BEBR

FACULTY WORKING
PAPER NO. 795

Impacts of Rate-Base Methods on Firm Operating Elasticity and Capital Structure: Theory and Evidence

Cheng F. Lee
Walter J. Primeaux, Jr.

College of Commerce and Business Administration
Bureau of Economic and Business Research
University of Illinois, Urbana-Champaign

BEBR

FACULTY WORKING PAPER NO. 795

College of Commerce and Business Administration

University of Illinois at Urbana-Champaign

August 1981

Impacts of Rate-Base Methods on Firm Operating Elasticity and Capital Structure: Theory and Evidence

Cheng F. Lee, Professor
Department of Finance

Walter J. Primeaux, Jr., Professor
Department of Business Administration

Abstract

A recent important article published in the Quarterly Journal of Economics relates finance theory to the microeconomic theory of the firm. This study undertakes the same task.

A vital question concerning the electric utility industry is how does each firm adjust its capital structure or operating strategy so as to minimize the possible adverse impace of Commission regulation upon its performance. By using both one way and two way analysis of variance, this paper demonstrates that different degrees of regulation does affect operating and financial strategies.

The above results indicate that different regulatory processes induce different operating strategies to permit a firm to neutralize the effects of the regulatory constraint. However, the evidence concerning a firm's adjustment of financial policy to avoid possible burdens of regulation is not as conclusive as in the case of operating strategy.

IMPACTS OF RATE-BASE METHODS ON FIRM OPERATING ELASTICITY AND CAPITAL STRUCTURE: THEORY AND EVIDENCE

I. INTRODUCTION

The effect of utility regulation on the financial behavior of firms is an important matter, but one important avenue of inquiry has remained relatively unexplored. That is, regulation is not a homogeneous commodity and all regulated firms are not subjected to the same degree of regulation. This condition raises an important question; if the quality of regulation differs among the regulatory regimes faced by the individual firms operating in different states, how does each firm adjust its capital structure and operating strategy so as to minimize the possible adverse impact of that regulation on its performance. That inquiry is the main purpose of this study; that is, do differences in regulatory regimes faced by regulated firms affect their capital structure and operating elasticity?

The research results lead to policy implications and, in addition, this paper attempts to serve as a bridge to link together financial management perspectives with the regulatory process. Furthermore, it demonstrates that the pooling time-series and cross-sectional Analysis of Variance (ANOVA), instead of cross-sectional ANOVA, can be used to detect the dynamic impact of the regulatory process or utility firms' operating and financial policies. Overall, this study, as did an earlier important study by Subrahmanyam and Thomadakis (1980), attempts to relate finance theory to the microeconomic theory of the firm.

The plan is as follows. The second section reviews previous studies; the third section develops the theoretical base for this

paper; the fourth presents empirical studies developed to test the relevant hypotheses; finally, a summary is presented and concluding remarks are provided.

II. PREVIOUS STUDIES

The landmark study by Modigliani and Miller (M & M) (1958) examined electric utility firms and discussed risk class of securities caused by the variability of earnings streams. Modigliani and Miller's (1958, 1963, 1965 and 1966) studies are all concerned with other matters and they are not explicitly concerned with the effect of different types of regulatory regimes on the degree of homogeneity with a risk class.

Boness and Frankfurter (1977) are somewhat critical of M & M and question whether risk class should be associated with industry. They examine what they term "the believed-to-be most homogeneous of industries, electric utilities." They conclude that the results of their tests are convincingly at variance with the notion that the electric utility industry is a homogeneous population. They conclude:

> Simply the M & M choice, as that of many others' using the definition of electric utilities (or any other "industry" for that matter) as a surrogate for risk class, was a poor choice.

Hite (1977) theoretically investigated the relationship among leverage, output effects, and the M & M theorems. He argued that output, investment and financing decisions must be optimized simultaneously. While the Hite study is interesting, it too does not explicitly address the questions of how operating decisions and operating strategy are affected by utility regulation.

In another study, Eiteman (1962) examined the permitted and earned rates of return of fifteen Bell Telephone companies in the 1950-59 period. Eiteman found that "...actual rates of return to book value of securities (that is, to original cost) ...have been highest for companies in the reproduction-cost jurisdictions and lowest for the companies in the original-cost jurisdictions."

Pike (1967), using electric utility data for 1961-63 found a mean rate of return of 6.38 percent on net plant in original cost jurisdictions and 6.63 percent where other valuation methods were used.

Petersen (1976) found that the allowed rates of return and the realized earnings were both higher for fair value firms than those in original cost jurisdictions; he found a higher allowed rate of return which is not consistent with some other work, including Hagerman and Ratchford (1978) and Primeaux (1978).

Some of the previous studies recognize that different types of regulation may cause differences in the level of earnings streams; yet, this possibility was ignored by the M & M and Boness and Frankfurter studies. Actually, Boness and Frankfurter did not address the question of leverage and differences in leverage in a risk class. They simply examined the M & M assumption that their sample of electric utilities represented a homogeneous risk class in measuring capital costs. Moreover, most of the latter studies do recognize the effect of different degrees of regulation on the level of the earnings stream, but they do not explicitly examine the differential impact of regulatory regimes. Adjustments of capital structure and operating strategy could occur as firms attempt to neutralize the effect of utility regulation on their business and financial risk. Moreover, these different regulatory effects may also affect the degree of homogeneity within a sample of electric utility firms.

