regression model, which takes this form:

$$k_s \text{ or } k_d = b_0 + b_1(\text{Leverage}) + b_2F_2 + \ldots + b_nF_n + e,$$

where $F_2 \ldots F_n$ are business risk factors which influence k_s and k_d and which may be correlated with firms' financial leverage.

The multiple regression model is based on the following assumptions:

1. The relationships between the dependent variable (k_s or k_d) and the independent variables (Leverage and F_i) are linear and correctly specified.
2. The independent variables (Leverage and F_i) are statistically independent.

3. The error term, e,

   a. has a normal distribution with a mean of zero.

   b. has a constant variance across observations.

   c. is independent across observations.

Violation of any of these assumptions can have a significant impact on the validity of the results. Tests for assumptional violations are discussed in Chapter IV.

To use the multiple regression model, two important steps are required: First, the business risk factors, the F_i's, must be selected. Then, measures must be chosen for each variable which appears in the model. The remainder of this chapter provides the rationale for the selection of the other risk factors and describes the measures selected for all the variables.

Dependent Variable Measures

Cost of Equity Measures

The cost of equity was measured in two ways, by a direct DCF estimate and indirectly by the inverse of the market/book (M/B) ratio. In the direct DCF model,

$$k_s = \frac{D_1}{P_0} + g,$$

the dividend yield is found by dividing D_1, next year's expected dividend as reported by Value Line, by P_0, the end-of-year stock price reported by Compustat. The growth rate, g, is the 5-year median expected growth rate in earnings as reported by Institutional Brokers Estimate System (IBES).[1]

The second measure recognizes that M/B ratios are functionally related to equity capital costs, and hence that the M/B ratio can serve as a proxy for the cost of equity. Rather than use the M/B ratio, that ratio's reciprocal, the B/M ratio was used; this facilitates the interpretation of the independent variable coefficients.[2] The DCF k_s, although a direct measure of equity costs, probably has significant measurement error because (1) it assumes constant growth whereas very few firms are actually expected to grow at a constant rate over a prolonged period, and (2) there is no assurance that the IBES median growth rate is the rate used by investors to value the stock. Conversely, the B/M ratio has less measurement error, but as a proxy for k_s, it may introduce specification error.

<u>Cost of Debt Measures</u>

Two measures were also used for the cost of debt, k_d. The first measure used the Standard & Poor's (S&P) Corporation bond rating as the dependent variable and thus as a proxy for k_d. The S&P letter ratings were converted into a numerical rating system with 2 = AAA, 4 = AA+, 5 = AA, 6 = AA-, 7 = A+, and so on (there is no number 1 or 3). This measure recognizes that a direct relationship exists between a company's bond rating and its cost of new debt. The second measure also uses reported bond ratings, but converted to their matching S&P yields. However, since S&P only reports yields on the primary rating groups, that is, on the letter classification without modifiers, all double A bonds (AA+, AA, and AA-) were assigned the yield reported for AA bonds, and so on.

The first measure, which uses bond ratings as a proxy for k_d, provides more detailed information, but (1) its independent variable coefficients measure the impact on rating rather than on k_d and (2) it assumes that at the analysis date the yield differentials between each rating category are equal (for example, that the yield differential between AA and AA- is equal to that between A- and BBB+), a condition that usually does not hold.

Leverage Measures

The independent variable of primary interest is financial leverage, which can be measured in many ways. This section provides the rationale for the leverage measures used in the multiple regression model.

Equity Regressions

Debt leverage can be measured in terms of either debt-to-assets or debt-to-equity. However, the theoretical studies discussed in Chapter II show that, under the Modigliani-Miller assumptions, equity cost is linearly related to the debt-to-equity ratio rather than the debt-to-assets ratio. For this reason, debt leverage was measured in terms of debt-to-equity.

Finance theory also suggests that financial leverage should be measured on a market value basis. Conversely, practicing financial managers and Wall Street analysts tend to focus on book value leverage measures. To further complicate matters, investors are more concerned with the amount of financial leverage a firm will use in the future (its target leverage) than with the current level. Theoretically, the best measure would be the expected market value debt-to-equity ratio. However, all measures are subject to measurement error, and a priori, it is impossible to state categorically that one measure will give better results than another, and hence four different leverage measures were used: (1) the market value debt-to-equity ratio (MVDE), (2) the book value debt-to-equity ratio (BVDE), (3) the expected book value debt-to-equity ratio (EXBVDE), and (4) the expected market value debt-to-equity ratio (EXMVDE).[3] Debt is defined in all leverage measures as short-term interest bearing debt plus long-term debt.

Market values were estimated as follows: (1) Book value was used for short-term debt. (2) The market value of long-term debt was estimated on the basis of embedded interest payments and the yield required on similarly rated bonds, assuming an average maturity of 20 years.[4] (3) The market value of common stock was calculated by multiplying year-end closing stock price times the year-end number of common shares outstanding. All data required for the book value and market value debt-to-equity ratios were obtained from Compustat. The expected book value debt-to-equity ratio was taken from Value Line's forecasted common equity ratio 3-5 years hence.[5] The expected market value debt-to-equity ratio was based on the expected book value measure, scaled to reflect current book/market relationships.

Debt Regressions

As described in Chapter 2, Hsia (1981) derives a theoretical relationship which indicates that the cost of debt is related to the value-to-debt ratio, and trial runs were conducted using this as the leverage measure. However, the explanatory power of the leverage variable was higher when debt-to-equity ratios were used as the leverage measure, and hence the final specifications for the debt regressions used the same leverage measures as the equity regressions.

Other Independent Variables

In addition to financial leverage, seven factors are often cited by security analysts as having an influence on an electric utility's cost of capital: (1) its regulatory climate, (2) its electric/gas sales mix, (3) its fuel mix, (4) the size of its construction program in relation to operating assets, (5) its nuclear construction program, (6) its reserve margin situation, and (7) its dividend policy. More factors could, of course, be added to the list, but a review of prior studies, the general literature, and utility analysts' reports suggests that the ones listed are the most important.[6] This section discusses the rationale for including these variables in the regression model along with the measures used.

Regulatory Climate[7]

Rationale. Risk is inherent in the utility industry due to the inability to forecast perfectly input prices, demand growth, construction costs, and so on. However, the regulatory agency, to some extent, can dictate the allocation of this risk between investors and ratepayers. Additionally, there are actions that regulators can take which systematically affect realized returns. For example, long regulatory lag times in periods of increasing input prices, coupled with the use of historic test periods, result in a bias towards realized returns that are less than those required. Further, regulators can purposely set allowed rates below required rates, or not allow a company to earn a return on all of its invested capital. Thus, the regulators themselves have considerable influence over equity riskiness.

It is possible to review the past and potential future actions of regulatory bodies, and then rank these agencies on the basis of their impact on realized rates of return. Currently, over twenty investment and research firms provide such rankings. According to Dubin and Navarro (1983), the ranking methodology is generally based on six objective criteria:

1. Allowed rate of return.
2. Average regulatory lag and the use of interim rates.
3. Test year used, historical or future.

4. Treatment of construction work in process (CWIP) and allowance for funds used during construction (AFUDC).

5. Treatment of tax benefits from investment tax credits and accelerated depreciation.

6. Inclusion of fuel adjustment clauses.

In today's operating environment, two more criteria should be added:

7. Phase-in of completed plants.

8. Recovery of costs of cancelled plants.

Together, these eight criteria significantly may affect the level and predictability, and hence "quality," of earnings.

From the investors' standpoint, a favorable regulatory climate in today's operating environment would include most or all of the following: a relatively high allowed rate of return, minimal regulatory lag and/or interim rate provisions, the use of a future test year, CWIP in the rate base, normalization of tax benefits, a full automatic fuel adjustment clause, a full cash return on plants as soon as they go into service, and full recovery of prudently incurred costs of cancelled plants. Conversely, an unfavorable regulatory climate would include the following: a relatively lower allowed rate of return, lengthy regulatory lag and no interim rate provisions, the use of an historical test year, AFUDC accounting for construction work in process, flow-through of tax benefits, restrictive or no fuel adjustment clauses, phase-ins of completed plants, and only partial recovery of cancelled plant costs. To the extent that unfavorable regulatory climates increase firms' riskiness, while favorable regulatory climates decrease firms' riskiness, investors should price this risk differential in their required returns.

Several recent studies have confirmed that the more unfavorable the regulatory climate, as measured by commission rankings, the higher the cost of equity. Dubin and Navarro (1983) conducted the most comprehensive study of the effects of regulatory environment to date. They used 1978 data with market-to-book ratio as a proxy for equity cost, and regulatory ranking, the rate of return on book equity, expected rate of return, dividend payout ratio, and fuel cost as a proportion of total costs as the independent variables. They concluded that, for an average utility, the change from a favorable ranking to an average/unfavorable ranking results in an equity cost increase of 2.28 percentage points. Trout (1979) in a study using 1976 data, concluded that moving from a very-favorable to an unfavorable regulatory environment raised equity costs by 1.97 percentage points. However, Fanara and Gorman (1986), in a recent study, found that the effect of regulatory climate on equity cost was considerably stronger in the early 1970s than in 1980.

Several studies have also examined the regulatory climate/debt cost relationship. For example, Dubin and Navarro (1983) and Archer (1981) concluded that regulatory climate also affects debt cost--the lower the regulatory ranking, the higher the cost. Dubin and Navarro found that, for an average utility, a change from a very favorable climate to an average or unfavorable climate (they used three categories for regulatory ranking) resulted in a drop in bond rating roughly equivalent to an S&P rating change from AA- to A.

Measure. Regulatory climate (REGRANK) was measured by the Salomon Brothers' regulatory ratings. These ratings, which can range from A+ to E-, where A+ is the most favorable climate and E- is the least favorable, were converted into a numerical scale as follows:[8]

Letter Rating	Numerical Rating
A+ to A-	1
B+ to B-	2
C+ to C-	3
D+ to D-	4
E+ to E-	5

Gas/Electric Sales Mix

Rationale. Many utilities (the combination companies) provide both gas and electric services, and there is some evidence suggesting that gas operations might be riskier than electric operations. For example, Joskow (1972) made an intensive study of the regulatory decision-making process in New York State. He found that gas departments of combination companies made an upward adjustment in their requests relative to the calculated cost of capital, which reflected the belief that gas sales were riskier than electric sales. However, Joskow did not present any economic justification to support his observation, and he noted that the commission typically allowed a higher equity return on gas operations than on electric operations, but the premium was normally less than that requested. On the other hand, Dubin and Navarro (1983) concluded that there is no risk differential between gas and electric operations.

Brigham, Vinson, and Shome (1983), and Brigham, Tapley, and Aberwald (1984) conducted multiple regression analyses in which cost of equity measures were the dependent variable, and various risk measures, including percentage of gas revenues to total utility revenues, were used as the independent variables. They concluded (1) that gas operations were (at least in 1983) slightly riskier than electric operations, (2) that the differential riskiness of gas and electric operations varies over time depending on the relative prices of gas and fuel oil, and (3) that differences across companies depend on other factors such as customer mix.[9]

Measure. The gas/electric sales mix was measured by the percentage of gas revenues to total gas plus electric revenues as reported by Compustat (PCTGASREV).

Fuel Mix

Rationale. Little work has been done which attempts to relate a firm's electric generation fuel mix to its capital costs. However, fuel expense accounts for about one-half of total operating expenses, and hence the variability of fuel prices has a significant impact on input price variability, which affects a firm's business risk.

