# Regulation and Reported R&D by Electric Utilities

by Sanford V. Berg

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ABSTRACT

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The impacts of regulations related to innovative activity are tested for the electric utility industry. State regulations allowing firms to include R&D in the rate base are shown to increase reported R&D. Also, regulations usually permit contributions to research consortia to be treated the same as internal R&D. Since we find that firms which belong to consortia report relatively more R&D, this regulatory policy also increases innovative activity by utilities.

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# Regulation and Reported R&D by Electric Utilities

By Sanford V. Berg*

A number of theoretical and empirical studies have examined the impact of regulation on research and development (R&D) activity by utilities. Few studies have looked specifically at the effects of state regulation on innovative activity, yet it is clear that state policies could discourage or stimulate R&D, since they might reduce the possibility of substantial gains as well as the risk of losses. Examined in this note are regulatory policies towards two aspects of innovative activity: the capitalization vs. expensing of R&D; and the treatment of membership contributions to R&D consortia.

To date, tests of the impact of regulation have been very crude. Wilder and Stansell (1974, hereafter WS) introduced a dummy variable for regulation in their analysis of R&D determinants, but they defined as "unregulated" those firms in four states which had given municipalities the electric utilities franchise power. Yet, from the standpoint of innovation, local regulation in four states (Minnesota, Nebraska, South Dakota, and Texas) can hardly be expected to differentially affect R&D behavior of firms.

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This note uses improved policy proxies to examine specific regulations affecting R&D. Some policies differ widely across states, such as whether R&D is allowed in the rate base.[1] Other policies, such as permitting externally-performed R&D to be treated the same as internal R&D, are widely adopted. The twenty-one states which permit inclusion of R&D in the rate base were identified on the basis of a survey by the National Association of Regulatory Commissioners (published in the Fall 1976 Baylor Law Review). Firms in these states would be expected to have relatively more R&D than other firms for several reasons. An equity owner would prefer capitalizing to expensing R&D if his discount rate is less than the rate of return on equity (Linhart, Lebowitz, and Sinden, 1974). Further reinforcing the incentive to purchase more R&D are possible Averch-Johnson considerations which might stimulate R&D which can be capitalized.

Federal and state regulation has tended to encourage membership in research consortia. The treatment of contributions certainly affects the incentive to join consortia. The main research center, the Electric Power Research Institute (EPRI), founded in 1972, now has over 900 projects and a budget of over $200 million. Although state commissions could have chosen to

[1]Note that what a state in general permits, and what actually occurs in practice are two different matters. A recent sample of cases discussed in Public Utilities Fortnightly (September 28, 1978) indicates a tendency for some state commissions to encourage R&D through test year adjustments and other procedures. New York, Vermont, and Florida cases were cited to illustrate how commissions could encourage R&D. Michigan, on the other hand, recently disallowed Detroit Edison contributions to EPRI for ratemaking purposes, on the grounds that prior authorization had not been obtained. The state proxy indicating whether R&D is allowed in the rate base or is expensed is quite crude, and may not adequately reflect state-specific policies.

reinforce free-rider problems by discouraging EPRI membership, they have not done so. Similarly, the old Federal Power Commission in 1970, in response to perceived low levels of R&D expenditures, issued Order No. 408, adopting policies to encourage electric utility R&D. Then in 1973, Order No. 483 ammended R&D accounting and reporting procedures. Utilities could request advance rate base assurances from the FPC for projects of $50,000 or more - applicable for both internal and external R&D. In addition, the order proposed that utilities could request authorization to track such expenditures for rate-making purposes. Of course, the FPC (now Federal Energy Regulatory Commission) only controls interstate rate-making, but the orders no doubt influence state regulators.

Empirical Results

This note tests whether R&D capitalization and EPRI membership increase reported R&D by electric utilities. In their test of regulatory impacts for 1968-70, WS used a double logarithmic functional form which made the level of R&D expenditures (R) a function of total utility operating revenues (St, here) and the ratio of electric to total operating revenue (Se/St).[2] WS found that the logarithm of one plus the ratio of electric to total operating revenue (ln(1+Se/St)) was positively associated with electric operations than with other (e.g., gas) operations." (WS p. 649) Another interpretation of this result is that specialization enhances R&D opportunities.[3]

[2] All variables except the zero-one dummy had a constant one added to each observation before taking logarithms (WS p.648).

[3] If a dummy variable for combination companies is explicitly introduced into the model (dropping Se/St), it has a negative sign, as would be expected. Detailed results are available from the author on request.

The basic variables in the WS equation were re-estimated for 1972. Except for the two proxies for rate of return (on rate base, RORB, and on common equity, RORCE), to be discussed momentarily, the results in Table 1 parallel WS. Permitting R&D in the rate base was found to significantly and positively affect reported R&D. In equations 3-5, the coefficient is relatively stable in magnitude. For (5), if the other variables are taken at their means, Dreg adds over one-third of a million dollars to R&D. This result is quite robust, holding whether or not profitability measures are included in the model.