III. THE THEORY

The rate base is defined as the gross valuation of public utility property, less depreciation. In electric utility rate making, the rate base is considered as an important variable because it is at the core of the rate determination process. The state regulatory commission must also establish a rate of return allowable on the rate base;[1] then that rate is applied to the rate base to determine the return amount which the utility may earn. Then, the specific rate schedules for the utility must be constructed. This indicates, therefore, that both the rate base and the rate of return affect the earnings which the utility generates from selling its services. The rate base is determined on the basis of original cost, fair value, or reproduction cost depending upon the state in which the firm is situated. State law prescribes which method is to be used in a given state.

A distinct difference exists between original cost, fair value, and reproduction cost methods of determining the rate base. Garfield and Lovejoy (1964, p. 60) explain that in the original cost method the property is valued at its cost when it was first used in a public utility application. The procedure is historical, in a sense, because the current market valuation of the equipment is irrelevant to its value for rate making.

Garfield and Lovejoy (1964, p. 59) explain that in fair value valuation of a rate base the value is determined by considering three factors: "(a) The actual cost of the property; (b) the present value of construction...; and (c) other matters generally taken to represent various intangibles." This technique clearly provides for a consideration of the current cost of equipment in determining the value of a rate base for rate making purposes.

The reproduction cost less depreciation rate base method of valuation involves "...the cost of duplicating the existing plant at recent or present prices, less depreciation." Garfield and Lovejoy (1964, p. 63). This procedure involves a consideration of construction costs and price level adjustments. This approach, therefore, considers changes in the value of money caused by inflation or deflation.

There are arguments advanced for and against the use of each of these three methods of rate base valuation; see Garfield and Lovejoy (1964, p. 58-65). The facts remain, however, that one of these methods is used in each state regulatory jurisdiction. It is obvious (from footnote 1) that each of these three methods of rate base determination will permit the firm to generate a different earnings stream or revenue requirement. Realized rates of return could be highest for reproduction cost jurisdictions and lowest for firms in original cost jurisdictions. Firms in fair value jurisdictions could generate rates of return in between original cost and reproduction costs unless the different allowed rates of return is used to compensate the low rate base.[2]

As mentioned above, the relative profitability among firms operating in different regulatory regimes has been intensively tested by different scholars. However, previous studies have not investigated the possible differences of operating elasticity among firms facing different types of regulation. The operating elasticity is generally defined as the percentage change of profit with respect to percentage charge of sales. This is an index indicating the tendency for the profitability of a firm to increase as sales increase with a particular level of production capacity. In financial analysis the degree of operating leverage (DOL) is generally used to measure the operating elasticity. This measure has recently become more popular in the empirical research, e.g., Mandelker and Rhee (1981) have recently investigated the relationship between beta estimate and the DOL, and found that they are generally positively related for both utility and non-utility industries. The DOL concept will be empirically analyzed for the firms in the sample facing different regulatory regimes. The assumptions used to derive the DOL are that both cost function and revenue function are linear. The justification of this issue for the electric utility industry will be explored in the following section.

Total risks faced by a firm are generally divided into business risks and financial risks. The market movements and values of common stock reflect investors' perceptions of both the potential return as well as the risks involved in financial investments. If one examines the motivation of stock investors, he finds that investors in utility equity investments generally place more emphasis in the stability of the income stream; in addition, these investors may have preference for dividend return rather than capital gain.[3] As the dividend payment for a firm is a function of the earning stream, as pointed out by Lintner (1956), a firm with a relatively certain income stream will have a relative stable dividend policy. Therefore, financial managers in the electric utility industry may generally adjust their financial strategies according to the regulatory regime they face to assure that both stable earning streams and dividend payments over time can be maintained.

Since the consumer's demand curve for electricity is not perfectly inelastic, there is a consumption response to price changes or price differences. Subrahmanyam and Thomadakis (1980) have shown that demand elasticity is one of the important microeconomic variables affecting risks. When prices of a commodity are raised, the consumer reduces his consumption because of the substitution effect and the income effect. The income effect means that the higher (lower) price reduces (increases) the real income of the buyer. Moreover, the substitution effect means that the higher (lower) price decreases (increases) the relative attractiveness of a commodity and makes the consumer willing to buy less (more) of it. One might expect more volatility in the income stream of an electricity firm under fair value, and reproduction cost jurisdictions than in original cost jurisdictions, mainly because of the nature of the regulatory process. The logic of this statement follows.

If one examines the rate base methods mentioned above, one finds that the original cost method is less cluttered with estimates and subjective judgment in its implementation of the regulatory procedure; the fair value method is next in its degree of subjective judgment and the reproduction cost method involves more estimates and subjective judgment than the other two. It is a combination of this subjective judgment and the probability of inconsistent estimates which yields the highest business risks for reproduction costs jurisdictions, the next highest for fair value, and the lowest for original cost jurisdictions. The more subjective estimation methods will yield less consistent prices and more consumer changes in consumption as was mentioned above. These adjustments also affect rates of return earned by the firms and, all other things equal, cause differences in business risk. Of course, parts of the volatility can also be caused by the change of allowed rates of return among different regulation regimes. Firms facing more volatile earnings streams may generally use less financial leverage to make their total risks equal to that of firms with lower business risks. This argument is based upon the assumption that an electric utility firm would like to have a net earning stream available to common stock holder at least as stable as the other firms within the same industry. Consequently, one would expect to find a lesser use of leverage in reproduction cost regimes, the highest usage of financial leverage in original cost regimes, and the fair value regimes would be in between these two extremes.[4] In sum, the managers of electric utility companies facing different regulatory regimes may adjust capital structures to make the total risk of their companies comparable to other electric companies competing for the same type of investors. It should be noted that whether the financial managers associated with different regulatory regimes have, in fact, adjusted their company's capital structure is an empirical issue. Hence, the possible differences of both the DOL and the capital structure among different regulatory regimes will be empirically tested in the following section.