Fuel price uncertainty is shaped by the underlying uncertainties in supply and demand. To complicate matters, the relative price uncertainties among the fuel sources change over time. In addition to price uncertainty, the fuels have different accident risk. For example, nuclear operating plant accidents can be much more disastrous than accidents in other types of plants. Also, nuclear plants are probably shut down more quickly, and stay down longer, than other types of plants. This is important, because (1) the variable costs associated with nuclear generation are lower than for other types of plants, so costs shoot up when a nuclear plant goes out of service, and (2) regulators may not allow the company to pass these costs on to consumers. This problem is exacerbated if the loss of a base load plant requires the utility to use peaker units. Further, the fuels have different environmental impact risk. To illustrate, the imposition of legislation further restricting the emission of sulfur and nitrogen oxides could significantly increase the costs of building and operating coal-fired plants. Finally, the fuels have different impacts on the firm's operating leverage. Nuclear plants have relatively high fixed costs, while fossil-fueled plants have relatively high variable costs. For all these reasons, there is a sound basis for believing that the five basic fuels--nuclear, coal, oil, gas, and hydrogeneration--have different inherent riskiness.

It is important to recognize that this inherent riskiness is not necessarily borne by the firm's capital suppliers, and hence does not necessarily affect capital costs. Regulators can effectively allocate much of the fuel mix risk to the firm's customers by such actions as automatic fuel adjustment clauses and full recovery of accident costs through rate increases. However, different regulatory agencies utilize different procedures, and hence allocate fuel mix risk differently. All of this complicates and perhaps obscures the relationship between fuel mix and the riskiness of the utility's securities.

<u>Measure</u>. Fuel mix was measured by three separate variables: (1) the percentage of nuclear generating capacity to total capacity (PCTNUC), (2) the percentage of coal generating capacity to total capacity (PCTCOAL), and (3) the percentage of oil generating capacity to total capacity (PCTOIL). Generating capacity data were obtained from Compustat. Gas generation and hydrogeneration were not included because these fuels represent a relatively small contribution to industry capacity.

<u>Construction Program</u>

<u>Rationale</u>. Large construction programs could be considered risky for several reasons. First, in an inflationary environment new plant is much more costly than

old plant, both in terms of construction costs and capital carrying costs. Commissions can deem that the company was "imprudent" either in deciding to build the plant or in the way the construction was carried out, and disallow a portion of the plant's total cost from rate bases. If the costs are not fully allocated to the ratepayers, then the construction program will have a direct impact on investors' returns. Second, large construction programs often require new equity financing. If the firm's stock is selling below book value at the time of sale, the current stockholders' equity position is diluted, and hence value is lost.

Third, there is the risk that the plant will be cancelled and investors will be forced to bear the costs of cancellation. And fourth, there is significant risk when the plant is actually available for service. Electric utilities must plan their new construction programs well in advance of the time that the capacity will actually be needed. If demand growth turns out to be less than was expected, then the capacity of the plant may not actually be required, and the risk exists that the regulators will not place the plant in the rate base. Under these circumstances, the carrying cost of the plant must be borne by the investors rather than the customers. Further, even if the capacity of the new plant is needed, regulators, to avoid "rate shock," may not grant a full and immediate cash return on the plant, choosing instead to phase the plant into the rate base and hence to delay the return.

Measure. The firms' construction programs were measured by the percentage of total construction expenditures forecasted for the next three years to total current gross plant (PCTCON). The data were provided by Salomon Brothers.

Nuclear Construction Program

Rationale. Over the past 10 years, changing regulatory, legislative, financial, and legal environments have had a significant adverse impact on nuclear construction costs. For example, the safety-related retrofits mandated after the Three Mile Island incident in March 1979 have, by themselves, added between $27 and $100 million to the cost of each reactor unit, nationwide. Further, it is estimated that electricity produced by reactors completed in the 1980s will cost 3 times as much as that produced by plants completed in the late 1970s, and 5 times more than plants completed in the early 1970s.

The effect of this substantial increase in nuclear plant costs, coupled with decreased demand growth, has been profound.[10] Over 100 nuclear units have been cancelled over the last 12 years. It is estimated that the cancellation costs in 1983 alone totalled $3 billion, and that the cost of future cancellations could easily top $20 billion.

Two main conclusions can be drawn: (1) The cost of placing nuclear reactors into service has escalated significantly since the first one was placed into service in 1956. (2) There is considerable risk that many of the units currently under construction will never see service. Thus, the utilities today having unfinished nuclear units face significant riskiness--either from cancellation or from placing units into service which are significantly more costly than those currently in service. Further, the slowing in demand growth has, in some cases, created excess capacity, and additional units merely add to the reserve.

The riskiness inherent in unfinished nuclear units is further compounded by the uncertainties of regulatory response. When a plant is cancelled, or is placed into service without a corresponding demand for its output, someone must bear a loss. The question then becomes: How will regulators allocate this loss?[11] At one extreme, the entire cost could be passed on to the firm's customers. In this case, the presence of unfinished nuclear units poses little risk to the firm's capital suppliers. At the other extreme, regulators could impose the entire cost on the utility's investors. Here, the possibility of abandoned or excess nuclear plant would have the greatest impact on security risk. Further, as in the case of nonnuclear plants, even needed capacity may not be given a full and immediate cash return upon completion in order to avoid "rate shock."

<u>Measure</u>. Nuclear construction was measured by the firm's total dollar investment in uncompleted nuclear plants expressed as a percentage of current gross plant (NUCCON).

This measure was obtained from Salomon Brothers and Compustat data, and the amount of investment includes both costs incurred to date and estimated completion costs.

Reserve Margin

Rationale. A high reserve margin tends to reduce the need for new construction, and in this sense it might reduce investors' perceptions about a firm's riskiness. Also, a high reserve margin reduces the risk of outages or hookup delays, both of which can lead to consumer complaints, to resistance to rate increases, and to a loss of regulatory goodwill. Conversely, a high reseve margin could indicate excess capacity, higher-than-necessary costs, and the possibility of regulatory penalties. A high reserve margin is especially troublesome for a company with a large construction program, for many of the problems associated with construction are exacerbated if new plant is not really needed.

Note, though, that it is often difficult to interpret reserve margins across firms. For example, a reserve margin of 40 percent might not be bad if most of the off-line plant consists of old, inefficient, high-operating-cost equipment which has been largely depreciated. However, the same 40 percent margin would be bad if the excess plant had a high cost and was as efficient as the plant being used to generate power. Also, high reserve margins are much worse for slowly growing utilities than for rapidly growing companies, whose growth can quickly eliminate high reserve margins.

Measure. Reserve margin was measured by the percentage of unused generating capacity to total peak requirement (RESMAR). Here total peak requirement is the higher of summer and winter peaks. This measure was taken from Compustat data.

Dividend Policy

Rationale. One of the most debated issues in finance is whether a firm's dividend policy affects its required return on equity. Miller and Modigliani (MM) (1961) argued that a firm's cost of common equity is unaffected by its dividend policy. They presented a well-developed proof, but that proof hinged upon some restrictive assumptions, including zero taxes and transactions costs. Basically, MM showed that a dollar of dividends is the same as a dollar of capital gains, and that dividend policy merely alters the dividend/capital gain mix that equity investors receive. The introduction of corporate taxes does not change MM's basic conclusions (but, as noted below, the introduction of personal taxes does).

Conversely, Gordon (1959) argued that dividends represent certain cash in the hand while retained earnings lead to uncertain capital gains and hence uncertain future cash flows, and thus investors require a higher return on low dividend payout stocks to account for their increased riskiness. Brennan (1971) questioned Gordon's argument, stating that Gordon was really talking about changes in investment policy, and not dividend policy.

The theories discussed above were all based on the assumption of a world with only corporate taxes. The introduction of personal taxes could affect the conclusions of earlier models, because capital gains are taxed at lower rates than dividends.[12] Farrar and Selwyn (1967) and Brennan (1970) argued that investors value after-tax returns. Thus, if two firms have equal risk, investors would require the same after-tax return, but the before-tax returns would depend on each firm's dividend yield/capital gains mix. The firm with the higher dividend yield would have a higher before-tax required return than the firm with the lower dividend yield, and hence the higher capital gain. Thus, they argued that a firm's cost of common equity is directly related to its dividend payout ratio--the higher the dividend payout, the higher the equity costs. This relationship is exactly opposite of that proposed by Gordon. Miller and Scholes (1978) went on to argue that investors have the ability to postpone the tax on dividends, or even to transform dividend income into capital gains income. If this is the case, then the tax differential can be effectively neutralized, and dividend policy again becomes irrelevant. Black and Scholes (1974) also supported dividend policy irrelevance, but they offered a different argument. They argued that firms' dividend policies attract particular investor clienteles, with high payout firms attracting low tax bracket investors and low payout firms attracting high tax bracket investors. If the clienteles are satisfied, then an individual firm can appeal to either clientele with no effect on its equity costs.

Rozeff (1981) suggested that dividend policy may be tied to agency costs. Shareholders recognize that managers may increase their personal wealth at the expense of outside shareholders, and this risk is taken into consideration in setting required rates of return. Dividend payments may serve as a way of monitoring management performance, since the requirement for external financing forces careful scrutiny of the firm, and a higher payout leads to a greater requirement for external financing. Thus, a higher payout could lead to reduced monitoring costs, and hence a lower cost of equity.

As with the financial leverage relationship, finance theory presents contradictory arguments concerning the relationship between dividend policy and equity costs. In fact, the dividend policy situation is even more confusing, for virtually all financial leverage theories posit a direct relationship between leverage and equity costs, but with dividend policy, theory provides three conflicting relationships: (1) a direct relationship, (2) an inverse relationship, and (3) independence.

Many empirical studies have been undertaken in attempts to shed light on the true effects of dividend policy. For example, Black and Scholes (1974) presented empirical evidence to support the dividend irrelevance theory. On the other hand, Litzenberger and Ramaswamy (1979) found a positive relationship between dividend yield and required return, which supported Brennan's theoretical position. Both studies used empirical forms of the Capital Asset Pricing Model with an added dividend yield term.[13]

All-in-all, the empirical results, like the underlying theories, reach conflicting conclusions, so it is difficult to say that the existing empirical evidence supports one side or the other.

Measure. Dividend policy is measured by a firm's payout ratio (PAYOUT). However, realized payout ratios can vary significantly from target payout ratios, and hence Value Line's forecasted average payout ratio in 3-5 years was used as the dividend policy measure in this study.

Notes

[1]IBES compiles the forecasts of leading Wall Street and Regional brokerage firms. For electric utilities, the growth rate data reflects the estimates of some 10 to 30 analysts, depending on the company.

[2]For example, companies with higher leverage would be expected to have higher equity costs, other things held constant, so the regression coefficient between k_s and leverage should be positive. However, leverage would be expected to be inversely correlated with the M/B ratio--the higher a company's debt ratio, the lower its M/B ratio, other things held constant. To make the signs of the independent variables consistent in the DCF k_s and M/B specifications, the M/B ratio was inverted and B/M was used.

[3]Leverage can also be measured by coverage ratios, which show the amount of earnings or cash flow available to cover a firm's interest payments. Several coverage measures were used in preliminary specifications, but their explanatory power was considerably less than debt-to-equity measures, and hence coverage measures were dropped.

[4]Average long-term debt maturity for a random sample of 10 companies was found to be 19.9 years. The minimum maturity was 16.3 years, while the maximum was 22.9 years. Errors in average maturity of plus or minus 5 years do not have a significant effect on estimated market values.

[5]Value Line estimates the average common equity ratio during a future three-year period. For example, in 1986, it reports the expected average equity ratio during the years 1988-1990. Thus, for all intents and purposes, the Value Line forecast represents the equity ratio expected three years into the future.

