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THE DETERMINANTS OF ELECTRIC UTILITY CONSTRUCTION EXPENDITURES

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Even before the full impact of the energy crisis was felt in the United States, an article in the *New York Times* predicted shortages of electric energy. Since the oil embargo, these predictions of shortages have occurred more frequently. One recent article in the *Wall Street Journal*, "Sweltering Summer", predicted blackouts and brownouts for the southwest in summer months while another one, "A Glimpse into the Future", predicted that electric energy is likely to be rationed in the late 1980s.

One reason for these predicted shortages is the purported inability of the electric utility industry to construct sufficient capacity to meet the growing demand for power. Inflated construction costs and inadequate rate relief are the culprits in most of these doom and gloom predictions.

Very little empirical work done in the past has addressed electric utility construction behavior patterns. Therefore, this paper will examine the relationship between construction spending by electric utilities and several related variables to determine what is causing the utilities to expend (or not to expend) resources on new plant and facilities.

In the next section the general theory on investment decision making will be reviewed for non-regulated firms and then compared to the theory for rate of return regulated firms. In the third section, the statistical model and the variables included in the study will be discussed. In the fourth section, the results will be presented, and the final section will contain the conclusions.

II. INVESTMENT DECISIONS

A non-regulated firm makes all investments that increase the wealth of the firm's shareholders. Financial theory demonstrates that all investments that have rates of return greater than the firm's risk adjusted cost of capital will increase the shareholder's wealth and should be made.

In Figure 1 the investment decision for the non-regulated firm can be seen. R^* represents the rate of return earned on the firm's investments, and R represents the firm's cost of capital. The firm should make all of the investments for which $R^* > R$ because these will increase the wealth of the shareholders. Investment in new facilities should not be made when $R^* < R$.

This investment decision can be compared to the decision facing a public utility which must operate under rate of return regulation. The public utility's investment decision is shown in Figure 2. R^* represents the rate of return

FIGURE 1

The Non-Regulated Firm's Investment Decision

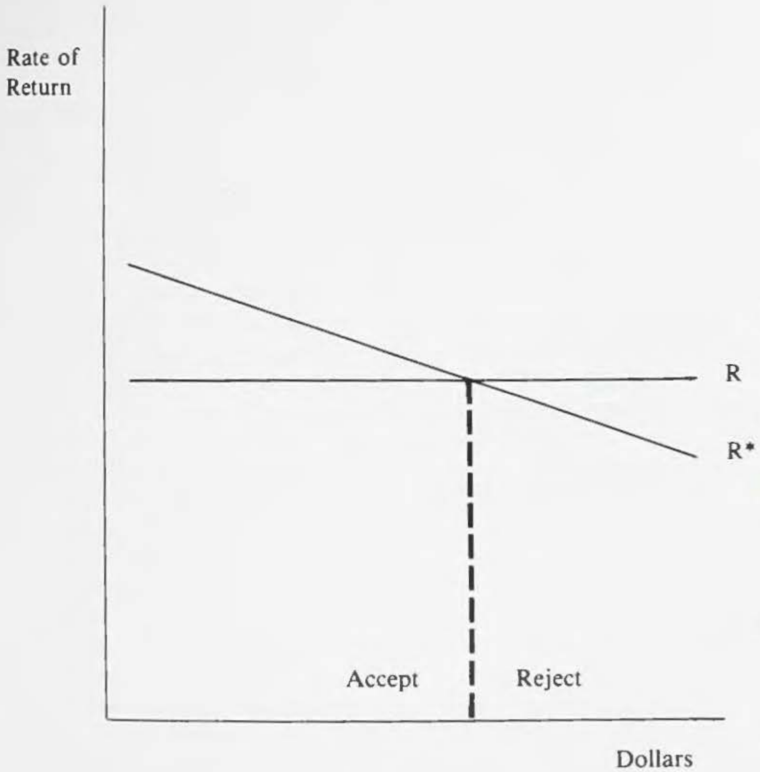
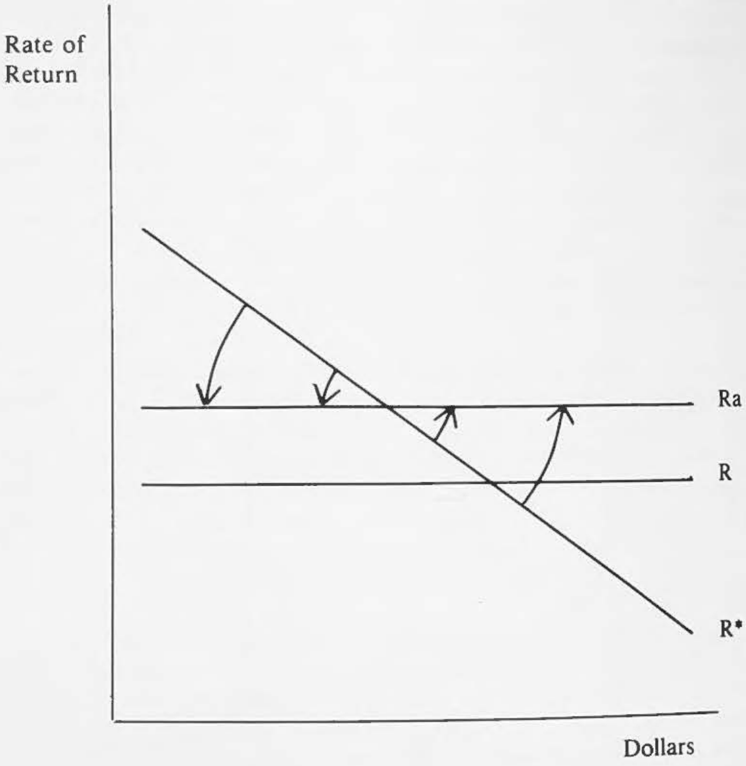