IV. EMPIRICAL INVESTIGATION[5]

Data from fifty-nine electric utility firms during 1958-75 are used to investigate the effects of different types of regulation on the operating and financial strategy of firms in the electric utility industry. Appendix A shows that the sample consisted of 34 firms regulated by original cost rates base jurisdictions, 19 firms regulated by a fair value rate base jurisdiction, and 6 firms from reproduction cost rate base jurisdictions.

A data summary is presented in Appendix B. The sample was selected from the electric utility firms listed in the Compustat utility tape. Firms operating in more than one state were eliminated because they were regulated by different regulatory bodies. This procedure avoided the joint effect on a single firm caused by different rate base methods being used in different states. Holding companies were also excluded. Some electric firms also sell natural gas; therefore, within the sample for each rate base method, roughly the same proportion of firms sold both gas and electricity as those selling only electricity. This approach was used to reduce the market power problem which is created when firms face no competition from substitute fuel when they sell both gas and electricity in a single market. The market power effects on firm risk determination has been theoretically analyzed by Subrahmanyam and Thomadakis (1980). To reveal the dynamic nature of the impact of different regulatory regimes, data for 18 years, 1958-75 were used in the analysis.

The possible impact of different regulation on the operating elasticity of the electric utility firms was evaluated by examining the degree of operating leverage. Following Hunt (1961), Mao (1969), and Weston and Brigham (1981) the degree of operating leverage (DOL) can be defined as:

$$DOL = \frac{Q(P-V)}{Q(P-V)-FC} \tag{1}$$

where: P = market price per unit of product

V = variable cost per unit of product

Q = total quantity of goods sold

FC = total fixed operating cost

Based upon the break-even formula, DOL can be rewritten as:

$$DOL = \frac{1}{1 - \frac{Q^*}{Q}} \tag{2}$$

where $Q^* = \frac{FC}{P-V}$ is the break-even point. Equation (2) indicates that the DOL is determined by the magnitude of both Q* and Q. If firm A's DOL is higher than the DOL of firm B, this implies that the percentage of profit increase from a one percent increase of net sales for firm A will be higher than that of firm B.

This approach to DOL, of course, assumes linearity in the total revenue and total cost functions. The discussion below shows that this is not an unreasonable assumption. When examining the cost curve for electrical generation, J. Johnston (1960) reported that marginal and average variable cost are constant over the relevant range of output in the short run. While he was less confident in his long-run estimates, because of severe defects in available data on capital costs, he reported that long-run average costs fall quickly and steeply and then approximates a horizontal straight line. Moreover, a recent study of electric power generation found that a large portion of all electric power was produced in the flat region of the average cost curve, supporting linear cost functions over a wide range of output (Christensen and Green, 1976, p. 673). Both of these results offer strong empirical support for linear cost curves. Note that both break-even and DOL types of analyses are short-run instead of long-run in nature [See Adar, Barnea, and Lev (1977)]. The conclusions from the empirical work by Johnston and Christensen and Green seem to adequately support the proposition that a linear total variable cost function is a very reasonable assumption in the electric utility industry.

On the revenue side, there seems to be equally strong support for a linear total revenue function. A set of published graphical presentations show that total revenue from electricity sales to residential, commercial, and industrial customers seemed to approximate a linear pattern between 1963 and 1973 (FPC, 1973, pp. LIII-LV). Moreover, the assumption of linear functions is frequently made because of computational ease and interpretation of regression results, as well as other reasons. Consequently, the assumption of a linear revenue function is not unrealistic in this case. See: Elliott (1973, pp. 25-26).

Together, the above evidence seems to justify the assumption of a linear total variable cost and total revenue relationship used in this analysis of DOL.

To investigate the impact of different regulatory regimes on firm's earnings elasticity, DOL's were calculated for fifty-nine firms during 1958-1975. Analysis of variance [ANOVA] statistical technique was used to test whether the DOL's for firms operating in fair value, original cost, and reproduction cost regulatory regimes were significantly different.

First the ANOVA is used to test whether the average DOL is different among the three regulatory regimes, in each year. The null and alternative hypotheses can be defined as

$$H_o = \mu_{1t} = \mu_{2t} = \mu_{3t}$$

$$H_A = \text{not all average DOL's are equal} \qquad (3)$$

where μ_{1t} = the average DOL for original cost regime in t^{th} year.

μ_{2t} = the average DOL for fair value regime in t^{th} year.

μ_{3t} = the average DOL for the replacement cost regime t^{th} year.

During the sample period, there exists 34, 19 and 6 firms for original cost, fair value and reproduction cost regimes respectively [See Appendix A]. Therefore, the number of observations is not equal for each separate group included in the sample. However, Neter and Wasserman (1974, Chapter 13) have shown that it is not necessary to have an equal number of observations within each group to utilize one-way ANOVA technique. To test the statistical hypotheses, as indicated in equation (3), we need the information associated with sum of squares, degrees of freedom, mean squares for both between group and within group to calculate the F value. The ANOVA table for both 1958 and 1975 are presented in Table 1a. The computed F value with the table value reveals that the null hypothesis cannot be rejected at 5% level of confidence for both 1958 and 1975; however, the null hypothesis can be rejected at the 10% level of confidence for both 1958 and 1975. It should be noted that the ANOVA results for other years can be interpreted in a similar way as is indicated here; the complete results for the eighteen years examined are presented in Table 1b.