The negative impact of profitability for 1972 differs from results obtained by WS for 1970 (using rate of return on equity). In a comment on that study, Delaney and Honeycutt (1976) took into account corporate interrelationships among the sample observations. Operating systems holding companies were consolidated into combined systems, while joint venture companies and subsidiaries of nonutility parent companies were excluded from the sample, dropping the sample of 207 observations to 135. For 1970, the profitability variable was insignificant for the new sample, compared with the positive, significant impact estimated by WS. They found a negative, significant impact for 1972, attributing the change to the refined sample, which reflected corporate interrelationships. However, since the negative coefficient for profitability reported here for 1972 used the original WS sample, other factors (such as intertemporal shifts) are probably present.

Table 1

R&D and Regulation, 1972
(t ratios in parentheses)

| | Variables | | | | | $R^2$ | F | N |
|---|---|---|---|---|---|---|---|---|
| lnR = | Const. | ln(St + 1) | ln(Se/St + 1) | | | | | |
| (1) | -9.8 | + 1.17 (17.8) | + 3.54 (3.9) | | | .68 | 164.2 | 158 |
| | | | | ln(1 + RORB) | | | | |
| (2) | -6.17 | + 1.25 (19.1) | + 3.83 (4.42) | -2.24 (-4.4) | | .72 | 126.4 | 155 |
| | | | | | Dreg | | | |
| (3) | -6.52 | + 1.25 (19.7) | + 3.75 (4.5) | -2.18 (-4.4) | + .63 (3.3) | .74 | 103.8 | 155 |
| | | | | ln(1 + RORCE) | | | | |
| (4) | -8.26 | + 1.33 (19.3) | + 3.39 (4.1) | -1.43 (-4.7) | + .61 (3.2) | .74 | 107.5 | 157 |
| (5) | -10.1 | +1.17 (18.3) | +3.46 (3.94) | | + .66 (3.32) | .70 | 120.2 | 158 |

$S_t$ = total operating revenue

$S_e$ = electricity operating revenue

RORB = rate of return on rate base

Dreg = 1 if R&D permitted in rate vase by state PUC

RORCE = rate of return on common equity

Data from Statistics of Privately Owned Utilities in the United States and Baylor Law Review (Fall, 1976)

Nevertheless, the Delaney-Honeycutt conclusion still holds - that the erratic estimate of how current profitability affects current R&D suggests caution be used when interpreting the impact of this variable.

The next set of results concerns how R&D expenditures are affected by membership in research consortia.[4] Table 2 presents results for 1972, 74 and 76 - using electricity operating revenue as an independent variable (the issue of how specialization affects R&D expenditures is not addressed). Eq. 1 indicates that R&D is fairly elastic with respect to firm size - a 10 percent increase in electricity operating revenue tends to be accompanied by a 14.4 percent increase in R&D expenditures. The elasticity drops off for 1974 when the oil embargo sent fuel prices up; operating revenues also rose - and R&D budgets actually declined, on average. In 1976, the estimated elasticity remained lower than previously (5), suggesting that a long run adjustment may have resulted in permanently lower total R&D elasticities. The positive and significant coefficients on the dummy variable representing EPRI membership for 1974 and 76 (eq. 4 and 6) support the hypothesis that membership in research consortia is accompanied by higher levels of R&D. Causation is more difficult to establish, since one could argue that relatively R&D - intensive firms chose to join EPRI in 1973 to expand their portfolio of research projects. However, the introduction of

[4] Information on membership and contributions was obtained from EPRI, whose member utilities represent about fifty percent of all investor-owned utilities and about eighty percent of the total kwh output of the utility industry.

Table 2

R&D and EPRI Membership

1972, 1974, 1976

| | | Variables | $R^2$ | F | N |
|---|---|---|---|---|---|
| 1) | 1972 | lnR = -11.07 + 1.44 lnSe<br>(17.99) | .67 | 323.7 | 159 |
| 2) | 1974 | lnR = -8.6 + 1.26 lnSe<br>(22.8) | .76 | 520.9 | 168 |
| 3) | 1972 | lnR = -11.3 + 1.48 lnSe - 0.28E<br>(17.3) (1.27) | .68 | 162.3 | 158 |
| 4) | 1974 | lnR = -8.27 + 1.19 lnSe + 0.71E<br>(22.3) (4.9) | .79 | 305.9 | 167 |
| 5) | 1976 | lnR = 8.79 + 1.26 lnSe<br>(23.5) | .77 | 550.8 | 171 |
| 6) | 1976 | lnR = -8.37 + 1.18 lnSe + 0.81E<br>(22.9) (5.6) | .80 | 338.0 | 170 |
| 7) | 1974 | lnRint = -8.52 + 1.23 lnSe + 0.048 ln(Rext)<br>(18.33) (1.4) | .75 | 250.8 | 167 |
| 8) | 1976 | lnRint = -9.43 + 1.26 lnSe + 0.047 ln(Rext)<br>(18.8) (1.56) | .78 | 281.1 | 163 |

Rint = R - estimated EPRI contribution. The contribution was estimated from votes each firm had in 1974, which appeared to be perfectly correlated with actual dollar contributions in $000.

