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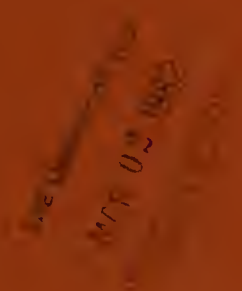
Edward Bubnys
Walter J. Primeaux, Jr.



College of Commerce and Business Administration
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Walter J. Primeaux, Jr., Professor
Department of Business Administration

Edward Bubnys
Illinois State University

Abstract

In an important publication in 1962, Eiteman brought statistical methods to bear in a study of the impact of public utility regulation on fifteen Bell Telephone Companies. After Eiteman's work, a number of additional statistical studies examined the rate base question; however, the focus of attention has been upon the effect of rate base methods on consumer prices or rates of return earned by the utility. This research is concerned with entirely different questions; the central question examined is how do different rate base regulatory regimes affect resource allocation and economic efficiency.

The paper uses a unique set of time series data for firms operating in states where rate base methods have changed anytime since World War II; consequently, firm effects are determined both before and after the change in regulatory regimes. Also, a new statistical approach was developed to assess the overall effect of changes in rate base methods.

RATE BASE VALUATION METHODS AND FIRM EFFICIENCY*

by

Edward Bubnys
Illinois State University
Normal, Illinois

and

Walter J. Primeaux, Jr.
University of Illinois
Urbana-Champaign, Illinois

INTRODUCTION

This study uses a new data set and a unique statistical procedure to evaluate the effects of different rate base methods on the economic performance of regulated firms.

Previously published studies have only used cross section data to assess the effect of rate base methods. However, regulation is imposed on individual firms and not upon the industry as an entity. Therefore, it seems that the relevant focus of attention of evaluative research should be on the firm, through time, and not a cross section of firms at a point in time. For that reason, the data of this study consists of time series information for individual firms located in all states where rate base methods have been changed sometime since World War II. This procedure, together with the specially-devised econometric method, makes it possible to examine the same individual firms operating under the constraints of both fair value and original cost rate base valuation.

PURPOSES OF THE STUDY

Several recent cases before the Illinois Supreme Court reflect current interest and concern about rate base valuation in the public utility rate determination process.[1] The opinions of all parties involved in those cases suggest that final operating results for a

utility firm would depend upon whether original cost or fair value rate base valuation is used in regulatory proceedings.

Some previous studies have attempted to assess the actual effects of different rate base methods on firm rates of return and prices charged to consumers. However, previous research has totally neglected the effects of different rate base methods on resource allocation and efficiency performance of firms subjected to different types of utility regulation. Such an evaluation is the central purpose of this study; the main objective is to determine whether different methods of rate base determination affect resource allocation and efficiency of electric utility firms. This is an important question because it is concerned with whether or not different forms of regulation affect the efficiency in which economic resources are used in the economy. The overall results show that some firms do modify their process of resource allocation, depending upon the regulatory regimes in which they operate; however, the results are not at all uniform and there seems to be no systematic relationship between changes in rate base method and their effect on resource allocation decisions.

PREVIOUS STUDIES

Studies of the economic effect of different rate base valuation methods emerged early in the history of electric utility regulation. However, as mentioned earlier, the focus of the previous research has been on prices paid by consumers and rates of return earned by utility firms. So, the previous research is only of indirect interest to this study.

In an important seminal paper, Eiteman[2] examined the impact of public utility regulation on fifteen Bell Telephone Companies. He found that original cost regulatory jurisdictions had permitted the highest rates of return on rate bases and firms operating in reproduction cost jurisdictions had permitted the lowest. Hagerman and Ratchford[3] reported similar results. Eiteman explained that the higher permitted rates had been only partially compensatory because actual rates of return to book value of securities have been highest for companies in reproduction cost jurisdictions and lowest in the original cost jurisdictions.[4]

Pike found that mean rate of return was 6.38 percent on net plant in original cost states and 6.3 percent where other valuation methods were used. The spread between earnings under different valuation methods had narrowed and was not statistically significant.[5]