The F values listed in Table 1b reveal that the DOL's are significantly different among different regulation regimes at the 5% or 10% level for ten of the 18 years examined. The average DOL ($\overline{DOL}$) figure listed in Table 1b shows that the DOL's associated with fair value valuation are always higher than those of original cost regimes. The larger profit response to sales increases in fair value regimes relative to original cost would tend to encourage utility firms to promote greater consumer usage. This implies a tendency for firms under fair value regulation to generate higher operating elasticity than firms under original cost jurisdictions. This reflects a differential response of the change of profit with respect to the change of sales within each regulatory regime. The implications of this finding are as follows.

The DOL is determined by the change of both Q and Q*; and Q* is determined by FC, P and V. Both Q and FC are decision variables which are generally affected by operating strategy of firms. Hence, the conclusion is that a firm's operating strategy is not independent of the regulatory regime it faces.

The next step examined DOL for pooled cross section and time series data for firms in the sample. Chang and Lee (1977) used pooled time-series and cross-section data to demonstrate the importance of time effects in financial analysis. To incorporate the time effect into the model, a two-way ANOVA is used to analyze the DOL for 59 firms during 1955-1975. The results are shown in Table 1c. Methodologically, the randomized Block Design is used to ascertain the independence of the error components. The sample sizes associated with the case being examined are unequal; however, the frequencies are proportional and therefore, the method used to calculate the variance component is identical to the equal sample size two-way ANOVA. [See Neter and Wasserman (1974, Chapter 19)]. Table 1c shows that the time factor and interaction factor are both significant at the one percent level and the regulation regime factor is significant at the ten percent level. This two way analysis for the DOL provides a more overall picture of the dynamic impact of the regulation process on the firm's operating decision. The previous analysis ignores the time effects and the interaction effects between time and regulation; therefore, the results are static and efficiency of the estimate of F values is diminished. This also illustrates the importance of using a correct specification for performing ANOVA analysis.

Two different measures of leverage were used to examine the impact of different degrees of regulation on electric utility company's financing strategy (or capital structure). Following Krainer (1977) and Miller and Modigliani (1958, 1963) both the income statement and the balance sheet measures of leverage were used to make this empirical test.

The first leverage measure is defined as total interest charges of firm i (Ii) divided by total returns for firm i (Xi) [Ii/Xi]; the second leverage measure is defined as total book value of long-term debt for firm i (Di) divided by total book value of asset (Ai) [$\frac{Di}{Ai}$]. The analysis of variance technique was again used to determine the extent of differences in leverage among firms operating in the three different regulatory regimes.

Table 2 reveals that there were really no differences in leverage among firms operating in the three different regimes for all 18 years when the Di/Ai definition is used. However, if the Ii/Xi definition is used (see Table 3), significant differences exist among firms in the three different regimes for 7 of the 18 years included in the sample.[7]

It is appropriate to consider the relative advantages of the two different definitions of leverage, $\frac{Di}{Ai}$ and $\frac{Ii}{Xi}$. Miller and Modigliani (1958) defined leverage as the ratio between market value of debt and market value of equity. Miller and Modigliani (1963) argued that $\frac{Ii}{Xi}$ can be used as an alternative leverage measure.[8] It is clear that the definition of $\frac{Ii}{Xi}$ is much closer than $\frac{Di}{Ai}$ to M & M's original theoretical concept of leverage if the marginal corporate tax rate is not zero. Krainer (1977) discussed the advantage of using $\frac{Ii}{Xi}$ as the leverage measure. He considers Xi a more natural measure for bond holders since a going concern's operating income, X_i, is the ultimate source for fulfilling the bond contract. In addition, Krainer argued that over time changes in the interest rate might itself be concealed in the debt-equity ratio.

Table 2 also shows that the $\overline{D}/A$'s for the electric utility firm are around forty-five percent. This figure is nearly identical to the Bell System's optimal capital structure.[9] The $\overline{D}/A$ with current debt included as part of total debt is presented in parentheses in Table 2. The results show that current debt of electric utility firms is approximately 2-3 percent.

Table 3 shows that firms facing original cost regimes except in 1974 and 1975, have the highest $\frac{\overline{Ii}}{Xi}$; and the $\frac{\overline{Ii}}{Xi}$'s of firms regulated by fair value regimes is higher than those of firms confronting reproduction cost regimes for 12 of 18 years. If interest charges are similar for all three regimes, then the different $\frac{\overline{Ii}}{Xi}$ may well be because regulation by reproduction cost regimes is more liberal than that of either original cost or fair value regimes; and the regulation for fair value is more liberal than that of original cost regimes, as found by Petersen (1976).[10]

The different leverage ratio measures seem to yield different results, as indicated in Tables 2 and 3, so several additional points should be mentioned. First, if two firms have different rates of return, then the income statement leverage ratio measure $(\frac{Ii}{Xi})$ instead of the balance sheet type of leverage ratio measure $(\frac{Di}{Ai})$ should be used to measure the degree of financial risk. This argument is based upon the fact that $\frac{Ii}{Xi}$ is a better proxy relative to $\frac{\bar{D}}{A}$ for measuring the potential of a firm to fulfill its obligation to creditors over time. Secondly, our empirical work shows relatively low leverage ratios in terms of $\frac{Ii}{Xi}$ associated with fair value regimes relative to original cost regimes. This indicates that firms under fair value jurisdictions have lowered their financial risk to make their total risk compatible with the total risk associated with firms under original cost jurisdictions. Finally, this analysis also implies that the empirical results obtained by Gale (1972), Hurdle (1974) and others using $\frac{Di}{Ai}$ instead of $\frac{Ii}{Xi}$, as a proxy for financial risk, may require some reexamination. Incidentally, data show that most of the long term debt of the utility industry is mortgage debt. The implication of mortgage debt (secured debt) on the value of a firm can be found in a recent analysis by Scott (1977).

