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WHAT CAN REGULATORS REGULATE? THE CASE OF ELECTRICITY

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THE literature of public regulation is so vast that it must touch on everything, but it touches seldom and lightly on the most basic question one can ask about regulation: Does it make a difference in the behavior of an industry?

This impertinent question will strike anyone connected with a regulated industry as palpably trivial. Are not important prices regulated? Are not the routes of a trucker and an airline prescribed? Is not entry into public utility industries limited? Is not an endless procession of administrative proceedings aging entrepreneurs and enriching lawyers?

But the innumerable regulatory actions are conclusive proof, not of effective regulation, but of the desire to regulate. And if wishes were horses, one would buy stock in a harness factory.

The question of the influence of regulation can never be answered by an enumeration of regulatory policies. A thousand statutes now forbid us to do things that we would not dream of doing even if the statutes were repealed: we would not slay our neighbor, or starve our children, or burn our house for the insurance, or erect an abattoir in the back yard. Whether the statutes really have an appreciable effect on actual behavior can only be determined by examining the behavior of people not subject to the statutes.

An order to a trucker not to haul goods between cities A and B is even more

difficult to assess. He may not wish to have this route, in analogy to the laws governing our personal behavior. But let him wish with all his heart to have it, and be denied; there still will be no economic effect of the regulation if others are allowed, in adequate number, to have the desired route.

The point at issue may be restated in the language of economics. An industry's output and price are normally governed primarily by the basic economic and technological determinants of supply and demand: by whether the demand curve is D_1 or D_2, and the supply curve S_1 or S_2 (see Fig. 1). Regulation will affect price and output only if it shifts the curves or the point on a curve where the industry operates. Does regulation introduce shifts in curves

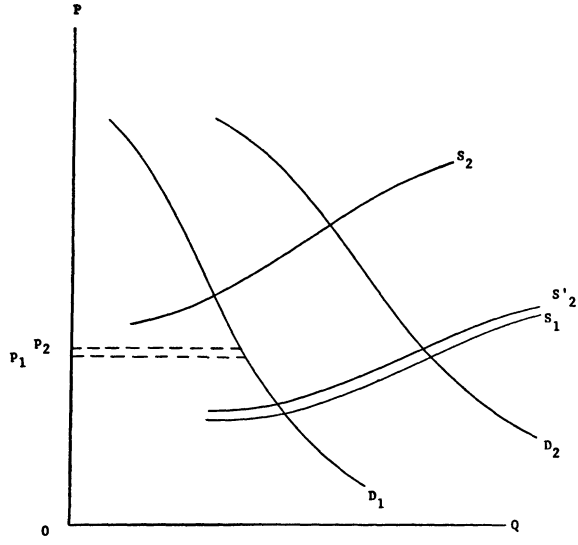

FIG. 1

of the magnitude of S_1 to S_2 or S_1 to S'_2? Then its effect will be negligible. Does regulation shift the effective operating point from p_1 to p_2? Then its effect will again be negligible.

The test of the economic effect of regulation is essentially independent of the content of the formal regulations. No degree of care in analyzing the regulations, or even their administration, will tell us whether they rubber-stamp or slightly heckle the state of affairs or substantially alter it.

What does one mean in saying that regulation has had large or small effects? He means that of the observed economic behavior in a cetrain industrial sector, a large or small part can be explained only by recourse to regulation. Consider these examples:

1. Is the decline of railroading due in any important part to ICC regulations? If in other economies with rising incomes and extensive adoption of automobiles

and trucks the railroad traffic shows a pattern similar to ours, then regulation has not been the primary influence.

2. Do utility commissions reduce the differential in prices of utility services to large and small buyers? If in a group of unregulated markets we observe a mean ratio of rates of large to small buyers of m_{nr}, and in regulated markets a ratio of m_r, do m_{nr} and m_r differ significantly? If of the total variance among markets in the ratio of rates of large to small buyers only 2 per cent can be explained by regulation, the regulations have negligible impact.
3. Do regulatory bodies succeed in preventing monopoly profits? We take it that they will usually prevent such profits from appearing explicitly in accounting statements. Whether they go beyond this may be judged, for example, by the fortunes of investors in stocks of regulated companies over periods extending from pre-regulation on, compared with those of investors in similar but unregulated enterprises.

These summary remarks will deceive no informed person as to the analytical and empirical complexity of the task of isolating the effects of regulation. They are intended only to suggest why one does not read the regulations to reach the answer.

We propose now to make an investigation of one regulated industry to explore techniques and hopefully reach tentative results. This is the electric utility industry. Here we face three major problems: (1) What firms are regulated? (2) What effects of regulation shall we study, and how shall we measure them? (3) How do we explain our findings?