[6]There should perhaps also be variables which measure a company's costs relative to other companies in its region on the grounds that a high-cost company is more exposed to load loss from cogeneration and/or industrial plant relocations, and also a variable that measures a company's operating efficiency on the grounds that operating inefficiencies will lead to high costs, hence to possible load loss and/or regulatory penalties. However, no one has, thus far, been able to develop quantitative measures for these variables, and hence they are not included in the regression models. To the extent that they (1) are important and (2) are not already captured in the included variables, their omission will result in larger error terms and lower R^2 values. However, their omission will not affect the leverage variable's coefficient unless cost and efficiency, on a company-by-company basis, are correlated with leverage.

[7]The term "regulatory climate" encompasses public service commission actions, legislative actions, and court actions. The terms "regulators" and "regulatory agencies" include all of these bodies, not just commissions.

[8]Various combinations of dummy variables were also used to measure regulatory climate. The results were similar, so the dummy variable specification was dropped.

[9]Various measures of customer mix were included in early specifications, but these did not affect explanatory power and were not statistically significant, and hence they were dropped.

[10]Electricity demand grew by about 7 percent per year up until the 1973 oil embargo. Recently, demand has been growing at an annual rate of less than 3 percent.

[11]For an excellent discussion of loss allocation, see Robinson (1981).

[12]Only 40 percent of capital gains were taxed under laws in effect during the study period. The Tax Reform Act of 1986 eliminated the preferential treatment of capital gains, but capital gains still retain a slight tax advantage due to deferral of taxes.

[13]For example, Litzenberger and Ramaswamy used this model:

$$k_i - k_{RF} = a_1 + a_2 b_i + a_3(d_i - k_{RF}),$$

where

k_i = expected rate of return on Firm i,

k_{rf} = risk-free rate,

b_i = the beta coefficient of Firm i,

d_i = the dividend yield on Firm i, and

a_1, a_2, a_3 = regression coefficients.

A statistically positive a_3 would mean that equity costs and dividend yield are positively related.

CHAPTER IV
REGRESSION RESULTS

Chapter III described the variables chosen for inclusion in the regression model and the specific measures selected for those variables. Now, Chapter IV provides additional information on the regression model and then presents the results of the regression runs.

Data Sample

The data set consisted of those electric utilities that were followed by Institutional Brokers Estimate System (IBES), Value Line, Salomon Brothers, and Standard & Poor's (Compustat). However, companies which had lowered or omitted their common dividends were excluded on the grounds that those firms clearly violated the constant growth assumption needed to estimate the DCF k_s. Two years of data were used, 1983 and 1984.[1] After applying these data restrictions, the sample consisted of 70 companies for 1983 and 66 for 1984. Appendix A contains a listing of the companies included in the sample set.

Regression Specifications

Two measures were used for both equity cost and debt cost, and four measures were used for leverage. Thus, there were eight different equity model specifications and eight different debt model specifications for each year. Table 4-1 summarizes the regression model specifications. In total, 32 separate model specifications constitute the primary regression runs. Additionally, other specifications were used to investigate side issues that arose during the study. These secondary specifications will be discussed as appropriate throughout the remainder of the study.

Table 4-1
Regression Model Specifications

Specification Designation	Year	Type	Dependent Variable	Leverage Measure
DCF3BV	1983	Equity	DCF k	BVDE
DCF3MV	1983	Equity	DCF k	MVDE
DCF3EXBV	1983	Equity	DCF k	EXBVDE
DCF3EXMV	1983	Equity	DCF k	EXMVDE
B/M3BV	1983	Equity	B/M ratio	BVDE
B/M3MV	1983	Equity	B/M ratio	MVDE
B/M3EXBV	1983	Equity	B/M ratio	EXBVDE
B/M3EXMV	1983	Equity	B/M ratio	EXMVDE
DCF4BV	1984	Equity	DCF k	BVDE
DCF4MV	1984	Equity	DCF k	MVDE
DCF4EXBV	1984	Equity	DCF k	EXBVDE
DCF4EXMV	1984	Equity	DCF k	EXMVDE
B/M4BV	1984	Equity	B/M ratio	BVDE
B/M4MV	1984	Equity	B/M ratio	MVDE
B/M4EXBV	1984	Equity	B/M ratio	EXBVDE
B/M4EXMV	1984	Equity	B/M ratio	EXMVDE
YLD3BV	1983	Debt	S&P k	BVDE
YLD3MV	1983	Debt	S&P k	MVDE
YLD3EXBV	1983	Debt	S&P k	EXBVDE
YLD3EXMV	1983	Debt	S&P k	EXMVDE
RAT3BV	1983	Debt	Bond rating	BVDE
RAT3MV	1983	Debt	Bond rating	MVDE
RAT3EXBV	1983	Debt	Bond rating	EXBVDE
RAT3EXMV	1983	Debt	Bond rating	EXMVDE
YLD4BV	1984	Debt	S&P k	BVDE
YLD4MV	1984	Debt	S&P k	MVDE
YLD4EXBV	1984	Debt	S&P k	EXBVDE
YLD4EXMV	1984	Debt	S&P k	EXMVDE
RAT4BV	1984	Debt	Bond rating	BVDE
RAT4MV	1984	Debt	Bond rating	MVDE
RAT4EXBV	1984	Debt	Bond rating	EXBVDE
RAT4EXMV	1984	Debt	Bond rating	EXMVDE

A Priori Expectations about Coefficient Signs

Table 4-2 contains the a priori estimates of the coefficients' signs based on the previous empirical and theoretical studies discussed in Chapter II. (Note that Appendix B contains a glossary of the variable measure symbols.) Regulatory environment, both regular and nuclear construction, and all of the leverage variables should have positive coefficients, indicating that an increase in the variable's value raises k_s and k_d. However, there are no strong logical arguments as to what the signs should be for the sales mix, fuel mix, reserve margin, or payout ratio variables.

Table 4-2
A Priori Coefficient Estimates

Factor	Measure	Estimated Coefficient Sign
Financial leverage	BVDE	+
	MVDE	+
	EXBVDE	+
	EXMVDE	+
Regulatory environment	REGRANK (1 = best, 5 = worst)	+
Gas/electric sales mix	PCTGASREV	?
Fuel mix	PCTNUC	?
	PCTCOAL	?
	PCTOIL	?
Construction program	PCTCON	+
Nuclear construction program	NUCCON	+
Reserve margin	RESMAR	?
Dividend policy	PAYOUT	?

Input Data Summary

Table 4-3 contains a summary of the input data. For the most part, the table is self-explanatory, but two points deserve clarification. First, the S&P bond ratings range from 4 = AA+ to 12 = BBB-, and the means for 1983 and 1984 indicate that the average company has an A rating. Second, the reserve margin, RESMAR, is negative for some utilities because they purchase a significant amount of the power they sell from other utilities. Note too that the means reflect unweighted rather than weighted averages.

Table 4-3
Input Data Summary

	1983			1984		
Variable	Minimum Value	Maximum Value	Mean	Minimum Value	Maximum Value	Mean
k_s	12.8%	19.0%	15.8%	12.9%	17.3%	14.8%
B/M Ratio	0.61	1.35	1.04	0.60	1.44	0.98
k_d	12.6%	13.6%	13.0%	12.1%	12.9%	12.5%
Bond Rating	5	14	7.9	4	13	7.5
REGRANK	2	4	2.8	2	5	2.8
BVDE	0.68	1.86	1.27	0.62	1.83	1.22
MVDE	0.44	1.91	0.96	0.36	2.02	0.94
EXBVDE	0.77	1.70	1.29	0.83	1.94	1.24
EXMVDE	0.48	1.63	0.97	0.53	1.79	0.93
PCTGASREV	0.0%	53.9%	13.7%	0.0%	66.2%	13.4%
PCTNUC	0.0%	83.0%	13.3%	0.0%	68.6%	13.6%
PCTCOAL	0.0%	100.0%	65.4%	0.0%	100.0%	63.6%
PCTOIL	0.0%	100.0%	9.1%	0.0%	100.0%	7.9%
PCTCON	9.0%	175.0%	36.5%	10.0%	161.0%	33.5%
NUCCON	0.0%	99.8%	17.9%	0.0%	94.8%	14.6%
RESMAR	-68.0%	54.5%	18.3%	-51.5%	56.2%	18.8%
PAYOUT	57.7%	94.7%	73.3%	52.9%	94.6%	72.0%

Note: Based on year-end data.

Dependent Variable Measure Correlations

Since two measures are being used for both debt and equity costs, and because one would expect a strong positive relationship between debt and equity costs, the first step in the analysis was to determine the correlations among the dependent variable measures. Table 4-4 contains these values.

Table 4-4
Dependent Variable Correlation Coefficients

	1983				1984			
	DCF k_s	B/M Ratio	S&P k_d	Bond Rating	DCF k_s	B/M Ratio	S&P k_d	Bond Rating
DCF k_s	1.00	0.74	0.59	0.64	1.00	0.58	0.47	0.49
B/M Ratio		1.00	0.58	0.63	1.00		0.61	0.69
S&P k_d			1.00	0.94			1.00	0.95
Bond Rating				1.00				1.00

There are three major points to note: (1) There was extremely high correlation between the two cost of debt measures in both years. This was expected, since each firm's S&P cost of debt is derived from the firm's S&P bond rating. (2) There was, in general, a strong positive correlation (from 0.47 to 0.69) between a firm's cost of debt measures and its cost of equity measures. This was also expected since the same underlying risk factors should affect the riskiness of a firm's securities, and hence its costs of debt and equity. (3) The correlations between the DCF k_s and the other dependent variable measures were stronger in 1983 than in 1984, but correlations among the other variables were not materially stronger in one year than the other. This could mean that the DCF k_s contains more measurement error in 1984 than in 1983.

The high correlation between a firm's bond rating and its DCF k_s suggests that this relationship be examined more closely. Thus, two new specifications were created with DCF k_s as the dependent variable in both specifications and (1) S&P bond rating as the independent variable and (2) S&P k_d as the independent variable. The results of these specifications are contained in Table 4-5.

Table 4-5
Relationship between DCF k_s and Debt Cost

	S&P k_d		S&P Bond Rating	
	1983	1984	1983	1984
Coefficient	1.99	1.59	0.36	0.22
t-statistic	(6.07)	(4.22)	(6.93)	(4.55)
Adjusted R^2	0.34	0.21	0.41	0.23

The average coefficient for S&P k_d was 1.79 over 1983 and 1984. This implies that a one percentage point increase in a firm's cost of debt would lead to a 1.79 percentage point increase in its cost of equity.

The average coefficient for bond rating was 0.29. Thus, a decrease in a firm's S&P bond rating from, say A+ to A, would increase its cost of equity by 29 basis points. A change by one full rating, say from AA to A, would increase a firm's equity cost by 87 basis points.

Equity Regression Results

Appendix C contains the regression results (coefficients and t-statistics) for the cost of equity regressions: Table C-1 reports the results using book value debt-to-equity as the leverage measure, Table C-2 contains the market value debt-to-equity results, Table C-3 contains the results using the expected book value debt-to-equity ratio as the leverage measure, and Table C-4 reports the results using the expected market value debt-to-equity ratio.

The Leverage/Cost of Equity Relationship

To begin, examine the adjusted R^2 (the explanatory power) of the equity regressions. First, the explanatory power of the DCF k_s specifications was significantly greater in 1983 than in 1984. This, in part, could reflect the smaller sample size in 1984, but this appeared to have minimal impact on the adjusted R^2 of the regressions using the B/M ratio as the dependent variable. The difference in explanatory power could also be caused by increased measurement error in the 1984 DCF k_s estimates. This explanation is consistent with the dependent variable correlation results discussed previously.