A two-way ANOVA model was used to test the time effect, the group effect, and the interaction effects in both $\frac{Ii}{Xi}$ and $\frac{Di}{Ai}$. The same sample, time periods, and design method as used in the two-way ANOVA for DOL analysis was used in these tests. The results are presented in Tables 4 and 5.

In the $\frac{Ii}{Xi}$ analysis, Table 4 indicates that both time effects and interaction effects are statistically significant at the one percent level. However, the regulation regime effect alone is not statistically significant. For the $\frac{Di}{Ai}$ analysis, Table 5 shows that only the time effect is statistically significant at the one percent level.

The results presented in Table 4 and 5 reveal that both the income statement and the balance sheet measures of leverage change over time.

However, the balance sheet type of leverage measure is not different for firms regulated by different regulatory regimes. Moreover, the income statement type of measure is different for firms operating in different regulatory regimes. It should be noted, however, that the difference is caused by the interaction of time and the different regulatory regimes. As mentioned in the earlier discussion of DOL, this dynamic approach is superior to the static analysis presented in Tables 2 and 3.

The analyses of this section reveal that the different degrees of regulation, as reflected by the different regulatory regimes, do change the DOL and cause some adjustments to the financial strategy of electric utility firms. This conclusion may have some implications for Boness and Frankfurter's findings about the heteroscedastic nature of utility firms within the utility industry. Boness and Frankfurter (1977) discussed fifty-one of the fifty-four firms included in the Miller and Modigliani (1966) study.

Of the fifty-one firms used by Boness and Frankfurter, we were able to classify without ambiguity forty-three according to the rate base method used in states in which they operate. We eliminated Texas firms, which were regulated at the local level, and firms operating in states where rate base methods could not be identified with a high level of accuracy.[11] Our classification shows that the M & M sample firms face at least three different regulatory regimes. Some firms in M & M's and in our sample produced both electricity and natural gas. From the market power theory developed by Hurdle (1974), it can be argued that firms producing both electricity and natural gas will have market power to generate more profit than those firms selling only one of these products.

This may be an additional reason for Boness and Frankfurter's findings; market power differences generally make firms dissimilar, even if they are in the same industry.

V. SUMMARY AND CONCLUDING REMARKS

By using both one way and two way analysis of variance, this paper has shown that different degrees of regulation in some degree does affect operating and financing strategies of electric utility firms.

The degree of operating leverage concept is used as a measure of operating elasticity; both balance sheet and income statement leverage ratios were also used as indices of financing strategy. It was found that different degrees of utility regulation do affect a firm's operating leverage; different regulation also causes a firm to adjust its financial leverage in terms of Ii/Xi to neutralize business risk, to some extent. In addition, strong time effects associated with both operation elasticity and capital structure were also observed.

The above results indicate that different regulatory processes induce different operating strategies to permit a firm to neutralize the effects of the regulatory constraint. However, the evidence concerning a firm's adjustment of financial policy to avoid possible burdens of regulation is not as conclusive as in the case of operating strategy. This result may be caused by more emphasis in the regulatory process on pricing instead of financial structure; although, regulators do consider capital structure to a lesser extent. If more emphasis was directed to control of capital structure, the results might be different.

This work has brought together important microeconomic concepts as discussed by Hite (1977), Subrahmanyam and Thomadakis (1980), and Greenberg, et. al., (1978) and previous financial research. The analysis demonstrates the relevance of microeconomics to the theory of finance and provides some insights into firm behavior under a regulatory constraint.

Table 1-a

Analysis of Variance - DOL Arranged by Rate Base Method

(1958 and 1975)

1958

Component	Degree of Freedom	Sum of Squares	Mean Square	F
Between-group means	2	.517155	.258578	2.8179*
Within-group means	56	5.138740	.091763	
Total	58	5.655895	-----	

1975

Component	Degree of Freedom	Sum of Squares	Mean Squares	F
Between-group means	2	.598972	.299436	2.6945*
Within-group means	56	6.223110	.111127	
Total	58	6.822082	-----	

*significant at 10% level

Table 1-b

Average DOL and the F values

	$\overline{DOL}$				F statistics
	Overall	Group 1	Group 2	Group 3	
1958	2.3325	2.2463	2.4472	2.3867	2.8179*
1959	2.2922	2.2213	2.3988	2.3574	2.7447*
1960	2.2804	2.2020	2.3856	2.3910	2.9418*
1961	2.2867	2.2001	2.3996	2.4169	3.1125**
1962	2.2665	2.1998	2.3627	2.3389	1.6630
1963	2.2517	2.1683	2.3848	2.3027	2.7558*
1964	2.2274	2.1385	2.3682	2.2852	3.3436**
1965	2.1757	2.0935	2.2982	2.2538	3.2999**
1966	2.1299	2.0569	2.2185	2.2633	2.8257*
1967	2.0967	2.0343	2.1682	2.2241	2.0121
1968	2.1063	2.0414	2.1796	2.2426	2.2828
1969	2.0569	1.9945	2.1414	2.1427	2.1569
1970	1.9864	1.9458	2.0635	1.9729	1.3475
1971	1.9776	1.9515	2.0414	1.9237	.8723
1972	1.9643	1.9294	2.0608	1.8567	2.2110
1973	1.9717	1.9493	2.0685	1.7920	2.4049*
1974	1.9512	1.9239	2.0613	1.7570	1.9150
1975	1.9716	1.9499	2.0851	1.7343	2.6945*