I. When Is a Firm Regulated?

Every enterprise producing and distributing electricity has been regulated since its founding by way of charter limitations and franchises; its use of public thoroughfares was enough to insure this. It would therefore be possible to say that there is no unregulated sector to provide a base for judging the effects of regulation. This statement would not be acceptable to the professional writers on public utilities: they hail the beginnings of effective regulation with the establishment of the public service commissions in New York and Wisconsin in 1907.[1]

Yet these specialists have assuredly not faced the problem of measuring the effects of regulation, so their judgments are suspect. Indeed, if we accepted their judgments our problem would be solved, for they never question the importance of (effective!) regulation.

There is no substitute for an objective measure of regulation, and the one we choose is the creation of a special state commission endowed with the

[1] 2 L. S. Lyon and V. Abramson, Government and Economic Life 636 (1940); Twentieth Cent. Fund, Electric Power and Government Policy 65, 235 (1948).

power to regulate rates of electric utilities.[2] It may be complained that some of these commissions were long ineffective, or that municipal regulation was effective earlier in some states. Such assertions can only be tested by a study invoking another criterion of the existence of regulation: the year the commission issued its first rate order upheld by the courts, the year the commission first spent $100,000 or published 100 pages of orders, etc. But it is intrinsic to the problem that there be an independent criterion of regulation, and that findings on effectiveness be conditional on acceptance of that criterion. There is a strict analogy with the problem of estimating the influence of monopoly, where the result is conditioned by the criterion of monopoly (concentration ratio, number of firms, etc.).

The classification of states by the existence of regulatory commissions with jurisdiction over electric utilities is given in the Appendix in Table A1. The beginning of regulation by this criterion varied as shown in the accompanying tabulation. Two-thirds of the states had commissions by 1915, three-quarters by 1922.

	States
Before 1910	6
1910–20	29
1920–30	1
1930–40	3
1940–50	2
1950–60	2

II. The Effects of Regulation on Rates and Returns

There are two basic purposes of the public regulation of prices: the curtailment of the exercise of monopoly power and the elimination of certain forms of price discrimination. There will no doubt be other effects on prices, including unintended effects such as the short term rigidity of price commonly associated with regulation, but we shall concentrate upon these basic purposes. Our analysis of effects will be limited to the period up to 1937, simply because by that time 39 states had regulating commissions. By that date every unregulated state had at least two adjoining states with regulatory commissions, and even a showing of no difference in rates thereafter would be ambiguous: it could be argued that the threat of regulation was always latent in the unregulated states. This position does not seem wholly convincing to us—in a sense the threat of regulation was operative as soon as the Interstate Commerce Commission was created—but the small number of unregulated states after 1937 offers statistical support for this terminus.

[2] In our statistical work we measure regulation from three years after the creation of the commission, on impressionistic evidence of the lag involved in organizing the commission, hence all statements regarding, for example, states regulating in 1917 should be interpreted to refer to states initiating regulation no later than 1914.

THE LEVEL OF RATES

We shall make little use of the direct comparison of the average level of rates in regulated and unregulated states, of which a sample summary is given in Table 1.[3] The ambiguity of simple differences may be illustrated by the data for 1917. In this year the average revenue per KWH was 1.88 cents in regulated states and 3.20 cents in unregulated states, which might suggest that regulation lowered rates by almost 40 per cent. But we can classify the rates of these states in several years (see Table 2). This classification makes clear the fact that rates were lower on average in the regulating states, not only *after* but also *before* regulation.

TABLE 1

AVERAGE REVENUE PER KWH, STATES WITH AND WITHOUT REGULATION, 1912–37*

YEAR	REGULATED		UNREGULATED	
	States	Revenue (Cents)	States	Revenue (Cents)
1912.....	6	2.30	41	2.99
1917.....	31	1.88	16	3.20
1922.....	33	2.44	12	3.87
1927.....	35	2.85	10	4.21
1932.....	34	2.91	8	3.69
1937.....	34	2.32	6	3.04

* A state is considered regulated in a given year if commission regulation was established three years previously.

TABLE 2

	NUMBER OF STATES	AVERAGE RATE		
		1917	1912	1907
States instituting regulation before 1912.....	6	1.88	2.30	2.76
States instituting regulation from 1912 to 1917	25	1.88	2.30	2.93
States not regulating before 1917.....	16	3.20	4.07	4.34

[3] The complete average rates are reported in the Appendix in Table A2. These average revenues per kilowatt hour involve the following adjustments of census data: for 1907 to 1922 revenues include sales by private electric companies to ultimate consumers, domestic and industrial, plus net sales to out-of-state electric companies, municipal electric companies, and electric railroads, but exclude intercompany sales within states. KWH figures are for KWH's generated by private electric companies plus net purchases of KWH's from electric railroads or out-of-state electric companies. For 1927 to 1937 revenue and KWH data are for current sold to ultimate consumers, including gross sales to electric railroads but excluding all sales to other electric companies.

The basic fact is, of course, that regulation is associated with economic characteristics which also exert direct, independent influences on rates—the size and urbanization of the population, the extent of industrialization, etc. To isolate the effects of regulation we must take direct account of these economic factors. We do so by the following procedure.