Second, the two specifications using market value debt-to-equity as the leverage measure had greater explanatory power than the two book value specifications. Further, the market value debt-to-equity ratios had considerably higher t-statistics than the corresponding book value measures. Thus, variations in equity costs among firms are more closely related to market value leverage measures, and hence equity investors appear to judge the financial risk of a firm in market value terms rather than book value terms. This conclusion is consistent with the theoretical relationships discussed in Chapter II. Further, this result supports the findings of Gordon (1974) and Mehta et al. (1980), who found that equity cost is positively related to market value leverage measures, but refutes the study of Robicheck, Higgins, and Kinsman (1973), which had inconclusive results when leverage was measured in market value terms.

Finally, the explanatory power of the specifications using expected debt-to-equity ratios was generally higher than those using current debt-to-equity ratios. Further, the leverage measure t-statistics were generally higher for the expected measures. This could indicate that expectational leverage measures more closely parallel investors perceptions of financial risk than do current measures. This supports the argument that firms' capital structures vary from optimal over time, but that investors recognize this and demand financial risk premiums based on long-run target capital structures rather than current structures.

One of the primary goals of this study is to estimate the cost of equity/leverage relationship. As just discussed, this relationship is strongest when leverage is measured in expected market value terms. Table 4-6 contains extracts from Table C-4 in Appendix C. The relationship between a firm's expected market value debt-to-equity ratio and its cost of equity was positive and statistically significant in both years for both measures of the cost of equity.

Table 4-6
Expected Market Value Debt-to-Equity
Coefficients and t-statistics

Dependent Variable			
DCF k_s		B/M Ratio	
1983	1984	1983	1984
2.25 (4.25)	1.59 (3.21)	0.36 (7.30)	0.36 (7.89)

The DCF k_s specification permits an easy interpretation of the impact of financial leverage on the cost of equity. The leverage coefficient averaged 1.92 over the two years. However, as previously discussed, there appears to be more measurement error in DCF k_s in 1984 than in 1983. Further, note that the coefficient when the B/M ratio is used as the cost of equity measure was the same in both years. Rather than average the coefficients, it seems that the 1983 estimate, 2.25, is a better estimate of the true, but unknown, relationship. Using this estimate, within the range of expected market value debt-to-equity ratios found in the sample (0.48 to 1.79 as reported in Table 4-3), a unitary increase in the expected market value debt-to-equity ratio increased equity cost, on average, by 2.25 percentage points. (A unitary increase means an increase in the debt-to-equity ratio from, say, 0.4 to 1.4 or from 1.0 to 2.0.)

Most practitioners think of financial leverage in terms of the debt (debt-to-value) ratio, so it would be useful to express the results in these terms. Table 4-7 illustrates the impact of leverage changes on equity cost in terms of both debt-to-equity and debt-to-value ratios. For example, an increase in a firm's market value debt ratio from 40 to 50 percent would increase its cost of equity by 1.28 - 0.54 = 0.74 percentage points, or by 74 basis points. Note that the relationship between equity cost and financial leverage is nonlinear when leverage is measured by the debt ratio. Thus, while an increase in the debt ratio from 40 to 50 percent increases equity cost by 74 basis points, an increase in the debt ratio from 50 to 60 percent increases the cost of equity by 1.13 percentage points.

Table 4-7
Impact of Leverage on Equity Cost

Expected Market Value Debt Ratio	Expected Market Value Debt-to-Equity Ratio	Increase in Financial Risk Premium from Base Level Debt Ratio of 30%
30%	0.43	--
40	0.67	+0.54
50	1.00	+1.28
60	1.50	+2.41

Table 4-8
Results Comparison

Study	Average Debt-to-Equity Coefficient		Study Period
	Book Value	Market Value	
Brigham and Gordon (1968)	0.33	--	1958 - 1962
Robichek et al. (1973)	0.9	--	1962 - 1969
Gordon (1974)	--	0.5	1958 - 1968
Mehta et al. (1980)	--	0.74	1968 - 1972
Gapenski (1986) (DCF k)	1.41	1.92	1983 - 1984
Gapenski (1986) (Div. Yld.)	2.01	2.94	1983 - 1984

Table 4-8 compares the results of this study with previous work. Of course, there are definitional differences among the studies, so a precise comparison is impossible. For example, only Robichek et al. and Gapenski used a direct measure of k_s as the dependent variable, all other studies used the dividend yield. To provide a better comparison, the cost of equity regressions were rerun using a dividend yield specification. That is, dividend yield was used as the dependent variable and dividend growth rate was added as an independent variable.[2] These runs resulted in an average EXMVDE coefficient and t-statistic of 2.94 (6.72) and 2.01 (3.35) for EXBVDE. Thus, this study finds leverage to have a much greater impact on electric utility equity costs than previously reported. However, capital costs have generally risen over the period of the studies, so one would expect the leverage coefficients to increase over time. Nevertheless, the market value coefficients reported here have increased much more dramatically than have capital costs.

To test for possible nonlinearities, each equity regression specification was rerun with an additional independent variable, the leverage measure squared. The coefficients of the second order terms were all statistically insignificant, and hence there was no indication that a quadratic relationship existed between equity cost and leverage over the range of observations.

<u>Other Risk Factors</u>

Perhaps the most startling result with regard to the other risk factors was the failure of regulatory climate to consistently affect a firm's equity cost. The regulatory rank variable was statistically significant in only 2 of 16 regression runs, and regulatory rank was not significant at all when leverage was measured by market value debt-to-equity ratios, although these leverage measures produced the highest explanatory power (R^2). Further, the sign of the regulatory rank coefficient was inconsistent.[3]

The dominant business risk factor was nuclear construction programs. The average coefficient of the nuclear construction variable over 1983 and 1984 (DCF k_s with expected market value debt-to-equity specification) was 0.018, which indicates that a firm with no incompleted nuclear plant would have a zero nuclear construction risk premium, a firm with a 20 percent nuclear construction to current gross plant ratio would have a 36 basis point nuclear construction risk premium, and a firm with an 80 percent nuclear construction ratio would have a 144 basis point risk premium. Of course, these premiums reflect the riskiness of "average" nuclear construction programs, but extremely high cost plants with significant regulatory opposition are clearly much riskier than incomplete nuclear plants that are on schedule, have relatively low costs, and are expected to be placed into service with full cost recovery. Thus, although the regression analysis confirms that equity investors view nuclear construction as having significant risk, it is probably not appropriate to apply the numerical results to particular firms.

There was also some evidence that investors considered reserve margin to be a risk factor for electric utilities. The reserve margin coefficient was statistically significant in 9 out of 16 runs, including 4 out of 8 runs using market value debt-to-equity leverage measures.[4] On average, a higher reserve margin decreases the riskiness of a firm's equity. However, the coefficient averaged only 0.012 in 1983 and 1984 in the DCF k_s specifications with market value leverage, so an average reserve margin of about 18.5 percent only reduced equity costs by 22 basis points, while a high margin of 50 percent would reduce k_s by 60 basis points compared to a firm with a zero reserve margin. As with nuclear construction, it is probably nonsensical to attempt to apply the reserve margin results to a particular utility, for as discussed in Chapter III, the impact of reserve margin is highly dependent upon the firm's particular situation.

Finally, there was some evidence that gas revenues are riskier than electric revenues and that nuclear operating plant is riskier than coal or oil generation. However, the results in this regard are not conclusive.[5] There was no indication that conventional construction programs or dividend policy affects the equity cost of electric utilities.

In Chapter III, several potential interactions were discussed. Specifically, it is possible that nuclear construction programs or nuclear operating plants could have a greater impact on equity cost if the utility were operating in a poor regulatory climate. Also, reserve margin could be viewed as unfavorable if the firm has large ongoing construction or nuclear construction programs. To test for possible interactions, the equity regressions were rerun with the following interaction terms added: REGRANK*NUCCON, REGRANK*PCTNUC, RESMAR*PCTCON. The coefficients of the interaction terms were mixed in sign and statistically insignificant. Thus, there was no evidence that the hypothesized interaction relationships affected equity cost.

Statistical Problems

Three major statistical problems often occur in multiple regression cross-sectional analyses: (1) heteroscedasticity, (2) multicollinearity, and (3) measurement error.

Heteroscedasticity. One of the assumptions of the classical normal linear regression model is that the error term has a constant variance across observations. This assumption is violated if the error term exhibits heteroscedasticity, or nonconstant variance. If heteroscedasticity occurs, the least squares parameter estimates (coefficients) remain unbiased, but the parameter variances will be biased, and hence the standard statistical tests (t-statistics and adjusted R^2) will be incorrect.

The statistical software used to conduct the regression analysis (SAS Version 5) can automatically adjust the covariance matrix to correct for heteroscedasticity. This option was used on all regressions. However, preliminary examination of corrected and uncorrected regressions indicated that heteroscedasticity was not a problem in this analysis; that is, the significance of the independent variables was unaffected by the heteroscedasticity adjustment.

Multicollinearity. Multicollinearity occurs when two or more independent variables are correlated with one another. In extreme cases, when there is a perfect linear relationship between two or more independent variables, it is impossible to calculate the least-squares parameters. This situation is easy to correct--merely delete one of the collinear variables. However, the problem becomes more difficult when two independent variables are highly, but not perfectly, correlated. In this situation, the coefficient estimates remain unbiased in the statistical sense, but (1) the estimated parameter standard errors are too large, and hence the t-statistics are biased downward, and (2) it is difficult to give proper interpretation to the coefficients, because standard interpretation requires that all other independent variables remain constant, a condition which cannot hold when independent variables are correlated.

Unfortunately, there is no accepted measure for defining when multicollinearity becomes a serious problem. Pindyck and Rubinfeld (1981) state a rule of thumb that is commonly used: Multicollinearity is likely to be a problem if the simple correlation between two variables is larger than the correlation of either or both variables with the dependent variable. However, they also state that this rule may be quite unreliable if there are more than two independent variables.

Appendix D contains the independent variable correlation matrix. The leverage measures are obviously highly correlated, but only one of these measures is used in each specification. However, there are relatively high correlations (defined here as greater than 0.30) between (1) the leverage variables and nuclear construction, and (2) the fuel mix variables. There is no accepted correction procedure for multicollinearity, but it is possible to examine the impact of the multicollinear variables on each others coefficients and t-statistics. This was accomplished by conducting a stepwise regression. Since the primary leverage variable of interest is the expected market value debt-to-equity ratio, the stepwise regression used this specification. The results are contained in Table 4-9.