Rext = External R&D (estimated EPRI contribution).

an EPRI dummy for the founding year, 1972, when contributions were minimal (equation 3) yields a negative (but insignificant) coefficient, suggesting that membership actually augments total R&D.

Equations 7 and 8 attempt to determine whether contributions to EPRI complement or substitute for other R&D expenditures (mostly internal R&D, Rint = total R&D less the estimated EPRI contribution). Using the double log formulation, internal R&D was positively affected by the level of the EPRI contribution in 1974 and 1976. An indication of possible impact was obtained by taking internal R&D as a function of electricity operating revenue and external R&D (plus one - so the logarithm would equal zero for non-EPRI members). However, the results were not significant at the 5 percent level. The results indicate again the need for more complete specification of a model which might include the membership choice decision, and changes in R&D over time. However, the results suggest that if regulatory agencies wish to encourage R&D, that membership in consortia should not be discouraged.

## Conclusions

The empirical results presented here indicate that characteristics of firms and particular regulatory policies affect the R&D intensity of electric utilities. Economists should find reassuring the relative robustness of the WS results (years 1968-70) extended to 1972-1976. Changes in FPC accounting procedures apparently have not altered the basic relationships. In addition, the capitalization of R&D expenditures and treatment of membership contributions to R&D consortia were both shown to be related to reported R&D.

Future work should consider three major issues. First, how well do reported R&D data reflect innovative activity by electric utilities? For example, some state agencies have classified pollution control expenditures as R&D on the basis of the technology being untried. Similarly, firms have some choice as to how engineering/development projects are to be accounted for. Second, how are the impact of other characteristics of firms best captured through economic models? The role of research consortia is particularly important, although the presence of nuclear capacity, degree of product specialization, and impact of holding companies also warrant further attention.[5] Finally, how are R&D inputs related to innovative outputs (cost reductions and quality improvements) and the diffusion of new technologies? There have been some studies on these questions - but much more work needs to be done in this area.

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[5]After completion of this study, a report to the Nuclear Regulatory Commission was brought to my attention. In that study, Delaney and Honeycutt (again aggregating the observations to take corporate interrelationships into account) consider a proxy for R&D in the rate base, percentage of plant in service that was nuclear, a proxy for wholesale oriented utilities, an index of multistate operations, and other variables. Their variable, total sales to ultimate customers in rate-base inclusion states, did not perform as well as the dummy used here, but the positive impact was noted. They also analyzed the determinants of internal vs. external R&D, and obtained some interesting results. Since EPRI was not operating in 1972 (their sample year), they did not examine the impact of that consortia. Their discussion of time trends and cross firm patterns is recommended for those wishing an in-depth treatment of R&D issues.

# Bibliography


Baylor Law Review, Fall 1976 Vol. 28, No. 4, Public Utility Regulation in Texas--A Sumposium.

Bailey, Elizaveth, "Innovative and Regulation," Journal of Public Economics 3(1974) 285-295.

Capron, W.M., ed. Technological Change in Regulated Industries, Washington: Brookings Institution, 1971.

Delaney, James B. and Honeycutt, T. Crawford, "Determinants of Research and Development Activity by Electric Utilities: Comment," Bell Journal of Economics, Vol.7, No.2, Autumn, 1976, 722-725.

Delaney, James B. and Honeycutt, T. Crawford, "An Empirical Analysis of Electric Utility Research and Development Activity," NR-AIG-002, Office of Nuclear Reactor Regulation, July 1976.

Fisher, F.M. and Temin, P., "Returns to Scale in Research and Development: What Does the Schumpeterian Hypothesis Imply?" Journal of Political Economy January-February 1973, 81: 56-70.

Griliches, Z. "Issues in Assessing the Contribution of Research and Development to Productivity Growth," Bell Journal of Economics Spring 1979, Vol.10, No.1.

Holloman, J. Herbert and Grenon, Michel, Energy Research and Development (A Report to the Energy Policy Project of the Ford Foundation, Ballinger Publishing Company, Cambridge, Mass. 1975) xxi-264.

Lindgren, Nilo, "Chauncey Starr and the Building of EPRI," EPRI Journal January/February 1978.

Linhart, Peter B., Lebowitz, Joel L., and Sinden, Frank W., "The Choice Between Capitalizing and Expensing Under Rate Regulation," Bell Journal of Economics and Management Science, Autumn 1974.

Link, Albert N. "Optimal Firm Size for R&D Innovations in Electric Utilities," Journal of Economics and Business, Vol.31, No.1 Fall 1978, 52-56.

"Recent Cases on Research and Development Costs," Public Utilities Fortnightly, September 28, 1978, 56-58.

San Miguel, Joseph G. "The Reliability of R&D Data in COMPUSTAT and 10-K Reports," Accounting Review Vol.Lll, No.3, July 1977, 638-641.

Smith, Bruce A. "The Record of Individual Utilities' Dynamic Productivity: Some Initial Measurements," in Public Utility Productivity: Management and Measurement, ed. Ealter L. Balk and Jay M. Shafritz, New York State Department of Public Service, 1975.