The main determinants of the level of rates for an unregulated monopolist would be the size of the market and its density (which affect both production and distribution costs), the price of fuel, and the incomes of consumers. We approximate the market size and density by the population in cities with

TABLE 3

REGRESSION EQUATIONS OF AVERAGE REVENUE PER KWH AND OUTPUT ON URBAN POPULATION, COST OF FUEL, PER CAPITA INCOME, PROPORTION OF HP FROM HYDROELECTRIC, AND REGULATION, 47 STATES, 1922

Dependent Variable	Constant Term	Regression Coefficients and Their Standard Errors					R^2	
		Urban Population	Cost of Fuel	Per Capita Income*	Proportion of HP from Hydroelectric	Regulation	Including Regulation	Excluding Regulation
Average revenue per KWH.....	.0918	−.0592 (.0248)	.0604 (.1665)	.230 (.204)	−.498 (.083)	−.0109 (.0068)	.567	.540
Output.....	−.166	.395 (.052)	−.577 (.349)	.718 (.428)	.491 (.174)	.0172 (.0143)	.694	.684

* Linear interpolations between averages for the following years: 1919–21—Source: Maurice Leven, *Income in the Various States* (1925); 1929–31—Source: U.S. Office of Business Economics, *Personal Income by States since 1929*, Supplement to the Survey of Current Business, 1956.

25,000 or more population; the fuel costs by an equivalent BTU cost and by the proportion of power derived from hydroelectric sources; and consumer incomes by per capita state income. We fit the equation,

$$\log p = a + b \log U + c \log p_F + dH + e \log Y + fR ,$$

where

p = average revenue per KWH, in cents;
U = population in cities over 25,000 (in thousands);
p_F = price of fuel (in dollars per BTU equivalent ton of bituminous coal);
H = proportion of power from hydroelectric sources;
Y = per capita state income, in dollars;
R = dummy variable, 0 if an unregulated state, 1 if a regulated state.

The results of fitting this equation to 1922 data are presented in Table 3. The regression of millions of KW's of output, in logarithms, on these variables is also added.

The effects of regulation may be expressed in two ways: by the regression coefficient of the dummy variable representing regulation or by the difference in the coefficient of multiple determination including and excluding regulation. By either standard, regulation had no effect upon the level of rates in 1922.

For the other census years we use the abbreviated regression equations summarized in Table 4. No effect of regulation is observable through 1932. The 1937 equation does display a regulation effect, but it is localized in the

TABLE 4

REGRESSION EQUATION OF AVERAGE REVENUE PER KWH ON URBAN POPULATION, PER CAPITA INCOME, PROPORTION OF HYDROELECTRIC POWER AND REGULATION, 1912–1937

Year	Number of States	Constant Term	Regression Coefficients and Their Standard Errors				R^2	
			Urban Population	Per Capita Income*	Proportion Hydro-electric†	Regulation	Including Regulation	Excluding Regulation
	I. All Sales							
1912.....	47	.663	−.0291 (.0134)	.....	−.552 (.062)	.0028 (.0590)	.654	.654
1922.....	47	.730	−.0533 (.0240)	.....	−.508 (.081)	−.0708 (.0596)	.546	.531
1932.....	42	.380	−.0478 (.0144)	.141 (.090)	−.336 (.058)	−.0630 (.0409)	.580	.554
1937.....	39	.323	−.0486 (.0157)	.123 (.121)	−.257 (.059)	−.102 (.043)	.496	.413
	II. Sales to Domestic Customers							
1932.....	42	1.036	−.0044 (.0125)	−.0804 (.0781)	−.132 (.050)	−.0371 (.0358)	.286	.266
1937.....	39	.726	−.0223 (.0130)	.0187 (.1002)	−.146 (.409)	−.0337 (.0358)	.271	.251
	III. Sales to Commercial and Industrial Customers							
1932.....	42	.622	−.0496 (.0149)	.....	−.349 (.059)	−.0306 (.0391)	.546	.539
1937.....	39	.572	−.0520 (.0159)	.....	−.262 (.061)	−.0925 (.0417)	.493	.422

* Per capita income variable introduced only in years in which annual data are available.

† In 1912 and 1922, ratio of HP capacity of water wheels and turbines to HP capacity of all prime movers; in 1932 and 1937, ratio of KW capacity of hydroelectric to KW capacity of all generators.

sales to commercial and industrial consumers—the class of consumers that regulation was *not* designed to protect. We believe even this modest 1937 effect would be eliminated by a fuller statistical analysis.[4]

We conclude that no effect of regulation can be found in the average level of rates.