Primeaux found that the three most commonly used methods of rate base determination resulted in firms earning approximately the same rates of return. The results were the same for both years (1967 and 1973) included in the sample.[6]

Primeaux, Bubnys and Rasche used time series data to examine the effect of differences in rate base methods in affecting real earnings, real prices and consumer welfare. The results show no support for the notion that firms generally fare better with respect to real realized earnings or real price levels under fair value instead of original cost rate base valuation.[7]

While the above studies examine important aspects of rate base valuation method, they do not examine matters of resource allocation and efficiency effects on firm decision making.[8]

III. THE THEORY

The rate making equation is as follows:

$$\text{Cost of service} = RR = E + d + T + (V-D)R \qquad (1)$$

where:

RR = revenue requirement of the firm

E = current operating expenses (excluding depreciation)

d = current depreciation expenses

T = current taxes

V = gross value of physical property

D = accrued depreciation

R = rate of return

(V-D) = rate base

(V-D)R = return amount

In the process of a rate case the firm is allowed to recover, through future rates charged for its services, all of the current operating expenses incurred, including current depreciation and taxes. Moreover, as indicated in the above rate making equation, the firm is also allowed to include in the rates charged for its services a component to cover (V-D)R. That is, the value of the rate base multiplied by a rate of return (this is the return amount).

Original cost jurisdictions value the (V-D) component in the equation at the value of the property when it was first installed in a public utility application. Fair value attempts to adjust the value of the (V-D) component to that level which more correctly reflects its

current value and reproduction cost attempts to adjust the value of the property to that level which would permit reproduction of the property.

The established rate base value (V-D), would generally be larger in fair value jurisdictions than in original cost states. Consequently, there would seem to be a greater incentive for a firm to require excessive capital stock in a fair value regime than in an original cost regime. This is especially true since the procedure involves an element of cost plus pricing which allows a utility firm to earn a larger accounting profit if its plant investment is larger. This tendency would cause two primary effects on the firms economic performance. First, it would cause available plant capacity to increase because a firm would tend to add larger amounts of capacity than it needs to satisfy consumer demand if it operates in a fair value regime instead of an original cost regime. Second, the level of capacity utilization would be expected to decline if a firm operates in a fair value regime because the excess capacity it installs would not be needed to satisfy consumer demand and would not be used.

PROCEDURE

As mentioned earlier, the sample consists of firms located in those states which changed the method of rate base determination anytime during the period 1948-1978.

The sample makes it possible to determine the reaction of the individual firms as they attempted to adjust to changes in rate base methods; in other words, as they made decisions under changing regulatory constraints. Instead of using cross section data, as was done in previous

studies, the decision was made to examine the effect of changes in rate base valuation methods on individual firms; therefore, the data consists of time series observations for a selected sample of firms which are unique.

Extreme care was taken to properly classify the firms included in the sample. This was deemed necessary due to inconsistencies in rate base valuation classifications found in various sources. The published rates base method for each state was validated by referring to six different sources to assure that the correct rate base method was used here.[9] The data were examined through time to ascertain which states had ever changed method during the period since WWII.

In some cases, there was ambiguity even after reviewing the above-mentioned references and state regulatory commissions were contacted to resolve remaining questions.

Overall, this review revealed that only four states had unambiguously changed during the 1948-1978 time interval. Alabama changed from fair value to original cost in 1971; Illinois changed from fair value to original cost in 1973; North Carolina changed from original cost to fair value in 1964 and Missouri changed from original cost to fair value in 1958. The fact that two states changes <u>to</u> original cost and two changed <u>from</u> original cost during the sample period tends to enhance the value of the data.

All possible privately owned firms from each of the four states changing rate base method during the 1948-1978 period were included in the sample. Since publicly owned firms are largely free of state regulation, and are sometimes given different regulatory treatment than

privately owned firms, they were excluded from the sample. The final sample consisted of one firm from Alabama, seven from Illinois, eight from Missouri, and four from North Carolina.

Some firms were excluded from certain equations because they were only generating companies and did not have residential sales and a few firms were totally omitted because of insufficient data.