FIGURE 2
The Regulated Firm's Investment Decision



on the investment in absence of regulation, R represents the utility's cost of capital, and Ra represents the allowed rate of return on the utility's rate base. If the new investment is allowed to enter the rate base, it will, in theory, earn the allowed return, Ra. R* is irrelevant because under regulation the investment can only earn Ra. The decision to make the investment now depends upon two factors. The first is whether or not the new facilities will be allowed to enter the rate base. This is a matter for the state regulatory commissions and laws to decide. If the assets do not enter the rate base, the incremental return on the investment by the firm will be zero, and clearly the investment would not be made. If the asset enters the rate base, it will earn Ra.

The second factor is the important one for our purposes, and it is the relationship between Ra and R. Only if Ra > R, will the shareholder's wealth be increased by the investment. Hence, if the managers of the utility firm are attempting to maximize shareholder wealth, they will make investments only when Ra > R.

The above analysis presents a very simplified picture. Clearly, the uncertainty involved in the decision making due to the tremendous lead times required for utility investments would also impact the decision. Nevertheless, the simplified theory provides a testable hypothesis concerning electric utility construction spending. Secondly, this simplified theory is often suggested by the same people who predict the energy shortages. The Northeast Utility Company's 1981 Annual Report devoted five pages to the discussion of rates of return and the cost of capital. It warned of "the real possibility of power shortages in parts of the country by the end of the decade" (p. 27) and blamed this danger on unfavorable regulation. This annual report emphasized the real and growing concern over the problem.

Finally, the effect of the allowed rate of return on regulated companies is well documented. Averch and Johnson's (1962), A-J, pathbreaking analysis demonstrated that if the allowed return is greater than the cost of capital, a utility will use excess capital. This might manifest itself in a large construction program. The A-J results have been closely scrutinized, and in Petersen (1975), Bailey (1973), Bailey and Coleman (1971), Peles and Stein (1976 and 1979), and Rau (1979) the A-J results have been shown to hold under varying assumptions.

Baumol and Klevorik (1970) observed that the A-J results, excessive use of capital, as predicted by A-J, will occur only as long as the allowed rate of return exceeds the cost of capital, Ra > R. When Ra = R, there is no incentive to invest in capital. Baumol and Klevorik suggest that the regulated firm will not operate when Ra < R. They did not consider the institutional constraints that could keep the utilities in operation. However, when Ra < R, there would be limited construction because the new facilities would be unprofitable. This is precisely the point demonstrated in Figures 1 and 2.

This paper will not attempt to debate the theory on a conceptual level. Instead, it will attempt to empirically analyze the determinants of utility construction expenditures. In particular, the effects of the regulatory constraint on capital expenditures will be examined. The model will be developed in the next section.

III. THE MODEL

Fifty electric utilities were identified for the study. For a utility to be included in the sample, it must have earned at least 50% of its revenues from electric sales. Furthermore, the utility must have operated primarily in one state. This criteria eliminates the problem of multiple jurisdictions with multiple allowed returns.