THE RATE STRUCTURE

We have examined two aspects of the rate structure for possible influences of regulation. The first is the ratio of monthly bills of domestic consumers for

TABLE 5

DIFFERENTIALS BY SIZE OF MONTHLY CONSUMPTION
1924 AND 1936

Year	Class of States	Number of States	Average Ratio of Larger to Smaller Monthly Bills
	A. 100 and 25 KWH per Month		
1924.....	Regulated	29	3.02
	Unregulated	10	3.25
1936.....	Regulated	30	2.79
	Unregulated	9	2.86
	B. 250 and 100 KWH per Month		
1924.....	Regulated	29	1.90
	Unregulated	10	2.15
1936.....	Regulated	30	1.83
	Unregulated	9	1.82

Source: U.S. Federal Power Commission, "Trends in Residential Rates from 1924 to 1936" (Washington, D.C.: 1937), Table 11. The observations are unweighted average rates for cities of over 50,000 population in each state.

larger amounts of electricity relative to smaller amounts. Here our expectation was that the regulatory bodies would recognize the greater potential political popularity of low rates for the numerous consumers who buy small quantities. The evidence is essentially negative (Table 5): in only one of four comparisons was the ratio of monthly bills significantly different in regulated

[4] The regression coefficient of regulation becomes non-significant if we shift from measuring urban population by the logarithm of population in cities over 25,000. A set of alternative regressions, reported in Tables A4 and A5, are also relevant; these equations employ total output and output per customer as independent variables, and thus raise identification questions which led to their replacement by those in the text, but seem worth reporting.

states from unregulated states.[5] The quantity rate structure for domestic consumers seems independent of the existence of regulation.

A second aspect of the rate structure where regulation might be expected to be influential is in the comparative charges to domestic and industrial buyers. The regulatory bodies would reduce domestic rates relative in industrial rates if they sought to reduce discrimination; the industrial users presumably have better alternative power sources and therefore more elastic demands. Or, again as a political matter, the numerous domestic users might be favored relative to the industrial users. To test this expectation, the average ratio of charges per KWH to domestic users to charges to industrial users was calculated for two years (see Table 6). The ratios are therefore directly opposite to those which were expected.[6] But a scatter diagram analysis reveals that the ratio of domestic to industrial rates depends primarily upon the average number of KWH sold to domestic customers divided by the

TABLE 6

AVERAGE RATIO OF DOMESTIC TO INDUSTRIAL PRICE PER KWH

	1917	1937
Regulated states.....	1.616 (29 states)	2.459 (32 states)
Unregulated states.....	1.445 (16 states)	2.047 (7 states)

average number of KWH sold to industrial customers, and the relationship does not differ between regulated and unregulated states.[7] Again no effect of regulation is detectable.

STOCKHOLDER EXPERIENCE

The final area to which we look for effects of regulation is investors' experience. Our basic test is this: Did investors in companies which were not regulated, or were regulated for only a few years, do better than investors in companies which were regulated from an early date?

To answer this question, we invest $1,000 in each electrical utility in 1907, reinvest all dividends and cash value of rights, and calculate the accumulated investment in 1920.[8] The year 1907 was chosen as the first date to reduce the

[5] In 1924 the ratio of bills for 250 and 100 KWH is barely significant at the 5 per cent level; the difference is opposite to that predicted as resulting from regulation.

[6] The 1917 difference is significantly different from zero at the 5 per cent level; the 1937 difference at the 10 per cent level.

[7] In 1937, 6 of 7 unregulated states had KWH per domestic buyer divided by KWH per industrial buyer above the mean of all states, but only 7 of 29 regulated states had ratios above the mean.

[8] A separate termination in 1918 yields the same results.

TABLE 7

MARKET VALUE IN 1920 OF INVESTMENT OF $1,000 IN 1907

(20 Electric Companies)

Year of Regulation	Company	Market Value in 1920	Relative Change in Sales, 1907–20 (Per Cent)
1887	*Massachusetts:*		
	Edison Electric Illuminating Co. of Boston	$1,689	246
	Lowell Electric Light Corporation	1,485	295
	New Bedford Gas & Edison Light Co.	1,528	164
	Edison Electric Illuminating Co. of Brockton	2,310	558
1907	*New York:*		
	Buffalo General Electric Co.	2,632	718
	Kings County Electric Light & Power Co.	2,356	279
	N.Y. and Queens Electric Light & Power Co.	1,059	225
1909	*Michigan:*		
	Detroit Edison Co.	4,273	1,412
	Houghton County Electric Light Co.	1,959	130
1910	*Maryland:*		
	Consolidated Gas, Electric Light & Power Co. (Baltimore)	6,547	286
	New Jersey:		
	Public Service Corp. of New Jersey	1,546	206
1911	*Ohio:*		
	Columbia Gas and Electric Co.	3,952	999
	Connecticut:		
	Hartford Electric Light Co.	2,028	728
	California:		
	Pacific Gas and Electric Co.	2,051	212
1913	*Illinois:*		
	Commonwealth Edison Co.	2,179	299
1914	*Pennsylvania:*		
	Philadelphia Electric Co.	4,254	296
Not regulated in 1920	Galveston-Houston Electric Co.	1,001	262
	Northern Texas Electric Co.	4,861	272
	El Paso Electric Co.	4,046	281
	Tampa Electric Co.	2,830	183