A separate set of equations was run for each firm in the sample; ordinary least squares multiple regression analysis was the approach used to develop the basic equations. Two different reduced form equations (for capacity utilization and capital intensity) were developed for each firm to assess the effects of different rate base methods on resource allocation and efficiency.[10]

The econometric approach involved the following steps: first, the data for all sample observations were included in the reduced form equations for each individual firm. Second, an equation was run for each firm for each dependent variable, using only the long subsample of data. For example, in the state of Illinois, the rate base method was fair value for 1948-1972 and original cost from 1973 onwards. Consequently, the long subsample, for firms in that state, would consist of the fair value observations which occurred during the 1948-72 period. The long subsample period differed from state to state, depending on when the rate base valuation change took place. The residuals computed from these regressions were used in subsequent steps in the analysis.

In the third step, the long subsample regression was extrapolated (forward or backward, depending upon the situation) through the short

subsample time period and the mean error was computed for the short subsample. Fourth, the standard error of forecast was computed for each short subsample time period based on estimates for the long subsample. Fifth, under the assumption that the standard error of forecasts are independent across time, the standard error of the mean forecast error was computed during the short subsample period. Finally, the ratio of the mean error for the short subsample to the standard error of the mean forecast error was used to compute a t ratio for the mean forecast error of the short subsample. Each of the above six steps was followed for each dependent variable, for each firm in the sample.[11]

EMPIRICAL RESULTS

The reduced form equation for the rate base effects on firm resource allocation and efficiency is as follows:

$$LY = B_1 + B_2LGNP + B_3LVA + B_4LPOP + B_5LPE + B_6LC + B_7T + B_8LGP + B_9IT + U$$

where: LY = natural log of dependent variable, explained below

LGNP = natural log of real GNP, in billions of dollars

LVA = natural log of real value added by manufacturing, in billions of dollars

LPOP = natural log of state population, in thousands of persons

LPE = natural log of real production expenses, in dollars

LC = natural log number of ultimate consumers, by number of consuming units

T = a time trend, a linear index where 1948 = 0, 1949 = 1, ... 1978 = 30

LGP = natural log real natural gas price, state averages, in thousands of dollars per trillion BTUs

IT = a profitability trend for the industry (net income of all electric utilities in the U.S., divided by operating revenue of all electric utility firms in the U.S.)

U = a random disturbance term.

The data and its sources are discussed in the appendix. The procedure involved in this study generated a large number of regressions and variables. Only partial information is presented in the tables.

CAPITAL INTENSITY

As mentioned previously, a public utility firm may tend to use more capital in its rate base if the fair value method is used because the firm would be expected to earn a larger return with that type of valuation. To the extent that this does occur and to the extent that capital stock becomes excessive, the results constitute a misallocation of economic resources.

Table 1 presents some statistics extracted from the individual firm equations with log of real capital intensity as the dependent variable. As mentioned earlier, throughout the analysis, the size of the long subsamples used to develop the firm equations in each state depended upon the year in which the rate base method was changed.

The t statistics indicate whether the change in rate base method actually affected capital intensity. Table 1 shows that three of seven Illinois firms reduced capital intensity when the valuation method changed from fair value to original cost; three firms increased capital intensity, while one firm did not change as the regulatory regime changed. The three reductions are consistent with the theory while the other four results are inconsistent.

TABLE 1

LOG OF REAL CAPITAL INTENSITY
(Log Undepreciated Electric Utility Plant, Real Terms)
KWM Sales to Ultimate Consumers (In 000 kwh)