** Significant at 5% level
 * Significant at 10% level

Table 1-c

Two-Way ANOVA for DOL by Different Rate Base Methods (1958-1975)

Sources	Nesting	Denominator	Degree of Freedom Numerator	Degree of Freedom Denominator	Sum of Square	Mean Square	F
A		A x C	17	952	18.705074	1.100298	52.5584***
A x B		A x C	34	952	1.981123	.058268	2.7833***
A x C	B		952		19.929912	.020934	
B		C	2	56	5.681455	2.840728	2.6453*
C	B		56		67.829617	1.211243	

Remarks: A = time factor
B = regulation regime factor
C = firm factor

***significant at 1%
*significant at 10%

Table 2

Average value of $\frac{Di}{Ai}$ and the F Statistics

	$\frac{Di}{Ai}$				F statistics
	Overall	Group 1	Group 2	Group 3	
1958	45.60 (47.29)*	45.72	45.98	43.71	.5255
1959	45.09 (47.06)	45.01	45.76	43.42	.8313
1960	44.89 (46.43)	45.01	44.90	44.19	.1004
1961	45.22 (47.04)	45.43	45.61	42.83	1.0352
1962	44.33 (45.65)	44.32	44.56	43.69	.0917
1963	43.71 (45.50)	43.34	44.45	43.42	.2870
1964	43.30 (45.39)	43.19	43.73	42.53	.1691
1965	42.97 (45.60)	43.21	43.07	41.28	.4060
1966	43.41 (46.95)	43.47	44.40	39.97	1.3751
1967	43.86 (48.14)	43.30	45.25	42.67	.6495
1968	44.74 (49.68)	44.85	45.75	40.95	1.3953
1969	44.84 (50.70)	45.09	45.10	42.65	.4807
1970	46.76 (51.29)	46.28	47.10	48.40	.7256
1971	46.79 (51.09)	46.74	46.97	46.51	.0480
1972	45.55 (50.33)	45.07	46.41	45.48	.6324
1973	44.80 (49.81)	44.35	45.14	46.34	.6162
1974	42.66 (46.53)	43.25	42.73	43.00	.3595
1975	43.75 (48.19)	44.01	43.03	44.54	.5897

*For the $\frac{Di}{Ai}$ values in parentheses, the Di value includes current liabilities.

Table 3

Average Value of $\frac{Ii}{Xi}$ and the F Statistics

	($\overline{I}i/Xi$)				F statistics
	Overall	Group 1	Group 2	Group 3	
1958	17.34%	17.90%	16.53%	16.77%	.5270
1959	17.03	17.59	16.42	15.77	.4317
1960	16.98	17.38	16.89	14.97	.6248
1961	17.29	18.12	16.67	14.54	2.6380*
1962	17.02	17.80	16.43	14.42	2.3609*
1963	16.94	17.58	16.76	13.90	1.9551
1964	16.88	17.68	16.59	13.23	2.4940*
1965	17.16	18.26	16.72	12.32	3.7811**
1966	17.91	19.09	17.65	12.02	5.3705**
1967	19.75	20.78	19.89	13.38	4.8172*
1968	21.50	22.50	21.64	15.40	3.0557*
1969	24.87	25.70	24.98	19.80	1.5019
1970	30.50	31.91	28.95	27.44	.8227
1971	33.74	35.99	29.95	32.97	1.6098
1972	33.27	34.42	31.44	32.53	.7418
1973	36.11	37.36	34.01	35.71	.6184
1974	42.86	43.53	39.45	49.82	1.7330
1975	38.12	39.02	34.80	43.55	1.9969

** Significant at 5% level
 * Significant at 10% level

Table 4

Two-Way ANOVA for $\frac{Ii}{Xi}$ by Different Rate Base Methods

(1958-1975)

Sources	Nesting	Denominator	Degree of Freedom Numerator	Degree of Freedom Denominator	Sum of Square	Mean Square	F
A		A x C	17	952	8.081381	.4753753	148.0694***
A x B		A x C	34	952	.194699	.005726	1.7834***
A x C	B		952		3.056387	.003211	
B		C	2	56	.141958	.070979	1.5289
C	B		56		2.599845	.046426	

Remarks: A = time factor
B = regulation regime factor
C = firm factor

***significant at 1% level

Table 5

Two-Way Analysis of Variance for $\frac{Di}{Ai}$ by Different Rate Base Methods

(1958-1975)

Sources	Nesting	Denominator	Degree of Freedom Numerator	Degree of Freedom Denominator	Sum of Square	Mean Square	F
A		A x C	17	952	.136924	.008054	6.1203***
A x B		A x C	34	952	.035416	.001042	.7915
A x C	B		952		1.252839	.001316	
B		C	2	56	.015690	.007845	.4026
C	B		56		1.091274	.019487	

Remarks: A = time factor
B = regulation regime factor
C = firm factor

***significant at 1% level

FOOTNOTES

[1]Rates of return are generally determined by the cost of capital. See Petersen (1976) for details. The regulatory process specifies relevant costs and expenses which may be recovered by the utility firm as services are priced to the buyer. The revenue requirement, that is the revenue that the utility is authorized to collect, may be defined as follows. See Garfield and Lovejoy (1964, p. 44) for the following treatment:

(1) Revenue requirement = cost of service
(2) RR = E + d + T + (V-W)R
where: RR = revenue requirement
E = operating expense
d = depreciation expense
T = taxes
V = gross valuation of the property serving the public
W = accrued depreciation
R = rate of return (a percentage)
(V-W) = rate base (net valuation)
(V-W)R = return amount, or earnings allowed on the rate base

[2]Hagerman and Ratchford (1978) have found the different allowed rates of return are used to compensate the different rate base. However, they could not determine whether this adjustment is optimal.