TABLE 8

REGRESSION EQUATIONS OF MARKET VALUE IN 1918 AND 1920 OF $1,000 INVESTMENT IN 1907, ON GROWTH IN SALES AND REGULATION*

(20 Electric Companies)

Terminal Year (t)	Constant Term	Growth in Sales	Regulation	R^2
1918.....	3.28	.332	−.015	.16
		(.227)	(.010)	
1920.....	3.27	.395	−.017	.21
		(.232)	(.010)	

* Market values in logarithms; growth in sales = log ($\text{sales}_t/\text{sales}_{1907}$).

possible impact of expectations of regulation, and even this date—which is later than we should like—reduced the number of companies we could trace to 20. The basic data are given in Table 7.

The pattern of increases in market values appears erratic. A simple regression of market value as a function of the increase in dollar sales of the utility system and the number of years of regulation is presented in Table 8. There is thus a slight, statistically insignificant effect of regulation on market values.[9]

III. Conclusion

Our study was undertaken primarily to investigate the feasibility of measuring the effects of regulation, but our inability to find any significant effects of the regulation of electrical utilities calls for some explanation. This finding is contingent upon our criteria of regulation and of the areas in which we sought effects, but both of these criteria are accepted by much of the literature of public utility economics.

The ineffectiveness of regulation lies in two circumstances. The first circumstance is that the individual utility system is not possessed of any large amount of long run monopoly power. It faces the competition of other energy sources in a large proportion of its product's uses, and it faces the competition of other utility systems, to which in the long run its industrial (and hence many of its domestic) users may move. Let the long run demand elasticity of one utility system be on the order of -8; then the system faces demand and marginal revenue curves such as those displayed in Figure 2. Given the cost curves we sketch, price will be MP.[10]

The second circumstance is that the regulatory body is incapable of forcing the utility to operate at a specified combination of output, price, and cost. As we have drawn the curves, there is no market price that represents the announced goal of competitive profits; let us assume that the commission would set a price equal to average cost at some output moderately in excess of output OM, say at R. Since accounting costs are hardly unique, there is a real question whether the regulatory body can even distinguish between costs of MS and MP. Let the commission be given this knowledge; then the utility can reduce costs below MS by reducing one or more dimensions of the services which are really part of its output: peak load capacity, constancy of current, promptness of repairs, speed of installation of service. It can also manipulate its average price by suitable changes in the complex rate structure (also

[9] An analysis of variance was also made of Table 7, grouping states into four classes, by year of regulation: 1887, 1907–1910, 1911–1914, not regulated in 1920. No significant effect of regulation was found.

[10] An elasticity of -8 implies that a utility will set prices 14 per cent above marginal cost. In the constant cost case, given a capital/sales ratio of 4, rates of return will exceed the competitive level by $3\frac{1}{2}$ per cent.

with effects on costs). Finally, recognize that the cost curve falls through time, and recognize also the inevitable time lags of a regulatory process, and the possibility becomes large that the commission will proudly win each battlefield that its protagonist has abandoned except for a squad of lawyers. Since a regulatory body cannot effectively control the daily detail of business operations, it cannot deal with variables whose effect is of the same order of

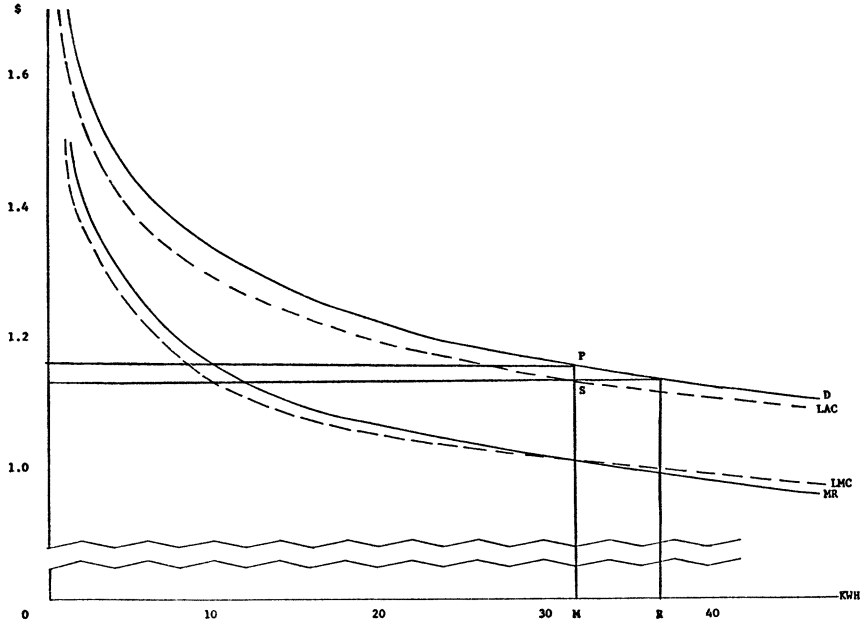

FIG. 2

magnitude in their effects on profits as the variables upon which it does have some influence.