FIRM NAME	MEAN ERROR	STD. DEV.	t VALUE	n_L	R^2	D.W.
ILLINOIS: (Fair value, 1948-72; original cost, 1973-78)						
Central Ill. Light	.230	.125	1.83[b]	25	.67	1.13
Central Ill. Public Service	.138	.066	2.09[b]	25	.97	1.26
Commonwealth Edison	.144	.062	2.30[b]	25	.96	1.40
Illinois Power	-.091	.061	-1.50[c]	25	.98	1.97
Mount Carmel	-.004	.068	-.058	25	.98	2.68
Sherrard Power System	-.187	.031	-6.04[a]	25	.99	2.77
South Beloit	-.117	.050	-2.35[b]	25	.99	1.78
ALABAMA: (Fair value, 1948-70; original cost, 1971-78)						
Alabama Power	.226	.023	10.01[a]	23	.99	1.80
MISSOURI: (Original cost, 1948-57; fair value, 1958-78)						
Empire District Electric	-.605	.106	-6.00[a]	21	.96	1.15
Kansas City Power & Light	-.118	.035	-3.39[a]	21	.99	2.42
Missouri Edison	-.190	.066	-2.89[a]	21	.99	1.23
Missouri Power & Light	-.0006	.030	-0.02	21	.99	1.97
Missouri Public Service	-.949	.153	-6.22[a]	21	.97	1.62
Missouri Utilities	.201	.051	3.92[a]	21	.99	2.01
St. Joseph Light & Power	-.306	.082	-3.72[a]	21	.95	1.60
Union Electric	-.490	.102	-4.82[a]	21	.95	1.73
NORTH CAROLINA: (Original cost, 1948-63; fair value, 1964-78)						
Carolina Power & Light	.265	.023	11.73[a]	16	.99	1.90
Duke Power	.261	.051	5.08[a]	16	.94	2.06
Nantahala Power & Light	.065	.192	0.34	16	.79	2.89
Yadkin	1.357	1.111	1.22	16	.80	2.61

[a]1% level, [b]5% level, [c]10% level

Source: Extracted from complete equations containing all variables in the model.

The table also shows that the one Alabama firm increased capital intensity as the state changed from fair value to original cost rate making. This change is inconsistent with theoretical expectations.

In the case of Missouri, backward extrapolation was used to compute the mean error and standard deviation of the forecast because the short subsample occurs before the change in regulatory regimes. Table 1 shows that one firm used the same level of capital intensity under both types of regulation and another had a higher level of capital intensity under original cost than under fair value regulation; in contrast six firms reflected the opposite result. The six firms employing a higher capital intensity under fair value behaved consistent with theory while other results are contrary to theoretical expectations.

Two firms in North Carolina experienced higher levels of capital intensity after the change from original cost to fair value rate base valuation and two did not change. The two experiencing higher levels of capital intensity under fair value were consistent with theory.

All-in-all the results of changes of rate base valuation methods on capital intensity seemed somewhat mixed. A summary of the state-by-state results for the individual firms reveals that the change in capital intensity was in the direction expected from the theory in the case of eleven firms, while the theory failed in nine instances. The results are quite clear; there is no systematic pattern, as a whole, firms did not seem to make additions to their capital stock to take advantage of the more liberal form of regulation.

CAPACITY UTILIZATION

If firms add generating capacity in excess of their requirements, merely to gain from changes in rate base method valuation, excess capacity would be created. To the extent that excess capacity is created, it constitutes a misallocation of economic resources. That issue is examined in this section.

Table 2 presents selected information extracted from the individual firm equations with log of capacity utilization as the dependent variable. The same procedure as used in the previous section was used to determine whether excess capacity was created as firms increased their capital stock and take advantage of the more generous rate base valuation method. One would expect that the increase in capital stock, under these circumstances, would increase excess capacity because the increase would not be necessary to satisfy consumer demand. Obviously, increases in capital stock induced by a more intense consumer demand, is not at issue here. These types of adjustments would be made irrespective of the method of rate base determination; indeed, they are rather independent of regulation. So, it is the additional excess capacity, created as firms adjust to the changing regulatory regimes, which is of concern.

Table 2 shows extracts from complete equations when capacity utilization was used as the dependent variable. Results for firms in the state of Illionis show that two firms' capacity utilization increased when regulation changed from fair value to original cost rate making. This is consistent with theoretical expectations. At the same time,