Two major conclusions can be drawn from the stepwise regressions. First, a utility's equity costs are affected most by leverage and nuclear construction programs. These two variables had the most explanatory power in both years, although in 1983 leverage appeared to dominate, while in 1984 nuclear construction dominated. (Note that in the B/M stepwise regressions which are not reported here, the dominant variable was leverage in both years.) Further, the

Table 4-9
Stepwise Regression Results
(DCF k_s with Expected Market Value Debt-to-Equity)

1983

Variables Added	Coefficient	t-statistic	R^2
EXMVDE	3.3433	8.57	0.52
EXMVDE	2.3693	5.46	0.61
NUCCON	0.0211	3.90	
EXMVDE	2.2154	5.11	0.63
NUCCON	0.0230	4.25	
RESMAR	-0.0102	1.88	
EXMVDE	2.1432	4.98	0.64
NUCCON	0.0228	4.33	
RESMAR	-0.0118	2.17	
PCTCOAL	-0.0050	1.67	

1984

Variables Added	Coefficient	t-statistic	R^2
NUCCON	0.0304	5.37	0.31
NUCCON	0.0210	3.49	0.41
EXMVDE	1.3726	3.30	
EXMVDE	1.8908	4.18	0.46
NUCCON	0.0179	3.03	
REGRANK	-0.4335	2.47	
EXMVDE	1.7019	3.73	0.49
NUCCON	0.0198	3.35	
REGRANK	-0.3864	2.22	
RESMAR	-0.0104	1.77	

collinearity between these variables had a large impact on the coefficient of the leverage variable (EXMVDE), which is the major variable of interest in this study. The coefficient of EXMVDE was 3.34 in 1983 when nuclear construction was not considered, but it fell to 2.37 with the addition of the nuclear construction variable. When all variables are included, the coefficient was 2.25, so only nuclear construction had a major impact on the coefficient of the leverage variable. A separate regression was conducted for 1984 in which the only independent variable was EXMVDE. Its coefficient was 2.07 with a t-statistic of 5.21. Note in Table 4-9 that the addition of the nuclear construction variable lowered the EXMVDE coefficient to 1.37. In each year, the leverage coefficient (as measured by EXMVDE) was reduced by about 30 percent by the inclusion of the nuclear construction variable. Over the two years, the coefficient of EXMVDE averaged 2.71 when the collinear nuclear construction variable was dropped from the regression. This compares with a coefficient of 1.92 when nuclear construction is included in the specification. When considering only 1983 because of possible measurement error in the 1984 DCF k variable, the EXMVDE variable fell from 3.34 to 2.25. Table 4-10 illustrates the impact of leverage changes on equity cost when the collinearity is removed, and a coefficient of 3.34 is used. (See Table 4-7 for comparison.) Now, an increase in a firm's market value debt ratio from 40 to 50 percent would increase its cost of equity by 110 basis points, and an increase in the debt ratio from 50 to 60 percent would increase a firm's equity cost by 1.67 percentage points.

Table 4-10
Impact of Leverage on Equity Cost
(Collinearity Removed)

Expected Market Value Debt Ratio	Expected Market Value Debt-to-Equity Ratio	Increase in Financial Risk Premium from Base Level Debt Ratio of 30%
30%	0.43	--
40	0.67	+0.80
50	1.00	+1.90
60	1.50	+3.57

The second conclusion that can be drawn from the stepwise regression is that regulatory climate did not appear to be a major risk factor for electric utilities equity investors in 1983 and 1984. In 1983, the regulatory climate variable (REGRANK) did not appear in the stepwise results, and in 1984 it appeared, but with the wrong sign. These results tend to confirm the earlier results using the full specifications, which support and extend the results of Fanara and Gorman (1986), who concluded that regulatory climate was a significant equity risk factor in the early 1970s, but that its influence diminished over time.

Measurement error. The classical linear regression model requires that all variables in the model be measured without error. In practice this is generally not the case. In this study, the dependent variables are merely proxies for investors' required rates of return, and hence measurement error exists. Measurement error in the dependent variable affects the intercept term, but the coefficients of the independent variables remain unbiased (see Pindyck and Rubinfeld (1981)).

However, measurement error in the independent variables, or in both the dependent and independent variables, has more serious consequences. Here, measurement error typically leads to coefficient estimates that are biased downward, and hence understate the true relationships. Again, there is every reason to believe that measurement error exists in the financial leverage measures, since they are all proxies for investors' views on firms' target capital structures. Thus, there is reason to suspect that the coefficients reported earlier understate the true, but unobservable, relationships. This point will be discussed in more detail in Chapter VI.

Debt Regression Results

The coefficients and t-statistics for the cost of debt regressions are presented in Appendix E: Table E-1 reports the results using book value debt-to-equity as the leverage measure, Table E-2 contains the market value debt-to-equity results, Table E-3 contains the results using the expected book value debt-to-equity ratio as the leverage measure, and Table E-4 reports the results using expected market value debt-to-equity as the leverage measure.

The Leverage/Cost of Debt Relationship

The first point to note is that the leverage measure used had considerably less impact on the debt regression results than on the equity regression results--the leverage coefficients and explanatory power (adjusted R^2) were much less sensitive across leverage measures. Further, unlike the equity results, the explanatory power was greater in 1984 than in 1983 for all specifications.

The current market value debt-to-equity measure had the highest explanatory power and t-statistics by a slim margin. Table 4-11 contains extracts from Table E-2 in Appendix E.

Table 4-11
Market Value Debt-to-Equity
Coefficients and t-statistics

Dependent Variable

S&P k_d		S&P Bond Rating	
1983	1984	1983	1984
0.84 (5.34)	0.52 (4.51)	4.51 (5.45)	4.06 (5.53)

The relationship between a firm's market value debt-to-equity and its cost of debt was positive and statistically significant for both years and both debt cost measures. Focusing on the S&P k_d specification, the average coefficient value was 0.68, which means that a unitary change in a firm's market value debt-to-equity ratio (within the sample range) would increase its cost of debt by 68 basis points. However, to be consistent in reporting both the debt and equity results, the impact of leverage on debt costs will be measured by the 1983 coefficient, 0.84.[5] Table 4-12 illustrates the impact of leverage changes on debt cost. For example, a change in a firm's market value debt ratio from 40 to 50 percent increases its cost of debt by 28 basis points, while an increase in debt utilization from 50 to 60 percent increases a firm's cost of debt by 42 basis points.

Table 4-12
Impact of Leverage on Debt Cost

Market Value Debt Ratio	Market Value Debt-to-Equity Ratio	Change in Financial Risk Premium from Base Level Debt Ratio of 30%
30%	0.43	--
40	0.67	+0.20
50	1.00	+0.48
60	1.50	+0.90

Note that the coefficient average over 1983 and 1984 was 0.69 using book value debt-to-equity, 0.65 using expected book value debt-to-equity, and 0.61 using expected market value debt-to-equity. Thus, the effect of leverage on the cost of debt was relatively invarient to the leverage measure used.

Second order leverage terms were also added to the debt specifications to test for nonlinear leverage relationships. These second order terms neither enhanced the explanatory power of the specifications nor proved to be statistically significant. Thus, there was no evidence that the leverage/debt cost relationship is quadratic when leverage is measured by debt-to-equity ratios.

Other Risk Factors

In general, the results of the debt regressions parallel those of the equity regressions. Other than financial leverage, the two factors which were consistently statistically significant were nuclear construction programs and reserve margins. Using the market value leverage specifications over both years, the average coefficient for nuclear construction was 0.0055 and for reserve margin, -0.0049. Thus, a firm with a 50 percent nuclear construction-to-current gross assets ratio would pay 27.5 basis points more in debt cost than a utility with no nuclear construction. Similarly, a firm with a 40 percent reserve margin would pay about 9.8 basis points less than a firm with a 20 percent reserve margin. Although nuclear construction programs and reserve margins have high statistical significance, their impact on debt costs is not very large. Further, these risk factors, as well as financial leverage, appear to have a much greater impact on equity cost than on debt cost. This could be due to two factors: (1) Utility debt is typically in the form of mortgage bonds, and hence debtholders have a claim against specific assets in the event of financial distress. (2) Perhaps more important, no major utility has defaulted on its first mortgage bonds in several decades, and debt investors could view the impact of such factors as nuclear construction and reserve margin as minimal as long as the regulatory agencies allow the utilities to earn enough to service the debt.

The debt regressions, like the equity regressions, were rerun with interaction terms added: specifically REGRANK*NUCCON, REGRANK*PCTNUC, and RESMAR*PCTCON. There was no consistent evidence that the hypothesized interaction relationships affected debt cost.

Statistical Problems

The debt regressions exhibited the same potential statistical problems as the equity regressions.

Heteroscedasticity. Corrections for heteroscedasticity were automatically performed by the software, although preliminary analysis did not indicate that a problem existed.

Multicollinearity. The procedures to assess the impact of multicollinearity that were used on the equity regressions were also used on the debt regressions. Table 4-13 contains the results of the stepwise regressions using the market value debt-to-equity ratio as the leverage variable. Note that a firm's financial leverage had the greatest impact on debt cost. In both years, MVDE was the first variable selected, and the explanatory power of the specification was improved only slightly by the addition of other variables.

As in the equity regressions, the addition of the nuclear construction variable had a considerable impact on the magnitude of the leverage coefficient. In 1983, the coefficient of MVDE was 0.9563 with leverage as the sole independent variable (see Table 4-13), but the coefficient dropped to 0.8400 when all explanatory variables were included (see Table E-2 in Appendix E). Similarly, in 1984 the coefficient dropped from 0.7299 to 0.5170.

Table 4-13
Stepwise Regression Results
(S&P k_d with Market Value Debt-to-Equity)

1983

Variables Added	Coefficient	t-statistics	R^2
MVDE	0.9563	7.91	0.48
MVDE	1.0031	8.57	0.53
PCTCOAL	0.0027	2.68	
MVDE	0.9876	8.56	0.55
PCTCOAL	0.0023	2.39	
RESMAR	-0.0033	1.85	
MVDE	0.8518	6.26	0.57
PCTCOAL	0.0023	2.46	
RESMAR	-0.0037	2.11	
NUCCON	0.0030	1.80	
MVDE	0.8647	6.43	0.59
PCTCOAL	0.0037	2.95	
RESMAR	0.0035	2.08	
NUCCON	-0.0042	2.39	
PCTOIL	0.0039	1.67	

1984

Variables Added	Coefficient	t-statistics	R^2
MVDE	0.7299	8.13	0.51
MVDE	0.7259	8.59	0.57
RESMAR	-0.0045	3.03	
MVDE	0.6058	6.07	0.60
RESMAR	-0.0048	3.30	
NUCCON	0.0033	2.02	
MVDE	0.5990	6.23	0.63
RESMAR	-0.0054	3.78	
NUCCON	0.0075	3.26	
PCTCON	-0.0047	2.41	

Also, note that the stepwise regression did not select the regulatory climate variable. Thus, as with the cost of equity, regulatory climate did not appear to be a major risk factor to electric utility debt investors in 1983 and 1984.

Measurement error. The same problems discussed in regard to the equity regressions apply to the debt regressions. The implications of measurement error will be discussed fully in Chapter VI.

This chapter discussed in detail the results of the regression model, which was used to estimate both the leverage/debt cost and leverage/equity cost relationships. In Chapter V, a second approach is used to estimate the leverage/debt cost relationship, the bond rating guidelines model.

Notes

[1]It was apparent that a major risk factor for electric utilities in recent years was nuclear construction programs. Thus, the inclusion of this variable was considered mandatory. Nuclear construction program data first became available in usable form in 1983, and hence this variable dictated the number of years used in the study.

[2]Dividend yield was measured by dividing Value Line's forecast of next year's dividend by the end-of-year stock price reported by Compustat. Dividend growth was estimated by the 5-year IBES median growth rate in earnings.

[3]The dividend yield specifications produced similar results. Regulatory climate was not statistically significant in any of the eight dividend yield specifications (four leverage measures over two years).

[4]Reserve margin was statistically significant in six of the eight dividend yield specifications.

[5]Alternative specifications with percent hydrogeneration and percent gas generation in lieu of percent coal generation and percent oil generation were also run. The results were similar to those reported--fuel mix did not appear to affect capital costs in 1983 and 1984.

[6]Unlike the equity regressions, there is no indication that the 1983 results are any better than the 1984 results for the debt regressions. However, in Chapter VI the debt and equity results will be compared, and using the 1983 debt regressions, allows comparison of like sample sets and economic conditions.