The theory of price regulation must, in fact, be based upon the tacit assumption that in its absence a monopoly has exorbitant power. If it were true that pure monopoly profits in the absence of regulation would be 10 or 20 per cent above the competitive rate of return, so prices would be on the order of 40 or 80 per cent above long run marginal cost, there might indeed be some possibility of effective regulation. The electrical utilities do not provide such a possibility.

APPENDIX

TABLE A1

DATES OF CREATION OF STATE COMMISSION ELECTRIC RATE JURISDICTION

State	Date of Electric Rate Jurisdiction	State	Date of Electric Rate Jurisdiction
Alabama	1915[a, b]	Nevada	1911
Arizona	1912	New Hampshire	1911[f, c]
Arkansas	1935[c, d]	New Jersey	1910
California	1911	New Mexico	1941[o]
Colorado	1913[e]	New York	1907[f]
Connecticut	1911[f, g]	North Carolina	1913
Delaware	1949	North Dakota	1919
Florida	1951	Ohio	1911[j]
Georgia	1907	Oklahoma	1913[p]
Idaho	1913	Oregon	1912
Illinois	1913	Pennsylvania	1914[f]
Indiana	1913	Rhode Island	1912
Iowa	[h, i]	South Carolina	1922[q]
Kansas	1911[j]	South Dakota	[h]
Kentucky	1934	Tennessee	1919
Louisiana	1934[k]	Texas	[h]
Maine	1913	Utah	1917
Maryland	1910	Vermont	1908
Massachusetts	1887[g, l]	Virginia	1914[r]
Michigan	1909[j]	Washington	1911
Minnesota	[h]	West Virginia	1913
Mississippi	1956	Wisconsin	1907
Missouri	1913[f, g]	Wyoming	1915[g]
Montana	1913	Washington, D.C.	1913
Nebraska	[m, n]		

Source: State laws, statutes, Public Utility Commission reports; Bonbright and Co. and F. P. C. surveys, and correspondence with commission, unless otherwise noted.

[a] No jurisdiction to change existing contracts.

[b] No jurisdiction over contracts with municipalities.

[c] Approves changes in rates only (i.e., new rates).

[d] "Concurrent jurisdiction" with municipalities. Commission hears appeals.

[e] 1921 Court decision: no authority in cities controlling public utilities under home-rule amendment of 1912. Denver (a home-rule city) voted to surrender control to commission in early 1950's. Number of home-rule cities in which commission has no jurisdiction is given as 13 in 1954.

[f] Sets maximum rates only.

[g] Power to investigate upon complaint only.

[h] None through 1960.

[i] Authority outside cities, 1954.

[j] Municipalities fix rates; commission hears appeals only.

[k] Power to fix rates in New Orleans, and other cities voting to surrender control, from 1921 on, subject to optional powers of municipalities. Primary control shifted from municipalities to state commission in 1934.

[l] Source: Barnes, I, "Public Utility Control in Massachusetts," 1930, p. 96. Requirement to furnish information to Gas and Electric Commission begins 1908.

[m] None in cities through 1960.

[n] Most companies are public.

[o] Commission had jurisdiction in cities under 10,000 population from 1921 on.

[p] Right to change rates fixed by municipal franchise established by 1915 court decisions.

[q] Jurisdiction over maximum electric rates, on complaint, granted in 1910, but no rate cases reported. In 1922, power of commission extended to allow fixing of rates on own motion. 1922 report indicates jurisdiction over electric utilities considered "recent" by commission.

[r] Excludes services rendered to a municipal corporation in 1914. In 1918, power strengthened so that utilities cannot change rates without commission approval.