[3]Under unrealistic extreme assumptions, Miller and Modigliani (1961) have argued that dividend policy will generally not affect the value of a firm. However, most recently Litzenberger and Ramaswamy (1980) used the tax effects, clientele effect and investors' preference arguments to show that investors might prefer dividends instead of capital gains.

[4]In analyzing leverage, diversification and capital market effects on risk-adjusted capital budgeting, Tuttle and Litzenberger (1968, pp. 428-29) have argued that the firm does have the option of neutralizing the risk inherent in a given investment opportunity through long-term borrowing or lending. In "The Tedinology of Risk and Return" Greenberg, et. al., (1978) also discussed the joint determination of financial risk and business risk in capital asset pricing process.

[5]In Tables 1-b, 2 and 3, group 1 = original cost regime; group 2 = fair value regime; and group 3 = reproduction cost regime.

[6]Adar, Barnea, and Lev's (1977) comprehensive CVP analysis has analyzed the economic implications of CVP and break-even analyses.

[7]Hite (1977) has shown that cost of capital need not decline with leverage even in perfect capital markets and with default-free debt. This finding may be used to justify why different regulation regimes affect the capital structure in some years and not in other years.

[8]They use this definition to show that the higher the marginal corporate tax rate and degree of leverage, the smaller the variance in after tax revenue.

[9]See Scanlon (1972) for detail.

[10]A more liberal regulation will generally increase a firm's total returns. See Primeaux (1978).

[11]The classification list is available from the authors. Primeaux (1978) discusses the difficulty of classifying states according to rate base methods; therefore, the procedure used by Primeaux was developed to avoid these difficulties. The same procedure was used in this study to assure accuracy.

REFERENCES

1. Adar, Z., A. Barnea and B. Lev (1977). "A Comprehensive Cost-Volume-Profit Analysis Under Uncertainty," The Accounting Review, LII, pp. 137-149.

2. Boness, J. A. and G. M. Frankfurter (1977). "Evidence of Non-Homogeneity of Capital Costs Within 'Risk Class'," Journal of Finance, 32, pp. 775-787.

3. Chang, H. S. and C. F. Lee (1977). "Using Pooled Time-Series and Cross-Section Data to Test the Firm and Time Effect in Financial Analysis," Journal of Financial and Quantitative Analysis, 12, pp. 457-471.

4. Christensen, L. R. and W. H. Green (1976). "Economics of Scale in U.S. Electric Power Generation," Journal of Political Economy, Vol. 84, No. 4, Part 1.

5. Eiteman, D. K. (1962). "Interdependency of Utility Rate-Base Type, Permitted Rate of Return, and Utility Earnings," Journal of Finance, Vol. 17, pp. 38-39.

6. Elliott, J. W. (1973). Economic Analysis for Management Decisions, (Homewood: Richard D. Irwin, Inc.).

7. Federal Power Commission (1971). The 1970 National Power Survey, (Washington: Federal Power Commission).

8. Garfield, P. J. and W. F. Lovejoy (1964). Public Utility Economics, Prentice-Hall, Inc., Englewood Cliffs, N.J.

9. Gale, B. T., "Market Share and Rate of Return," Review of Economics and Statistics, Vol. LIV, No. 4, pp. 412-23.

10. Greenberg, E., W. J. Marshall and Y. B. Yawitz (1978). "The Technology of Risk and Return," American Economic Review, 68, pp. 241-251.

11. Hagerman, R. L. and B. T. Ratchford (1978). "Some Determinants of Allowed Rates of Return on Equity to Electric Utilities," The Bell Journal of Economics, 9, pp. 46-55.

12. Hite, G. L. (1977). "Leverage, Output Effects and the M-M Theorems," Journal of Financial Economics, 4, pp. 177-202.

13. Hunt, P. (1961). "A Proposal for Precise Definition of 'Trading on the Equity' and 'Leverage'," Journal of Finance, 16, pp. 377-86.

14. Hurdle, Gloria G. (1974). "Leverage, Risk, Market Structure and Profitability," Review of Economics and Statistics, Vol. LVI, No. 4, pp. 478-85.

15. Johnston, J. (1960). Statistical Cost Analysis, (New York: McGraw-Hill Book Co., Inc.).

16. Krainer, R. E. (1977). "Interest Rates, Leverage, and Investor Rationality," Journal of Financial and Quantitative Analysis, 12, pp. 1-31.

17. Lintner, J. (1956). "Distribution of Incomes of Corporations Among Dividends Retained Earnings and Taxes," American Economic Review, 46, pp. 97-113.

18. Litzenberger, R. H. and K. Ramaswamy (1979). "The Effect of Personal Taxes and Dividends for Capital Asset Prices: Theory and Empirical Evidence," Journal of Financial Economics, 7, pp. 163-195.

19. Mandelker, G. N. and S. G. Rhee (1981). "The Impact of Financial and Operating Leverages on the Systematic Risk of Common Stocks," Journal of Finance, forthcoming.

20. Mao, J. C. T. (1969). Quantitative Analysis of Financial Decision, The MacMillan Company, New York.

21. Modigliani, F. and M. H. Miller (1958). "The Cost of Capital, Corporation Finance and the Theory of Investment," American Economic Review, Vol. XLVIII, pp. 261-97.