CHAPTER V
THE BOND RATING GUIDELINES MODEL

Model Overview

Firms' bonds are rated for quality by many rating agencies. These agencies assign ratings, such as AAA, AA, A, BBB, which reflect the agency's judgment of the default risk of the issue. Also, these same firms provide data on bond yields for the various ratings. Recently, one of these agencies, Standard & Poor's (S&P) Corporation, made public its rating guidelines for financial leverage for several industries. For example, S&P might state that, other things held constant, a debt ratio of 48 percent plus or minus 5 percent is required for an AA rating, while a ratio of 42.5 percent plus or minus 5 percent would result in an A rating. (Some overlaps occur, and in these cases "other things" determine the actual bond rating.) With the bond yields for each rating, and the rating guidelines known, it is possible to estimate the effect of financial leverage on debt costs. For example, if the yield on AA-rated bonds was 12.6 percent, and the yield on A-rated bonds was 12.9 percent, then a one percentage point change in the debt ratio would be associated with a (12.9 - 12.6)/(48.0 - 42.5) = 0.055 percentage point change in the cost of debt. In this chapter, such a relationship is used to estimate the financial leverage/debt cost relationships for 1983 and 1984.

Bond Ratings

Standard & Poor's assigns bond ratings to electric utilities based on both nonfinancial and financial criteria. The nonfinancial criteria include (1) service territory, (2) fuel mix, (3) operating efficiency, (4) regulatory treatment, (5) management, and (6) competition/monopoly balance. The financial criteria include (1) construction risk, (2) earnings protection, (3) financial leverage, (4) cash flow adequacy, (5) financial flexibility/capital attraction, and (6) accounting quality.[1] Table 5-1 contains a breakdown of the sample set by Standard & Poor's bond rating. The ratings ranged from AA to BB in 1983 and from AA+ to BB+ in 1984, with the vast majority (over 98 percent) of companies being rated from AA+ to BBB-.

Table 5-1
Sample Set Bond Ratings

Rating	Number of Companies 1983	Number of Companies 1984
AA+	0	5
AA	16	16
AA-	8	4
A+	9	13
A	10	5
A-	5	4
BBB+	7	8
BBB	6	5
BBB-	8	5
BB+	0	1
BB	1	0
	70	66

Bond Rating Guidelines

Standard & Poor's provides explicit guidelines for the leverage ratios associated with its bond ratings; those guidelines for the electric utility industry are contained in Table 5-2. It should be noted that S&P, in its discussion of guidelines, states that a strong (or weak) leverage ratio could be offset by some other factor such as coverage. Also, S&P is very interested in a firm's trends, so a company with a debt ratio of 50 percent, but with a target debt ratio of 45 percent and a trend which indicates that it is moving towards the target, might be rated on the basis of the 45 percent target ratio rather than the 50 percent current figure. Thus, companies' actual ratings will not always be consistent with the guidelines contained in Table 5-2.

Table 5-2
Standard & Poor's Rating Guidelines for Electric Utilities

	Leverage Guidelines		
Rating	1982	1985	Average Midpoint
AAA	Debt Under 45%	Debt Under 41%	Under 43.0%
AA	42 - 47	39 - 46	43.5
A	45 - 55	44 - 52	49.0
BBB	Over 53	50 - 58	54.0
BB	--	Over 56	Over 56.0

Sources: (1) Standard & Poor's Corporation, Credit Overview (New York, 1982), 40.

(2) Standard & Poor's Corporation, Credit Week (New York, February 18, 1985), 2244.

Nevertheless, the rating guidelines do provide the range of typical debt ratios. Since the data sample (1983 and 1984) falls between the published guidelines (1982 and 1985), an average of the two guidelines is used to estimate the guideline midpoints. The midpoint for an AA rating is a 43.5 percent debt ratio; for an A rating, 49.0 percent; and for a BBB rating, 54.0 percent.

Bond Yield Spreads

Standard & Poor's Corporation also reports yields by rating on several different types of bonds, including public utilities (electric, gas, and telephone). Table 5-3 contains the December average yields on the S&P public utility index for 1983 and 1984. The data in Table 5-3 can easily be converted to yield spreads. In 1983, the spread between double A and single A issues was 0.26 percentage points, and between single A and triple B issues, 0.71

Table 5-3
S&P Public Utility Index Yields

	Yield to Maturity		
Rating	1983	1984	Average
AAA	12.62%	--	--
AA	12.64	12.11%	12.38%
A	12.90	12.43	12.67
BBB	13.61	12.93	13.27

Source: Standard & Poor's Corporation, Security Price Index Record (New York, 1986), 224-227.

Notes: (1) Yields are averages for the month of December.
(2) S&P discontinued its AAA utility index on January 1, 1984.

percentage points. In 1984, the spread was 0.32 percentage points between AA and A ratings and 0.50 percentage points between A and BBB rating. Over the two-year period, the average spread was 0.29 percentage points between double A and single A utility bonds and 0.61 percentage points between single A and triple B bonds.

Model Results

The rating guidelines and yield spreads presented in the previous two sections can be combined to estimate the relationship between financial leverage and debt cost. This analysis is summarized in Table 5-4. Over the range in ratings which encompasses the bulk of the sample (AA to BBB), on average a one percentage point increase in the debt ratio, say from 48 to 49 percent, increases the cost of debt by 0.087 percentage points, or by 8.7 basis points.

Table 5-4
Financial Leverage/Cost of Debt Relationships

Bond Rating	AA		A		BBB
Average Yield	12.38%		12.67%		13.27%
Yield Spread		0.29		0.60	
Midpoint Debt Ratio	43.5%		49.0%		54.0%
Leverage Spread		5.50		5.00	
Change in k_d per Percentage Point Change in Debt Ratio		0.053		0.120	
Average Change in k_d per Percentage Point Change in Debt Ratio			0.087		

These data can be used to estimate the impact of a change in leverage from, say, a 40 percent debt ratio to a 50 percent debt ratio. Table 5-5 illustrates the results.

Table 5-5
Impact of Leverage on Debt Cost

Book Value Debt Ratio	Book Value Debt-to-Equity Ratio	Change in Financial Risk Premium from Base Level Debt Ratio of 40%
40%	0.67	--
50	1.00	+0.56
60	1.50	+1.76

Table 5-5 was constructed by assuming (from Table 5-4) that each percentage point change in debt ratio from 40 to 49 percent will increase debt costs by 5.3 basis points, while each percentage point change from 49 to 60 percent will increase debt costs by 12 basis points.

Thus, the bond rating guidelines model indicates that an increase in the debt ratio from 40 to 50 percent increases a firm's cost of debt by 56 basis points, while an increase from 50 to 60 percent debt increases a firm's debt cost by 1.76 - 0.56 = 1.2 percentage points.

In this chapter, the bond rating guidelines model was used to estimate the cost of debt/leverage relationship. In prior chapters, an econometric model was presented which estimated the same relationship. In Chapter VI, the results of both models will be summarized and compared, and final conclusions will be presented.

Notes

[1]For a more complete discussion of Standard & Poor's bond rating process, see Standard & Poor's (1982).

CHAPTER VI
SUMMARY AND CONCLUSIONS

Chapter III discussed the econometric model, and Chapter IV presented the empirical results. Chapter V introduced the bond ratings guidelines model and presented its results. Now, in Chapter V, the results are summarized and compared, and final conclusions are drawn.

In Chapter I, the objectives of the study were stated as follows: (1) to estimate empirically the relationships between financial leverage and the costs of debt and equity, (2) to determine if the relationships between leverage and capital costs are affected by the leverage measure chosen, (3) to determine if the empirical relationships between leverage and capital costs exhibit any nonlinearities, and (4) to identify those business risk factors which influence an electric utility's capital costs. The summary and conclusions here are structured to address those objectives.

The Choice of Leverage Measure

The econometric model included two measures of both debt cost and equity cost, and four measures of financial leverage: (1) current book value debt-to-equity ratio (BVDE), (2) current market value debt-to-equity ratio (MVDE), (3) book value debt-to-equity ratio expected 3-5 years hence (EXBVDE), and (4) market value debt-to-equity ratio expected 3-5 years hence. Note that all four primary measures express leverage as the ratio of debt-to-equity, because theoretical studies suggest that the relationship between equity cost and leverage is linear when leverage is measured by the debt-to-equity ratio.[1]

Equity cost relationship. In the equity regressions, the t-statistics and adjusted R^2 were higher using market value measures than with book value measures. Also, the expected market value measure had higher (in three of four specifications) t-statistics and adjusted R^2 than the current market value measure. This leads to two conclusions: (1) equity costs are more closely related to market value measures than to book value measures, and (2) equity costs are more closely related to future capital structures than to current structures.

These two findings, which have not been reported in the previous empirical studies, support two hypotheses about the financial leverage/equity cost relationship. First, as theory indicates, the relationship is based upon market value leverage rather than book value leverage. Second, current leverage measures have less impact on equity cost than expectational measures. Apparently, investors believe that firms stray from target capital structures, and a firm's perceived financial risk is related more to target structures than to current structures.

Debt cost relationship. The choice of leverage measure had much less impact in the debt regressions than in the equity regressions. Like the equity case, market value measures did have slightly higher explanatory power and t-statistics than did book value measures. However, current leverage measures were more closely related to debt costs than were expectational measures. Since debt costs are highly related to bond ratings, this could mean that rating agencies (particularly Standard & Poor's) are more influenced by current capital structure than by expectations of capital structure changes.

Leverage/Capital Cost Relationships

The primary objective of this study is to estimate the relationships between financial leverage and the costs of debt and equity. Since some of the equity results are tied to the debt results, the discussion begins with the leverage/debt cost relationship.

Leverage/debt cost relationship. Table 6-1 summarizes the results presented in Chapters IV and V. Both the

Table 6-1
Impact of Leverage on Debt Cost

	Basis Point Change in Debt Cost	
Change in Debt Ratio	Econometric Model	Rating Guidelines Model
40% to 50%	28	56
50% to 60%	42	120

econometric approach and the rating guidelines approach support the contention that financial leverage increases debt costs. However, as is vividly shown by Table 6-1, the rating guidelines model shows this relationship to be much stronger than indicated by the econometric model.

There are three possible explanations for this difference. First, those firms with the highest cost of debt (those rated below BBB-) were mostly dropped from the sample set because those firms had recently cut or omitted their common dividends. Thus, the highest debt cost firms were systematically excluded from the sample. Second, as discussed in Chapter IV, measurement error can cause a downward bias in the coefficient estimate. Third, the rating guidelines provided by S&P assume that all other factors are held constant at industry average values. As shown earlier, there is a positive correlation between financial leverage and several of the business risk factors. Thus, the rating guidelines model tends to remove the collinearity that is known to exist.[2] These three factors could explain the differences in the results of the two models.

Leverage/equity cost relationship. This study suggests two methods for estimating the relationship between a firm's financial leverage and its cost of equity. First, the relationship was estimated directly using the econometric model. Second, an econometric model was used to estimate the relationship between a firm's cost of equity and its cost of debt, and this relationship was combined with the rating guidelines model. The results of these two approaches are presented in Table 9-2.[2] As with debt cost, the direct econometric estimation of the equity cost/leverage relationship is substantially lower than the estimation based on the bond guidelines model. Again, this could be caused by the three factors previously discussed.[3]

Table 9-2
Impact of Leverage on Equity Cost

Change in Debt Ratio	Basis Point Change in Equity Cost: Direct Estimation	Basis Point Change in Equity Cost: Debt Cost Comparison
40% to 50%	74	111
50% to 60%	113	240

Both estimates, however, are substantially higher than those reported previously by Brigham and Gordon (1968), Robichek, Higgins, and Kinsman (1973), Gordon (1974), and Mehta et al. (1980). Although some of this difference can be attributed to specification differences and generally rising capital costs, the impact of financial leverage was clearly greater than previous studies have indicated.

Nonlinearities

Both the debt and equity regression specifications were modified to include second order terms. That is, the leverage term squared was added. The addition of these second order terms neither enhanced the explanatory power of the specification nor produced statistically significant coefficients. Thus, within the range of observations, there was no indication that the leverage/capital costs relationships are quadratic when leverage is measured by some form of the debt-to-equity ratio.