TABLE A2

AVERAGE REVENUE PER KWH BY STATE, IN CENTS, 1907–37

State	1907	1912	1917	1922	1927	1932	1937
Maine	1.90	1.42	1.51	1.62	2.06	1.96	2.03
New Hampshire	2.36	1.69	1.78	3.92	4.39	3.80	3.03
Vermont	2.62	1.91	2.21	1.89	*	*	*
Massachusetts	4.66	3.96	2.82	3.23	3.74	3.79	3.05
Rhode Island	4.50	3.44	2.32	2.32	*	*	*
Connecticut	3.50	3.53	2.64	3.25	3.46	3.56	2.81
New York	2.19	2.22	1.86	2.09	2.58	3.05	2.21
New Jersey	4.17	2.71	2.50	3.22	4.04	3.97	3.03
Pennsylvania	3.49	2.22	1.50	2.15	2.40	2.55	1.96
Ohio	3.38	2.75	1.85	2.36	2.60	2.73	2.01
Indiana	3.18	2.86	2.42	3.02	2.89	3.11	2.24
Illinois	2.94	2.28	1.93	2.24	2.62	2.68	2.20
Michigan	2.22	1.89	1.46	2.01	2.40	2.67	1.94
Wisconsin	3.67	2.36	1.82	2.43	2.77	3.18	2.41
Minnesota	2.74	2.76	1.74	2.85	3.14	3.15	2.63
Iowa	5.44	5.23	1.29	1.94	3.72	3.79	2.66
Missouri	3.57	3.56	2.86	3.10	2.83	2.64	2.22
North Dakota	5.69	6.52	7.05	6.73	8.02	6.01	4.36
South Dakota	3.35	4.03	5.41	5.58	7.27	5.65	4.33
Nebraska	4.44	4.41	3.11	3.59	3.57	3.24	2.78
Kansas	2.20	1.77	2.08	2.68	3.27	3.29	2.66
Virginia	3.05	2.40	1.72	1.88	2.44	2.65	2.22
West Virginia	2.44	2.32	1.55	1.36	*	*	1.59
North Carolina	2.70	1.08	1.34	2.12	1.30	1.79	1.59
South Carolina	1.07	.86	.48	1.01	1.54	1.65	*
Georgia	1.23	1.45	1.13	1.27	1.97	2.19	*
Florida	5.94	4.91	4.54	5.24	5.51	4.59	3.90
Kentucky	4.01	3.65	3.38	3.55	3.20	3.12	2.30
Tennessee	3.61	2.78	.70	2.04	2.40	1.90	1.99
Alabama	2.92	2.22	.79	1.22	1.66	1.69	*
Mississippi	4.08	3.38	3.66	4.66	4.67	3.59	*
Arkansas	5.84	5.50	4.01	4.33	4.46	3.22	2.64
Louisiana	4.53	3.86	3.27	5.26	3.05	2.55	2.06
Oklahoma	4.32	4.37	3.24	3.39	3.26	3.12	2.36
Texas	4.82	4.38	2.94	3.18	3.09	2.82	2.36
Montana	1.57	.84	.74	.81	*	*	*
Idaho	4.85	1.22	1.37	.70	2.00	2.06	1.56
Wyoming	5.51	5.08	3.32	4.97	5.17	4.49	3.64
Colorado	2.57	2.49	2.09	2.85	3.39	4.10	3.10
New Mexico	5.66	4.93	4.93	5.32	7.15	*	*
Arizona	5.72	3.12	2.65	2.59	2.53	*	*
Utah	9.01	1.42	.98	4.41	*	*	*
Nevada	1.14	1.34	1.46	1.65	2.54	2.70	2.47
Washington	1.06	2.57	1.66	1.41	1.51	1.45	1.44
Oregon	1.94	2.09	2.11	1.39	2.09	2.10	1.89
California	1.97	1.39	1.29	1.57	2.18	2.20	1.82

Source: U.S. Bureau of the Census, Census of Electrical Industries, quinquennial.

* Not presented separately to avoid disclosure of information for individual establishments. Where data for two or more adjoining states are presented, the combined data were used provided the states in the combination had the same regulation status in the year under consideration. Rates for combinations employed are as follows: Vermont and Rhode Island, 1927 = 3.44, 1932 = 3.54, 1937 = 2.81; Montana and Utah, 1927 = 1.08, 1932 = 1.94, 1937 = 1.13; Delaware, Maryland, and Washington, D.C., 1907 = 3.68, 1912 = 3.22, 1917 = 2.01, 1922 = 2.52, 1937 = 1.95; Delaware, Maryland, Washington, D.C., and West Virginia, 1927 = 2.39, 1932 = 2.35. Combinations of Delaware with adjoining states do not meet the above criterion but are included because Delaware's rated horsepower capacity is less than 10 per cent (in 1927) of the total for either combination.