TABLE 2

LOG OF CAPITAL UTILIZATION
(Log Net Generation (in 000 kwh))
Prod. Plants x 8760

FIRM NAME	MEAN ERROR	STD. DEV.	t VALUE	n_L	R^2	D.W.
ILLINOIS: (Fair value, 1948-72; original cost, 1973-78)						
Central Ill. Light	-.450	.189	-2.38[b]	25	.36	1.79
Central Ill. Public Service	.920	.162	5.66[b]	25	.74	2.48
Commonwealth Edison	.130	.086	1.51[c]	25	.86	1.80
Illinois Power	-.150	.142	-1.05	25	.65	2.20
Mount Carmel	-1.163	.221	-5.27[a]	25	.72	2.06
South Beloit	-.275	.229	-1.20	25	.38	1.65
ALABAMA: (Fair value, 1948-70; original cost, 1971-78)						
Alabama Power	.062	.059	1.05	23	.88	2.15
MISSOURI: (Original cost, 1948-57; fair value, 1958-78)						
Empire District Electric	.307	.120	2.56[a]	21	.64	1.42
Kansas City Power & Light	.267	.151	1,77[b]	21	.50	2.20
Missouri Power & Light	-1.240	.251	-4.94[a]	21	.98	2.46
Missouri Public Service	1.614	.602	2.68[a]	21	.55	2.89
Missouri Utilities	1.671	1.101	1.52[c]	21	.86	2.33
St. Joseph Light & Power	1.648	.167	9.86[a]	21	.86	1.82
Union Electric	-.020	.220	-0.09	21	.71	2.13
NORTH CAROLINA: (Original cost, 1948-63; fair value, 1964-78)						
Carolina Power & Light	.019	.084	0.22	16	.79	3.37
Duke Power	-.471	.075	-6.31[a]	16	.86	2.84
Nantahala Power & Light	-1.709	.124	-13.83[a]	16	.91	3.00
Yadkin	-1.152	.650	-1.77[a]	16	.62	1.99

[a]1% level, [b]5% level, [c]10% level

Source: Extracted from complete equations containing all variables in the model.

two firms experienced no change and two firms experienced decreased levels of capacity utilization. The results for the latter firms are inconsistent with theoretical expectations.

The table also shows that the one firm from the state of Alabama experienced no change in capacity utilization as that state changed from fair value to original cost rate making. This is not consistent with theory.

Table 2 also shows that five firms experienced decreased capacity utilization as Missouri changed from original cost to fair value rate base valuation. One firm experienced increases in capacity utilization and one experienced no change during that same time period.

Three firms experienced decreases in capacity utilization in North Carolina when that state changed from original cost to fair value rate base methods and one firm experienced no change in capacity utilization rates when this change was made.

Again, as with capital intensity, it cannot be concluded that utilities follow any systematic trend to change capacity in response to a valuation method change. While ten firms behaved here as expected, eight others did not.

CONCLUSIONS

The capital intensity and capacity utilization variables in this study are probably legitimate proxies for economic efficiency in terms of resource allocation. Certainly, it seems that if managers had adjusted those variables to take advantage of the benefits to their firms that they would have allocated too much capital to the production process and would have injected inefficiency into the process.

The results show that firms did not generally behave as theory would expect. That is, changes in regulatory regimes did not seem to make firms increase or decrease capital intensity so as to take advantage of the benefits they could gain by that type of change. It is true that firms may not be able to quickly change capital stock to take advantage of differences in the regulation process. However the lag time periods are long enough to permit adjustments to take place in the direction necessary to test the theory. Yet, the expected adjustments did not actually take place.

The results, then, are quite clear. There is no reason to believe that different rate base valuation methods induce differential inefficiency into the economic system because of the utility's attempt to benefit from the change in regulatory structure. This is not to say that regulation, as an institution, does not inject inefficiency into the system. Indeed, it may cause firms to become quite inefficient; however, that subject is not at issue here. The research was designed to test for relative efficiency under different regulatory regimes of rate base valuation.

FOOTNOTES

*We thank Robert H. Rasche for helpful comments concerning the statistical technique used in this paper.