Business Risk Factors

Since the econometric model included other independent variables to account for nonconstant business risk, some judgements can be made concerning business risk factors.

Equity risk factors. The dominant equity business risk factor in 1983 and 1984 was nuclear construction programs. A firm with a 20 percent nuclear construction to current gross plant ratio was estimated to have a 36 basis point nuclear construction risk premium, while an 80 percent nuclear construction ratio leads to a 144 basis point premium. These premiums reflect "average" nuclear construction programs, which perhaps do not exist.

There is some evidence that equity investors considered reserve margins to be a business risk factor for electric utilities. An average reserve margin of about 18.5 percent reduced equity costs by 22 basis points, while a high margin of 50 percent reduced equity costs by 60 basis points, when compared to a firm with a zero reserve margin.

There is also some indication that gas revenues were riskier than electric revenues, and that nuclear operating plant was riskier than coal or oil generation, but the results are not conclusive.

Perhaps the most striking result is that regulatory climate did not appear to affect equity cost in 1983 and 1984. This supports the results of Fanara and Gorman

(1986), who concluded that regulatory climate was a significant risk factor in the early 1970s, but that its influence diminished over time.

Debt risk factors. In general, the results of the debt regressions parallel those of the equity regressions. The two business risk factors that affected debt costs were nuclear construction programs and reserve margins. A firm with a 50 percent nuclear construction ratio would pay 27.5 basis points more in debt cost than a firm with no nuclear construction program. A firm with a 40 percent reserve margin would pay about 9.8 basis points less than a firm with a 20 percent reserve margin. No other business risk factors, including regulatory climate, consistently affected debt costs.

Conclusions

The primary objective of this study is to estimate the financial leverage/capital costs relationships for electric utilities. The results indicate strong positive relationships between financial leverage and both debt and equity costs. Although the two methods used did not produce identical results, there is strong evidence that the impact of financial leverage on the cost of equity is much greater than reported in previous studies.

NOTES

[1]Several coverage ratios as well as debt-to-value measures were also used, but those leverage measures had less explanatory power and lower statistical significance than the debt-to-equity measures.

[2]The debt cost comparison estimation was calculated as follows: (1) According to the rating guidelines model, an increase in debt ratio from 40 to 50 percent increases debt cost by 56 basis points, while an increase in leverage from 50 to 60 percent increases debt cost by 120 basis points. (2) From Table 4-5, equity costs change by 1.99 basis points for every basis point change in debt cost (the 1.99 coefficient is the 1983 estimate). (3) Thus, a 56 basis point change in debt costs is estimated to have a 56(1.99) = 111 basis point change in equity costs, and so on.

[3]Note that the 1983 EXMVDE coefficient was 3.34 when the collinearity was removed. When the only independent variable is financial leverage, an increase in a firm's debt ratio from 40 to 50 percent leads to a 110 basis point increase in its cost of equity, and an increase from 50 to 60 percent increases equity costs by 167 basis points. These values are much closer to those reported in Table 9-2 for the debt cost comparison model.

APPENDIX A
SAMPLE SET

Allegheny Power System
American Electric Power
AZP Group (Arizona Public Service)
Atlantic City Electric*
Baltimore Gas & Electric
Boston Edison
Carolina Power & Light*
Central & Southwest
Central Illinois Public Service
Cleveland Electric Illuminating
Commonwealth Edison
Consolidated Edison of New York
Delmarva Power & Light
Detroit Edison
Dominion Resources
Duke Power
El Paso Electric
FPL Group
Florida Progress
Gulf States Utilities
Hawaiian Electric
Houston Industries (Houston Light and Power)
Idaho Power
Illinois Power
Iowa Electric Light & Power
Iowa-Illinois Gas & Electric
Iowa Resources
Ipalco Enterprises (Indianapolis Power and Light)*
Kansas City Power & Light
Kansas Power & Light
Kentucky Utilities
Louisville Gas & Electric
Middle South Utilities
Minnesota Power & Light
Montana Power
Nevada Power
New England Electric System
New York State Electric & Gas
Niagara Mohawk Power
Northeast Utilities
Northern Indiana Public Service
Northern States Power
Ohio Edison
Oklahoma Gas & Electric

Orange & Rockland Utilities
Pacific Gas & Electric
Pacificorp (Pacific Power and Light)
Pennsylvania Power & Light
Philadelphia Electric
Portland General Electric
Potomac Electric Power
Public Service of Colorado
Public Service of New Mexico
Public Service Electric & Gas
Puget Sound Power & Light
San Diego Gas & Electric
SCANA (South Carolina Electricity and Gas)
Southern California Edison
Southern
Southern Indiana Gas & Electric
Southwestern Public Service
Teco Energy
Toledo Edison
Tucson Electric Power
Union Electric
Utah Power & Light
Washington Water Power*
Wisconsin Electric Power
Wisconsin Power & Light
Wisconsin Public Service

<u>Notes</u>: (1) Utilities with recent organizational changes have their former designations in parentheses.

(2) An asterisk following the company name indicates 1983 data only.

APPENDIX B
GLOSSARY OF SYMBOLS

Symbol	Measure	Definition
B/M	Book-to-market ratio	Book value of equity divided by market value of equity
BVDE	Book value debt-to-equity ratio	Book value of debt divided by book value of equity
DCF k	Cost of equity	Discounted cash flow estimate of k_s
EXBVDE	Expected book value debt-to-equity ratio	Book value debt-to-equity ratio expected 3-years hence
EXMVDE	Expected market value debt-to-equity ratio	Market value debt-to-equity ratio expected 3-years hence
MVDE	Market value debt-to-equity ratio	Market value of debt divided by market value of equity
NUCCON	Nuclear construction program	Dollar value of uncompleted nuclear construction divided by current gross plant (%)
PAYOUT	Payout ratio	Common dividend divided by net income (%)
PCTCOAL	Coal-fueled generation capacity	Coal generation capacity divided by total capacity (%)
PCTCON	New construction program	Dollar value of total construction program divided by current gross plant (%)
PCTGASREV	Gas/electric sales mix	Gas revenues divided by total utility revenues (%)
PCTNUC	Nuclear-fueled generation capacity	Nuclear generation capacity divided by total capacity (%)
PCTOIL	Oil-fueled generation capacity	Oil generation capacity divided by total capacity (%)

REGRANK	Regulatory climate	Regulatory ranking as reported by Salomon Brothers
RESMAR	Reserve margin	Capacity in excess of peak load divided by capacity (%)
S&P k	Cost of debt	Bond yield by rating reported by S&P

APPENDIX C
EQUITY REGRESSION RESULTS

Table C-1
Coefficients Using Book Value Debt-to-Equity
(t-statistics in parentheses)

Variable	DCF k_s 1983	DCF k_s 1984	B/M Ratio 1983	B/M Ratio 1984
BVDE	1.0669 (1.79)	1.2818 (2.44)	0.0614 (0.90)	0.1405 (2.15)
REGRANK	0.1769 (0.78)	-0.1232 (0.66)	0.0488 (1.89)	0.0745 (3.22)
PCTGASREV	0.0047 (0.67)	0.0108 (1.54)	0.0008 (1.01)	0.0022 (2.56)
PCTNUC	-0.0012 (0.17)	0.0025 (0.38)	0.0023 (2.77)	0.0009 (1.11)
PCTCOAL	-0.0126 (2.24)	-0.0063 (1.33)	-0.0007 (1.06)	-0.0002 (0.36)
PCTOIL	-0.0088 (0.95)	-0.0117 (1.41)	-0.0002 (0.15)	-0.0006 (0.59)
PCTCON	0.0020 (0.25)	0.0083 (0.84)	-0.0014 (1.52)	-0.0000 (0.04)
NUCCON	0.0324 (4.17)	0.0173 (1.71)	0.0047 (5.24)	0.0038 (3.00)
RESMAR	-0.0148 (2.33)	-0.0150 (2.37)	-0.0021 (2.88)	-0.0011 (1.40)
PAYOUT	0.0372 (2.03)	0.0124 (0.86)	0.0022 (1.06)	0.0009 (0.51)
INTERCEPT	11.6474 (7.26)	12.7830 (10.25)	0.6757 (3.68)	0.4747 (3.05)
Adjusted R^2	0.51	0.40	0.52	0.50

Table C-2
Coefficients Using Market Value Debt-to-Equity
(t-statistics in parentheses)

Variable	DCF k_s 1983	DCF k_s 1984	B/M Ratio 1983	B/M Ratio 1984
MVDE	2.0042 (4.06)	1.5428 (3.27)	0.2941 (5.90)	0.3089 (6.42)
REGRANK	-0.0179 (0.08)	-0.3147 (1.59)	0.0085 (0.40)	0.0241 (1.19)
PCTGASREV	0.0054 (0.85)	0.0082 (1.25)	0.0012 (1.86)	0.0021 (3.10)
PCTNUC	-0.0039 (0.59)	0.0027 (0.41)	0.0019 (2.80)	0.0008 (1.18)
PCTCOAL	-0.0078 (1.50)	-0.0040 (0.86)	-0.0000 (0.05)	0.0002 (0.44)
PCTOIL	-0.0036 (0.39)	-0.0078 (1.00)	0.0006 (0.71)	-0.0001 (0.16)
PCTCON	0.0040 (0.54)	0.0055 (0.57)	-0.0011 (1.51)	-0.0008 (0.83)
NUCCON	0.0221 (2.90)	0.0135 (1.35)	0.0029 (3.76)	0.0026 (2.59)
RESMAR	-0.0122 (2.10)	-0.0143 (2.34)	-0.0017 (2.87)	-0.0009 (1.39)
PAYOUT	0.0253 (1.52)	0.0061 (0.44)	0.0008 (0.47)	-0.0007 (0.47)
INTERCEPT	12.2114 (9.16)	13.8894 (11.9)	0.6520 (4.85)	0.6260 (5.26)
Adjusted R^2	0.59	0.44	0.69	0.69

Table C-3
Coefficients Using Expected Book Value Debt-to-Equity
(t-statistics in parentheses)

Variable	DCF k_s 1983	DCF k_s 1984	B/M Ratio 1983	B/M Ratio 1984
EXBVDE	1.2859 (1.94)	1.5318 (2.41)	0.1350 (1.80)	0.2017 (2.59)
REGRANK	0.1789 (0.80)	-0.1138 (0.62)	0.0427 (1.70)	0.0728 (3.22)
PCTGASREV	0.0060 (0.83)	0.0084 (1.23)	0.0011 (1.34)	0.0020 (2.40)
PCTNUC	-0.0018 (0.24)	0.0039 (0.58)	0.0022 (2.72)	0.0011 (1.31)
PCTCOAL	-0.0127 (2.28)	-0.0073 (1.52)	-0.0007 (1.15)	-0.0004 (0.61)
PCTOIL	-0.0095 (1.03)	-0.0103 (1.26)	-0.0003 (0.24)	-0.0005 (0.50)
PCTCON	0.0017 (0.21)	0.0035 (0.34)	-0.0015 (1.59)	-0.0007 (0.58)
NUCCON	0.0313 (3.98)	0.0233 (2.33)	0.0044 (4.97)	0.0045 (3.66)
RESMAR	-0.0137 (2.15)	-0.0114 (1.73)	-0.0020 (2.73)	-0.0006 (0.75)
PAYOUT	0.0286 (1.56)	0.0068 (0.46)	0.0015 (0.72)	0.0001 (0.05)
INTERCEPT	11.9815 (7.89)	12.9038 (10.42)	0.6541 (3.81)	0.4735 (3.12)
Adjusted R^2	0.52	0.40	0.54	0.52