For the fifty firms in the sample, the construction expenditures for 1981 were identified from *Argus Utility Scope*. The year, 1981, was the most recent year for which all of the data was available so it was selected for the sample period. Since a larger utility might spend more on new facilities simply due to its size than a smaller utility, the 1981 construction expenditures were divided by the year-end total capitalization. This new variable, CONCAP, provides a relative measure for each utility's construction in new facilities.

The following model suggests that the construction expenditures, CONCAP, are a function of several variables. The b_i are regression coefficients, and e_i is the regression error term.

$$\text{CONCAP} = b_0 + \sum b_i(\text{variables}) + e_i \quad (1)$$

This model was used to determine the effect of the independent variables on construction expenditures, CONCAP. The independent variables are listed in Table 1 and are discussed below. These variables were chosen because of their potential effect on utility construction expenditures.

From Table 1 it can be seen that the average utility in our sample spent an amount in excess of 47% of its total capitalization in 1981 on new plant and facilities. However, there was a considerable range in CONCAP, 23% to 94%.

The purpose of this analysis is to determine some of the factors which explain spending by electric utilities. Nine independent variables were chosen because of their potential impact on the construction expenditures. These nine variables are listed following CONCAP in Table 1. A discussion of each variable, its potential effect on CONCAP, and the reasons for including it follow.

The previously discussed theory suggests that the allowed rate of return will impact the utility's decision to build new plant and facilities. Therefore, a variable which measures the allowed return must be included. RANK is a measure used as a proxy for the allowed rate of return. The actual allowed rate of return was not used because it is not correct to compare this number from state to state. For example, a very high allowed return can be, in part, nullified by a very conservative rate base or cost of service valuation or by a lengthy regulatory lag. Since each state has its own regulatory laws, the

TABLE 1
DESCRIPTION OF THE VARIABLES

	Mean	Standard Deviation	Range
CONCEPT	47.64%	13.8%	23% - 94%
RANK	2.29	0.52	1.00 - 3.00
POPCH	12.00%	14.6%	(3.7)% - 53.1%
POP80	8,478,460	5,850,147	921,000 - 23,669,000
COAL	52.58%	36.10%	0% - 100%
PI-CH	39.8%	21.69%	8.8% - 86.1%
PI-80	47,130	34,880	$4,700 - 145,000
RES	26.10%	9.77%	7% - 50%
PURCH	8.40%	14.80%	(7)% - 76%
INTERNAL	68.86%	18.75%	28.5% - 100.0%
MKTBK	77.86%	9.22%	62.0% - 105.0%
BOND*	11.00	*	6 - 17

*Bonds are rated on an alphabetic scale. This scale was converted to numbers to allow the computation of the regression statistics. The mean of 11 represents an approximate ranking of A. The range was from BB+ to AAA.

explicit rate of return granted may serve only as window dressing when all of the other regulatory variables are considered.

The inclusion of rank as a proxy for the overall regulatory environment allows us to test for the effect of the regulatory environment on capital spending. Our previously discussed theory suggests that a positive relationship will exist between the regulatory environment (our proxy for the overall allowed return) and construction expenditures. States with very high quality regulatory laws and procedures make it profitable for utility capacity to be maintained. The variable RANK is found as follows.

Considerable differences exist between the various states' regulatory laws and procedures. As demonstrated in Davidson and Chandy (1983) the ratings of the states' regulatory environments by several investor services can capture a considerable amount of the difference between the states. The ranking procedure developed in Davidson and Chandy (1983) is used to proxy the regulatory effects on the construction expenditures. This procedure averages the rankings given to the various states by five investor services, Argus, Merrill Lynch, Goldman Sachs, Duff and Phelps, and Value Line, for the year 1981. The scale of the rank is from 1 to 3. A state rated a 1 would be considered to have a below average regulatory environment while a state rated a 3 would be considered to have an above average environment. Each of the investor services has its own method for ranking the states' regulatory environment, so individual ranking systems were converted to the 1 to 3 scale and averaged. This is the variable, RANK, included in the regression. It captures the differences between the states and serves as a proxy for the true allowed return. Our ranking for each state appears in Table 2.