22. Miller, M. H. and F. Modigliani (1961). "Dividend Policy, Growth and The Valuation of Shares," Journal of Business, 58, pp. 411-433.

23. Modigliani, F. and M. H. Miller (1963). "Corporate Income Taxes and the Cost of Capital: A Correction," American Economic Review, Vol. LII, pp. 433-43.

24. Modigliani, F. and M. H. Miller (1965). "The Cost of Capital Corporation Finance and the Theory of Investment: Reply," American Economic Review, Vol. LV, pp. 524-27.

25. Miller, M. H. and F. Modigliani (1966). "Some Estimates of the Cost of Capital to the Electric Utility Industry, 1954-58," American Economic Review, Vol. LVI, pp. 333-91.

26. Neter, J. and W. Wasserman (1974). Applied Linear Statistical Models: Regression, Analysis of Variance and Experimental Design. Richard D. Irwin, Inc.: Homewood, Illinois.

27. Petersen, H. C. (1976). "The Effect of 'Fair Value' Rate Base Valuation in Electric Utility Regulation," Journal of Finance, Vol. XXXI, pp. 1487-90.

28. Pike, J. (1967). "Residential Electric Rates and Regulations," The Quarterly Review of Economics and Business, Vol. 7, pp. 45-52.

29. Phillips, C. F. Jr. (1969). The Economics of Regulation. Homewood, Illinois: Richard D. Irwin, Inc., revised edition.

30. Primeaux, Jr., W. J. (1978). "Rate Base Methods and Realized Rates of Return," Economic Inquiry, Vol. XVI, pp. 95-107.

31. Scanlon, J. J. (1972). "Bell System Financial Policies," Financial Management (Summer 1972), pp. 16-26.

32. Scott, J. H., Jr. (1977). "Bankruptcy, Secured Debt, and Optimal Capital Structure," Journal of Finance, 32, pp. 1-19.

33. Subrahmanyam, M. G. and S. B. Thomadakis (1980). "Systematic Risk and the Theory of the Firm," The Quarterly Journal of Economics, 94, pp. 437-51.

34. Tuttle, D. L. and R. H. Litzenberger (1968). "Leverage, Diversification and Capital Market Effects on a Risk-Adjusted Capital Budgeting Framework," Journal of Finance, 23, pp. 427-43.

35. Weston, F. and E. F. Brigham (1981). Managerial Finance. Hinsdale, Ill.: The Dryden Press.

M/C/88

APPENDIX A

Firms Included in the Sample
(According to Rate Base Method)

Original Cost

Bangor Hydro-Electric Co.

Central Hudson Gas & Electric

Central Main Power Co.

Concord Electric Co.

Consolidated Edison Co.

Green Mountain Power Corp.

Long Island Lighting Co.

Maine Public Service

New York State Electric & Gas

Niagra Mohawk Power Corp.

Orange & Rockland Utilities

Pacific Gas & Electric

Public Service Co. of Colorado

Rochester Gas & Electric

San Diego Gas & Electric

Southern California Edison

United Illuminating Co.

Boston Edison Co.

Central Louisiana Electric Co.

Consumer's Power Co.

Detroit Edison Co.

Edison Sault Electric Co.

Fitchburg Gas & Electric

Florida Power & Light

Florida Power Corp.

Hawaiian Electric Co.

Kansas Gas & Electric

Kansas Power & Light

Madison Gas & Electric

Savannah Electric & Power Co.

Tampa Electric

Upper Penninsula Power Co.

Wisconsin Electric Power Co.

Wisconsin Power & Light

APPENDIX A (cont.)

Fair Value

Arizona Public Service Co.

Duquesne Light Co.

Pennsylvania Power & Light Co.

Public Service Electric & Gas Co.

Tucson Gas & Electric Co.

Atlantic City Electric Co.

Central Illinois Light Co.

Central Illinois Public Service Co.

Commonwealth Edison Co.

Illinois Power

Indianapolis Power & Light Co.

Louisville Gas & Electric Co.

Missouri Utilities Co.

Philadelphia Electric Co.

Public Service Co. of Indiana

Public Service Co. of New Mexico

St. Joseph Light & Power

Southern Indiana Gas & Electric Co.

UGI Corporation

Reproduction Cost

Cincinnati Gas & Electric Co.

Cleveland Electric Illuminating Co.

Columbus Southern Ohio Electric Co.

Dayton Power & Light

Ohio Edison

Toledo Edison

APPENDIX B

Data Summary

1. Total operating revenue for firm i = PQi; data obtained Moody's Public Utility Manual [MPUM].
2. Total variable cost for firm i = VQi; data obtained from MPUM.
3. Total operating fixed cost for firm i = FCi; data obtained from MPUM.
4. Total returns for firm i = Xi; this variable was defined to be net operating revenues plus taxes. Data from MPUM.
5. Total interest charges for firm i = Ii. It was defined to be interest on long-term debt plus other interest charges. Data from MPUM.
6. Total long-term debt (or total debt) of firm i = Di. The book value of long-term debt (or total debt) for firm i. Data obtained from MPUM.
7. Total book value of assets for firm i = Ai.
8. Rate base methods were validated by referring to 5 different sources to assure that the correct rate base method was used in this study. This information was obtained from Eiteman (1962), Pike (1967), Phillips (1969), and Senate Document No. 56, 90th Congress 1st Session <u>State Utility Commissions Summary and Tabulation of Information Submitted by the Commissions</u>, and State of Arizona, <u>Arizona Corporation Commission Annual Report</u> (1970).