Table C-4
Coefficients Using Expected Market Value Debt-to-Equity
(t-statistics in parentheses)

Variable	DCF k_s 1983	DCF k_s 1984	B/M Ratio 1983	B/M Ratio 1984
EXMVDE	2.2496 (4.25)	1.5898 (3.21)	0.3599 (7.30)	0.3596 (7.89)
REGRANK	-0.0093 (0.21)	-0.2741 (1.42)	0.0055 (0.28)	0.0248 (1.40)
PCTGASREV	0.0068 (1.08)	0.0056 (0.85)	(0.0015) (2.48)	0.0015 (2.52)
PCTNUC	-0.0852 (0.79)	0.0036 (0.56)	0.0016 (2.64)	0.0009 (1.58)
PCTCOAL	-0.0082 (1.61)	-0.0051 (1.12)	-0.0000 (0.09)	-0.0000 (0.04)
PCTOIL	-0.0049 (0.59)	-0.0068 (0.86)	0.0004 (0.55)	0.0001 (0.16)
PCTCON	0.0047 (0.64)	0.0028 (0.29)	-0.0010 (1.45)	-0.0015 (1.71)
NUCCON	0.0191 (2.43)	0.0178 (1.83)	0.0022 (3.05)	0.0034 (3.78)
RESMAR	-0.0097 (1.66)	-0.0117 (1.88)	-0.0012 (2.28)	-0.0002 (0.41)
PAYOUT	0.0133 (0.78)	0.0017 (0.11)	-0.0012 (0.78)	-0.0019 (1.46)
INTERCEPT	12.8409 (9.80)	14.1255 (11.98)	0.7444 (6.10)	0.6879 (6.34)
Adjusted R^2	0.60	0.44	0.75	0.75

APPENDIX D
INDEPENDENT VARIABLE CORRELATION MATRIX

	PCTNUC	PCTGASREV	REGRANK	EXBVDE
PCTNUC	1.00/ 1.00			
PCTGASREV	0.06/ 0.09	1.00/ 1.00		
REGRANK	0.03/-0.14	-0.02/ 0.08	1.00/ 1.00	
EXBVDE	0.02/-0.16	-0.34/-0.19	0.34/ 0.29	1.00/ 1.00
MVDE	0.20/-0.02	-0.20/-0.15	0.34/ 0.42	0.67/ 0.64
BVDE	0.01/-0.01	-0.30/-0.29	0.32/ 0.27	0.71/ 0.64
PCTCOAL	0.03/-0.03	-0.15/-0.03	0.06/ 0.17	0.16/ 0.32
PCTOIL	-0.04/ 0.09	-0.05/-0.05	-0.01/-0.08	-0.01/-0.05
PCTCON	0.22/ 0.33	0.32/ 0.45	0.23/ 0.29	-0.10/-0.14
NUCCON	0.35/ 0.43	0.55/ 0.56	0.41/ 0.29	0.04/ 0.03
RESMAR	0.00/-0.04	-0.03/-0.01	-0.07/-0.27	-0.06/ 0.05
PAYOUT	-0.02/ 0.14	0.12/ 0.21	0.21/ 0.25	0.24/ 0.31
EXMVDE	0.19/-0.09	-0.23/-0.06	0.34/ 0.42	0.81/ 0.82

	PAYOUT	RESMAR	NUCCON	PCTCON
EXMVDE	0.25/ 0.29	-0.10/-0.13	0.58/ 0.48	0.30/ 0.40
PCTCOAL	0.27/ 0.32	-0.17/-0.08	-0.10/-0.09	-0.15/-0.23
PCTOIL	0.01/-0.07	0.22/ 0.15	-0.11/-0.11	-0.13/-0.09
PCTCON	-0.27/-0.23	-0.07/-0.04	0.71/ 0.81	1.00/ 1.00
NUCCON	-0.02/ 0.02	0.09/ 0.07	1.00/ 1.00	
RESMAR	-0.06/ 0.05	1.00/ 1.00		
PAYOUT	1.00/ 1.00			

	MVDE	BVDE
MVDE	1.00/ 1.00	
BVDE	0.78/ 0.84	1.00/ 1.00
PCTCOAL	0.05/ 0.09	-0.43/-0.41
PCTOIL	-0.11/-0.13	0.09/ 0.03
PCTCON	-0.14/-0.22	-0.04/-0.06
NUCCON	-0.22/-0.21	0.02/-0.07
RESMAR	-0.07/ 0.21	0.05/ 0.07
PAYOUT	0.00/ 0.01	-0.09/-0.17
EXMVDE	0.90/ 0.87	0.65/ 0.62

	PCTOIL	PCTCOAL
EXMVDE	-0.03/-0.16	-0.11/ 0.10
PCTCOAL	-0.63/-0.54	1.00/ 1.00
PCTOIL	1.00/ 1.00	

Note: The number before the slash (/) is for 1983 and the number following the slash is for 1984.

APPENDIX E
DEBT REGRESSION RESULTS

Table E-1
Coefficients Using Book Value Debt-to-Equity
(t-statistics in parentheses)

Variable	S&P k_d 1983	S&P k_d 1984	S&P Bond Rating 1983	S&P Bond Rating 1984
BVDE	0.8327 (4.65)	0.5518 (4.49)	4.9368 (5.45)	3.9497 (4.80)
REGRANK	0.0358 (0.53)	0.0925 (2.13)	0.4314 (1.26)	1.0271 (3.53)
PCTGASREV	-0.0007 (0.31)	-0.0009 (0.57)	-0.0031 (0.28)	-0.0028 (0.25)
PCTNUC	0.0021 (0.97)	0.0016 (1.00)	0.0135 (1.22)	0.0119 (1.12)
PCTCOAL	0.0019 (1.13)	0.0010 (0.88)	0.0038 (0.45)	0.0054 (0.73)
PCTOIL	0.0018 (0.64)	0.0006 (0.31)	0.0085 (0.60)	0.0025 (0.19)
PCTCON	-0.0026 (1.06)	-0.0015 (0.64)	-0.0171 (1.38)	-0.0093 (0.60)
NUCCON	0.0080 (3.39)	0.0071 (2.97)	0.0564 (4.76)	0.0552 (3.46)
RESMAR	-0.0056 (2.95)	-0.0052 (3.51)	-0.0341 (3.52)	-0.0356 (3.58)
PAYOUT	0.0022 (0.40)	0.0042 (1.24)	0.0543 (1.95)	0.0477 (2.12)
INTERCEPT	11.6006 (24.02)	11.1847 (38.28)	-3.7610 (1.54)	-3.94 (2.01)
Adjusted R^2	0.50	0.62	0.65	0.70

Table E-2
Coefficients Using Market Value Debt-to-Equity
(t-statistics in parentheses)

Variable	S&P k_d 1983	S&P k_d 1984	S&P Bond Rating 1983	S&P Bond Rating 1984
MVDE	0.8400	0.5170	4.5148	4.0625
	(5.34)	(4.51)	(5.45)	(5.53)
REGRANK	0.0017	0.0410	0.3053	0.5827
	(0.03)	(0.86)	(0.87)	(1.90)
PCTGASREV	-0.0014	-0.0021	-0.0085	-0.0112
	(0.72)	(1.34)	(0.81)	(1.09)
PCTNUC	0.0012	0.0018	0.0086	0.0131
	(0.56)	(1.15)	(0.77)	(1.30)
PCTCOAL	0.0041	0.0018	0.0160	0.0120
	(2.50)	(1.64)	(1.84)	(1.67)
PCTOIL	0.0042	0.0022	0.0216	0.0141
	(1.55)	(1.15)	(1.52)	(1.50)
PCTCON	-0.0018	-0.0022	-0.0128	-0.0157
	(0.75)	(0.95)	(1.03)	(1.06)
NUCCON	0.0048	0.0062	0.0405	0.0471
	(1.95)	(2.56)	(3.16)	(3.04)
RESMAR	-0.0047	-0.0051	-0.0289	-0.0341
	(2.52)	(3.42)	(2.96)	(3.59)
PAYOUT	-0.0041	0.0024	0.0190	0.0329
	(0.77)	(0.70)	(0.68)	(1.50)
INTERCEPT	12.2681	11.6294	0.3427	-0.6789
	(28.89)	(41.03)	(0.15)	(0.37)
Adjusted R^2	0.54	0.62	0.65	0.73

Table E-3
Coefficients Using Expected Book Value Debt-to-Equity
(t-statistics in parentheses)

Variable	S&P k_d 1983	S&P k_d 1984	S&P Bond Rating 1983	S&P Bond Rating 1984
EXBVDE	0.7554 (3.54)	0.5398 (3.42)	3.7068 (3.23)	4.2721 (4.12)
REGRANK	0.0624 (0.87)	0.1062 (2.31)	0.6670 (1.74)	1.0925 (3.62)
PCTGASREV	-0.0005 (0.21)	-0.0021 (1.21)	-0.0046 (0.37)	-0.0105 (0.94)
PCTNUC	0.0020 (0.81)	0.0022 (1.33)	0.0127 (1.01)	0.0163 (1.49)
PCTCOAL	0.0019 (1.07)	0.0007 (0.57)	0.0043 (0.45)	0.0028 (0.36)
PCTOIL	0.0014 (0.48)	0.0013 (0.65)	0.0071 (0.44)	0.0072 (0.54)
PCTCON	-0.0028 (1.06)	-0.0030 (1.18)	-0.0181 (1.29)	-0.0221 (1.32)
NUCCON	0.0079 (3.12)	0.0095 (3.83)	0.0586 (4.30)	0.0732 (4.48)
RESMAR	-0.0050 (2.47)	-0.0040 (2.45)	-0.0313 (2.85)	-0.0258 (2.39)
PAYOUT	-0.0036 (0.61)	0.0025 (0.67)	0.0232 (0.73)	0.0332 (1.38)
INTERCEPT	12.0271 (24.66)	11.2878 (36.69)	-0.7164 (0.27)	-3.3763 (1.67)
Adjusted R^2	0.43	0.57	0.55	0.67

Table E-4
Coefficients Using Expected Market Value Debt-to-Equity
(t-statistics in parentheses)

Variable	S&P k_d 1983	S&P k_d 1984	S&P Bond Rating 1983	S&P Bond Rating 1984
EXMVDE	0.7926 (4.41)	0.4281 (3.35)	3.7357 (3.79)	3.7480 (4.61)
REGRANK	0.0266 (0.38)	0.0734 (1.47)	0.5129 (1.34)	0.7682 (2.42)
PCTGASREV	-0.0012 (0.56)	-0.0029 (1.73)	-0.0084 (0.71)	-0.0177 (1.64)
PCTNUC	0.0009 (0.42)	0.0022 (1.31)	0.0083 (0.67)	0.0158 (1.49)
PCTCOAL	0.0037 (2.12)	0.0014 (1.18)	0.0127 (1.34)	0.0086 (1.14)
PCTOIL	0.0033 (1.17)	0.0024 (1.19)	0.0161 (1.03)	0.0163 (1.25)
PCTCON	-0.0017 (0.67)	-0.0026 (1.03)	-0.0128 (0.94)	-0.0205 (1.28)
NUCCON	0.0046 (1.71)	0.0079 (3.15)	0.0434 (2.97)	0.0596 (3.73)
RESMAR	-0.0040 (2.00)	-0.0045 (2.78)	-0.0265 (2.43)	-0.0286 (2.78)
PAYOUT	-0.0078 (1.34)	0.0019 (0.50)	0.0039 (0.12)	0.0251 (1.05)
INTERCEPT	12.5320 (28.13)	11.6712 (38.31)	1.7609 (0.72)	-0.2138 (0.11)
Adjusted R^2	0.48	0.57	0.57	0.69

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