[1]Union Electric Co. v. Illinois Commerce Commission (1978)--Ill 2d--381 N.E. 2d 1002; appeal: Union Electric Co. v. Illinois Commerce Commission (1979)--Ill. 2d--396 N.E. 2d 510; rehearsing denied Nov. 30, 1979. A similar case was Illinois Bell Telephone Co. v. Illinois Commerce Commission (1978)--Ill 2d--381 N.E. 2d 999; in Allstate Insurance Co. vs. Helen F. Elkins (1979)--Ill 2d--396 N.E. 2d 528 Justice Ryan in his dissent referred to the 1979 case. "In that case we held that the previous construction...precluded us from considering the relative merits of the 'original cost' method as against the 'fair value' method...we need not speculate which of the two methods we would accept 'were we writing on a clean slate'."

[2]D. K. Eiteman, "Interdependence of Utility Rate Base Type, Permitted Rate of Return, and Utility Earnings," Journal of Finance, March 1962, Vol. 17, pp. 38-52.

[3]Robert L. Hagerman and Brian T. Ratchford, "Some Determinants of Allowed Rates of Return on Equity to Electric Utilities," Bell Journal of Economics, Vol. 9, No. 1, Spring 1978, pp. 52-53.

[4]Eiteman, Op. Cit., p. 52.

[5]J. Pike, "Residential Electric Rates and Regulations," The Quarterly Review of Economics and Business, Summer 1967, Vol. 7, pp. 45-52.

[6]Walter J. Primeaux, Jr., "Rate Base Methods and Realized Rates of Return," Economic Inquiry, Vol. XVI, No. 1, 1978, p. 95-107.

[7]Walter J. Primeaux, Jr., Edward Bubnys and Robert H. Rasche, "Inflation and Rate Base Valuation," Faculty Working Paper No. 793, College of Commerce and Business Administration, University of Illinois at Urbana-Champaign, August 1981, p. 32.

[8]Yet the goal of efficiency is stated by some economists to be the paramount economic problem. See: Richard Caves, American Industry: Structure, Conduct, Performance (Englewood Cliffs: Second ed., 1962), pp. 104-105.

[9]The information was obtained from U.S. Federal Power Commission, Federal and State Commission Jurisdiction and Regulation of Electric, Gas and Telephone Utilities (Washington, D.C.: various years); Eiteman, op. cit.; Pike, op. cit.; Phillips, op. cit.; U.S. Senate, State Utility Commissions Summary and Tabulation of Information Submitted by the

Commissions. Document 56, 90th Cong., 1st sess., Washington, 1967; State of Arizona, Arizona Corporation Commission, Annual Report, June 1970.

[10]Several cost and demand studies influenced the development of the reduced form equation used in this study. The strongest influence was Gregg A. Jarrell, "The Demand for State Regulation of the Electric Utility Industry," The Journal of Law and Economics, Vol. XXI, October 1978, pp. 269-295.

[11]An alternative means for testing for a change in the reduced form equations coincident with the change of regulatory regimes would be the more conventional Chow tests. In those cases where the short subsample is less than the number of regressors this test is somewhat cumbersome, but not difficult to apply. The shortcoming of such tests, from the perspective of this investigation is that the test fails to reveal whether the real rate of return (or prices) goes up or down in those cases where the hypothesis of stability across the regimes can be rejected. In this sense the test is not constructive. The major caution to note concerning the test applied here is the assumption of independence of the forecast errors over time. If the regression residuals are seriously autocorrelated, our estimates of the standard error of forecast are biased upwards, and consequently our test would be biased in favor of failing to reject the hypothesis of no change in structure. However, in most of the regressions reported below there does not appear to be a serious autocorrelation problem.

APPENDIX

The Data and Sources

All data expressed in real terms were deflated by the implicit price deflator. The electric utility operating data were obtained from Statistics of Privately-Owned Electric Utilities in the United States (Washington, D.C.: U.S. Federal Power Commission, various years). Population data were obtained from Statistical Abstract of the United States (Washington: U.S. Government Printing Office, various years). GNP data was obtained from the Economic Report of the President, 1980 (Washington: U.S. Government Printing Office, 1979). Value added by Manufacturing came from two sources: Historical Statistics of the United States, Colonial Times to 1970 (Washington: U.S. Government Printing Office, 1975), and Statistical Abstract of the United States. Natural gas prices were obtained from revenue and physical sales data found in Gas Facts (American Gas Association annual reports, various years).