TABLE 2
THE AVERAGE RANK OF STATE REGULATORY ENVIRONMENT

STATE	RANK	STATE	RANK
Alabama	1.0	Montana	1.0
Arizona	2.2	Nebraska	1.8
Arkansas	2.0	Nevada	2.0
California	2.2	New Hampshire	2.4
Colorado	2.0	New Jersey	2.0
Connecticut	1.8	New Mexico	3.0
Delaware	2.4	New York	2.4
Florida	3.0	North Carolina	3.0
Georgia	1.6	North Dakota	1.2
Hawaii	3.0	Ohio	2.2
Idaho	2.2	Oklahoma	1.8
Illinois	2.2	Oregon	2.2
Indiana	3.0	Pennsylvania	1.4
Iowa	1.4	Rhode Island	1.4
Kansas	2.0	South Dakota	1.0
Kentucky	2.8	Tennessee	1.2
Louisiana	1.6	Texas	3.0
Maine	1.0	Utah	3.0
Maryland	2.0	Vermont	2.4
Massachusetts	1.8	Virginia	1.8
Michigan	1.4	Washington	2.0
Mississippi	1.4	West Virginia	1.2
Missouri	1.0	Wisconsin	3.0

These ranks for the regulatory environment of the states were obtained by averaging the ranks supplied by the following analysts or investors services, Argus, Merrill Lynch, Goldman Sachs, Duff and Phelps, and Value Line.

The next variable in Table 1 is POPCH. POPCH measures the population growth from 1970 to 1980 in each state. Our hypothesis is that utilities in states with considerable growth in population will have larger construction expenditures so a positive relationship is expected between POPCH and CONCAP. We can see in Table 1 that the average population growth in our sample was 12%, but there was a considerable range in this variable. State population figures were used as a proxy for the service area population. There were no consistently reliable population statistics available on service area population.

COAL is the next variable. This variable measures the percentage of generation in 1980 by coal-fired plants. It is included to determine whether utilities with generation by other than coal (i.e., nuclear or oil-fired plants) are switching to coal. Our hypothesis is that electric utilities using oil or nuclear fired generation may be switching to coal. The shortages of oil in the 1970's and the bad publicity of nuclear power combined with the increasingly difficult licensing procedures may force a negative relationship between the variables COAL and CONCAP.

PI-CH measures the change in personal income in each state from 1970 to 1980. This variable has been included to measure the general economic climate in the states. States that are healthier economically may foster growth in power demand, and therefore the construction expenditures may be higher in these states. We hypothesize a positive relationship between CONCAP and PI-CH.

RES is the percentage of reserve at peak that the utility's system maintained in 1980. A utility with a large reserve would need fewer new plants, while a low reserve could signal the need for greater construction. The reserve averaged 26% but ranged from 7% to 50% for the firms in the sample. If construction spending decisions were made with the maintenance of a sufficient safety margin in mind, then a negative relationship between RES and CONCAP would exist.

PURCH measures the extent of the utilities' dependence upon purchased power in 1980. The average company in the sample purchased about 8% of its power, but there was a considerable range. A utility which relies upon purchased power to meet its demand may be forced to build new plants to decrease this reliance. Under these conditions, a positive relationship between PURCH and CONCAP will occur.

INTERNAL measures the percentage of the utilities' funds that have been generated internally for 1980 construction expenditures. A relatively large construction program would cause the utility to rely more heavily upon external funding. A large amount of externally generated funds in 1980 might retard construction spending in 1981. On the other hand, the availability of internally generated funds would permit greater construction expenditures. The average utility raised 69% of its funds internally, but this ranged from 28.5% to 100.0%.

The last two variables MKTBK and BOND are measures of the utilities' financial health. MKTBK measures the utilities' market to book ratio at year-end 1980, and BOND is a measure of the utilities' S&P bond rating for 1980 for each company's highest quality bonds. We hypothesize a positive relationship between the financial health of the utilities and construction expenditures.

A considerable amount of effort was spent in determining the appropriate independent variables. Our primary purpose is to determine whether it is the regulatory environment, capacity requirements, or the financial health of the individual utility firms which influences the decision makers. The variables were chosen accordingly.

If in the regression, the variable RANK is shown to be the most important, then it will appear that the allowed rate of return theories have some validity. On the other hand, if variables such as RES or PURCH are strongly related to the construction expenditures, then it will appear as though the construction is dependent upon capacity related matters. It is also very probable that the construction depends upon the utility's prediction of growth in demand. Since these predictions are made by the companies for their internal use, they were not available for this study.