TABLE A3

AVERAGE REVENUE PER KWH BY STATE AND TYPE OF CUSTOMER, IN CENTS, 1932 AND 1937

STATE	DOMESTIC		COMMERCIAL AND INDUSTRIAL	
	1932	1937	1932	1937
Maine	6.4	5.3	1.4	1.5
New Hampshire	7.3	5.6	2.9	2.4
Vermont and Rhode Island	7.0*	5.8*	2.7*	2.2*
Massachusetts	6.1	5.3	3.0	2.4
Connecticut	5.5	4.6	2.8	2.3
New York	6.2	5.0	2.4	1.8
New Jersey	7.3	5.5	3.1	2.4
Pennsylvania	5.9	4.6	2.0	1.6
Ohio	5.4	3.9	2.2	1.6
Indiana	6.0	4.7	2.5	1.8
Illinois	5.3	4.3	2.0	1.8
Michigan	4.4	3.5	2.2	1.6
Wisconsin	5.4	3.8	2.6	2.0
Minnesota	5.7	4.1	2.6	2.2
Iowa	6.6	5.0	2.8	2.1
Missouri	4.9	3.9	2.2	1.8
North Dakota	7.0	4.7	5.4	4.2
South Dakota	7.1	5.1	4.9	3.9
Nebraska	5.7	4.6	2.7	2.3
Kansas	5.5	4.9	2.5	2.1
Delaware, Maryland, and Washington, D.C.	†	3.8*	†	1.6*
Delaware, Maryland, Washington, D.C., and West Virginia	5.0*	.....	1.9*	.....
Virginia	5.6	4.1	2.0	1.8
West Virginia	†	4.4	†	1.3
North Carolina	5.8	3.8	1.4	1.4
South Carolina	5.6	*	1.4	*
Georgia	5.4	*	1.8	*
Florida	6.7	5.3	3.6	3.2
Kentucky	6.2	4.2	2.5	1.9
Tennessee	6.2	3.4	1.4	1.7
Alabama	5.3	*	1.4	*
Mississippi	6.6	*	3.0	*
Arkansas	7.3	5.7	2.6	2.2
Louisiana	7.6	5.7	1.9	1.6
Oklahoma	6.3	5.3	2.6	1.9
Texas	6.2	4.8	2.3	1.9
Montana and Utah	4.8*	4.0*	1.6*	.9*
Idaho	3.6	3.1	1.7	1.3
Wyoming	6.8	6.1	3.8	3.0
Colorado	6.1	5.5	3.4	2.5
New Mexico	*	*	*	*
Arizona	*	*	*	*
Nevada	5.0	4.2	2.3	2.1
Washington	2.7	2.7	1.3	1.2
Oregon	3.2	2.8	1.7	1.6
California	4.3	3.8	1.8	1.5

Source: U.S. Bureau of the Census, Census of Electrical Industries, quinquennial.

* Not presented separately to avoid disclosure of information for individual establishments. See Table A2, footnote, for criterion for inclusion.

† See combined data for Delaware, Maryland, Washington, D.C., and West Virginia.

TABLE A4

REGRESSION EQUATIONS OF AVERAGE REVENUE PER KWH* ON OUTPUT, OUTPUT PER CUSTOMER, INCOME, AND REGULATION, 1907–37

YEAR	NUMBER OF STATES	REGRESSION COEFFICIENTS AND THEIR STANDARD ERRORS					R^2	
		Constant Term	Output†	Output per Customer‡	Per Capita Income§	Regulation	Including Regulation	Excluding Regulation
1907.....	45	.502	.0039 (.0427)	−.628 (.072)	.0882 (.1279)	.....	‖	.737
1912.....	47	.648	−.0237 (.0649)	−.702 (.089)	.0497 (.2032)	.0112 (.0816)	.701	.701
1917.....	47	1.061	−.0268 (.0357)	−.631 (.060)	−.138 (.141)	.0269 (.0346)	.850	.848
1922.....	47	.928	−.0155 (.0282)	−.692 (.051)	−.0662 (.1055)	.0283 (.0350)	.890	.889
1927.....	45	1.157	−.0274 (.0188)	−.664 (.048)	−.118 (.071)	.0029 (.0252)	.921	.921
1932.....	38	.772	−.0383 (.0167)	−.700 (.049)	.0479 (.0548)	−.0219 (.0195)	.907	.903
1937.....	38	.655	−.0456 (.0145)	−.672 (.047)	.0876 (.0545)	−.0210 (.0180)	.921	.917

* Cents, in logarithms.
† Millions of KWH's, in logarithms.
‡ Thousands of KWH's, in logarithms.
§ Dollars, in logarithms.
‖ Not computed because only Massachusetts was regulated.

TABLE A5

REGRESSION EQUATIONS OF AVERAGE REVENUE PER KWH* ON OUTPUT, OUTPUT PER CUSTOMER, AND INCOME, BY TYPE OF CUSTOMER, 1932 AND 1937

YEAR	NUMBER OF STATES	CONSTANT TERM	REGRESSION COEFFICIENTS AND THEIR STANDARD ERRORS				R^2	
			Output†	Output per Customer‡	Per Capita Income§	Regulation	Including Regulation	Excluding Regulation
	I. Sales to Domestic Customers							
1932.....	37	.628	−.0492 (.0145)	−.807 (.068)	.0407 (.0509)	−.0140 (.0193)	.843	.840
1937.....	38	.522	−.0520 (.0110)	−.807 (.056)	.0835 (.0450)	−.0270 (.0145)	.882	.870
	II. Sales to Commercial and Industrial Customers							
1932.....	37	.969	−.0382 (.0312)	−.694 (.120)	.....	−.0565 (.0362)	.630	.603
1937.....	38	.870	−.0541 (.0278)	−.602 (.113)	.....	−.0380 (.0352)	.668	.657

* Cents, in logarithms.
† Millions of KWH's, in logarithms.
‡ Thousands of KWH's, in logarithms.
§ Dollars, in logarithms.