IV. RESULTS

The results of the step-wise regression appear in Table 3. The variables are listed in the order in which they entered the regression. First of all, notice that the constant is large and significantly different from zero. The existence of this constant suggests, as might be expected, that there is a fixed amount of construction expenditures made irrespective of the independent variables in the study.

Of the 11 independent variables in the study, the first three account for most of the model's explanatory power, as measured by the R^2 (39.5% of 46.6%). The model's F statistic was 3.02, which was significant at the 0.05 level.

The first variable to enter the regression is INTERNAL. This variable measures the extent of internally generated construction funds. The beta coefficient is small but is significantly different from zero. The small beta suggests a small but significant relationship. This coefficient is also nega-

TABLE 3
RESULTS OF THE STEPWISE REGRESSION

Variable	Beta	t statistic	R^2	F statistic
INTERNAL	−0.356	−3.71*	0.276	3.02
RES	−0.336	−1.65	0.357	
RANK	8.357	1.98*	0.395	
PURCH	0.193	1.54	0.412	
COAL	0.082	1.40	0.434	
BOND	−1.188	−1.27	0.452	
POP80	−0.002	−0.43	0.459	
PI80	0.242	0.39	0.460	
MKTBK	6.942	0.28	0.461	
PI-CH	15.309	0.58	0.462	
POP-CH	−21.626	−0.58	0.466	
CONSTANT	61.959	3.308*		

*Significantly different from zero at the .05 level.

tive. Companies with large construction expenditures generate a relatively smaller amount internally. This relationship may exist because utilities with larger construction programs will have proportionately less internal funding available simply due to the size of the construction program. Therefore the cause and effect relationship between INTERNAL and CONCAP is unclear. All that we can surmise is that the negative relationship exists.

RES entered the regression next. Its beta is very small and is negative. The beta coefficient is significantly different from zero at the 0.10 level of significance. There is a very small inverse relationship between the level of reserve and construction spending. The lower the level of the reserve, the greater the construction spending by the utility.

The third variable to enter the regression is RANK. The beta coefficient is large, significantly different from zero, and positive. This relationship suggests that the utilities that operate in states with more favorable regulatory climates are spending relatively more on new facilities. This positive relationship confirms the theory that utilities operating under a favorable regulatory climate do have larger construction spending programs. However, the strength of this variable, as measured by its incremental addition to the R^2, is not quite as large as the theory suggests. Nevertheless, the relationship is evident.

The remaining variables have statistically insignificant beta coefficients, but the sign of these coefficients is in the direction that was anticipated.

There did not appear to be any serious multicollinearity between the variables reported here. As shown in Table 4, the only variables which have correlation coefficients above 60% are POPCH and PI-CH. The large correlation between these variables, 94.5%, suggests that these variables may be multicollinear. However, these are the last two variables to enter the regression, which implies that they have the least explanatory power. The model was rerun excluding these variables, but the results were not materially different and have not been reported here. Because of the lack of importance to the overall results of these two variables, multicollinearity is not a major problem. Nor was there any significant violation of the other assumptions needed for regression studies.

V. CONCLUSIONS

Blackouts and brownouts have been predicted to occur in the future in the United States because of inadequate construction of power plants. This paper examines the relationship between construction in new facilities and several variables. It was found that the regulatory environment and the utility's reserve margin both affect the level of construction expenditures.

TABLE 4
PEARSON CORRELATION COEFFICIENTS

	POPCH	PICH	RANK	COAL	RES	PURCH	INTER	BOND	MKTBK
POPCH	1.000								
PICH	.945*	1.000							
RANK	.245*	.220	1.000						
COAL	−.143	.097	.148	1.000					
RES	−.334	−.339	.068	.065	1.000				
PURCH	.020	.022	−.141	−.410	−.131	1.000			
INTER	−.092	−.145	.063	.078	.079	−.123	1.000		
BOND	.125	.172	.585*	.346*	.140	−.184	.173	1.000	
MKTBK	.485*	.474*	.414*	.207	−.163	−.151	.219	.450*	1.000

*Significant at the 0.05 level

These results indicate that utilities do attempt to build new power plants when they have low reserve margins, but that the regulators do impact the decision as well. More responsive regulation may prevent power shortages from occurring. It is the opinion of the authors of this paper that it is imperative for regulators to be educated in the effects of regulation, particularly on the utilities' ability to meet future demand.

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