Faculty Working Papers

COMPETITION, PRICES AND X-EFFICIENCY

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of Business Administration

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College of Commerce and Business Administration
University of Illinois at Urbana-Champaign

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Summary:

The purposes of this study were (1) to assess the magnitude of price effects whenever an electric utility firm faces direct competition from another electric utility firm and (2) to observe these price effects of competition compared with X-efficiency effects on costs.

The results support the presence of lower prices with competition which accompany the elimination of X-efficiency, as hypothesized by Leibenstein. However, the results show that firms did not recoup all of the price concessions they granted because of competition. This suggests that firms were unable to generate sufficiently large cost economies to offset the price reductions caused by competitive pressure.

COMPETITION, PRICES AND X-EFFICIENCY

By Walter J. Primeaux, Jr.

INTRODUCTION

In his most recent contribution to economics, Harvey Leibenstein points out that regulation of natural monopolies presents very complex problems which are far from solved.[1] Leibenstein says: "Somehow the regulatory means must include elements that induce the monopoly to try to achieve approximately as low levels of X-inefficiency as are achieved, at least on the average, by competitive industries." He does not embark upon the very complex task of inventing regulatory systems for the regulation of monopolies but he does recognize the importance of the problem of "natural monopoly". He explains that his analytical apparatus shows up the inadequate and social wasteful results of current regulation of some monopolies.[2]

Of course in this economy competition usually provides a regulatory function over prices; and competition's decline in the early history of the utility industries, caused concern about possible abuses by unregulated monopoly and this condition generated a climate for the imposition of state regulation.[3]

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*Jon Nelson, Robert Rasche, Patrick Mann, John Mikesell, Julian Simon, Daniel Hollas, Milton Kafoglis, and John Moorehouse read an earlier version and offered suggestions for improvement.

[1]Harvey Leibenstein, Beyond Economic Man (Cambridge: Harvard University Press, 1976, pp. 252-253.

[2]Ibid., p. 253.

[3]Burton N. Behling, Competition and Monopoly in Public Utility Industries (Urbana: University of Illinois, 1938, pp. 18-28.

One important purpose of "natural monopoly" regulation is to control prices charged for public utility services. Yet very little is known about the actual effect of commission regulation on the prices charged for utility services. A previous study assessed the effects of X-inefficiency on electric utility costs[4] but the accompanying price effects, by using direct competition as a regulator, have not been determined. This past deficiency was caused largely by the general lack of knowledge by economists that competition does exist in the electric utility business and data are available to test the effects of rivalry in a "natural monopoly" environment.[5] The purposes of this study were (1) to assess the magnitude of price effects whenever electric utility firms face direct competition and (2) to observe how these price effects of competition compared with the X-efficiency effects on costs examined in a previous study.

The results support the presence of lower prices with competition which accompany the elimination of X-inefficiency, as hypothesized by Leibenstein.[6] However, the results show that firms did not recoup all of the price concessions they granted because of competition. This suggests that firms were unable to generate sufficiently large cost economies to offset the price reductions caused by competitive pressure.

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[4]Walter J. Primeaux, Jr. "An Assessment of X-Efficiency Gained Through Competition," The Review of Economics and Statistics, Vol. LIX, No. 1, February, 1977.

[5]Walter J. Primeaux, Jr. "A Reexamination of the Monopoly Market Structure for Electric Utilities," in Promoting Competition in Regulated Markets, Almarin Phillips (ed.) (Washington: The Brookings Institution, 1975, pp. 175-200).

[6]Leibenstein, op. cit., p. 207.

PREVIOUS STUDIES

Individual studies by several economists have assessed the impact of competition between natural gas and electricity by examining differences in economic performance between monopoly electric firms competing with monopoly gas firms. These results were then compared with combination firms, that is, those which sell both gas and electricity and do not face a substitute. These studies are useful and interesting; however, they have only focused upon the high degree of substitutability of these two types of energy for some uses as the source of competition among firms[7] and they are not concerned with the effects of direct competition. Moreover, they were not preceded by studies of X-efficiency and costs, so these relative effects were not developed or compared.

The effects of direct competition existing between two electric utility firms in the same city have been generally overlooked by economists. A notable exception is an important study by Richard Hellman.[8] Hellman examined government competition with privately owned electric firms. He also presents case studies of a number of cities where direct competition

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[7]See: Franklin H. Cook, "Competitive Price Economies of Combination Utilities," Public Utility Fortnightly, January 19, 1967, LXXIX, pp. 34-36; Bruce M. Owen, "Monopoly Price in Combined Gas and Electric Utilities," Antitrust Bulletin, May 1970; Irwin M. Stelzer and Bruce C. Netschert, "Hot War in the Energy Industry," Harvard Business Review, Volume 45, Nov.-Dec. 1967, pp. 14-26 and 190-92; Joe D. Pace, "The Relative Performance of Combination Gas Electric Utilities," Antitrust Bulletin, Volume 17, Summer 1972, pp. 519-65; J. W. Wilson, "Residential Demand for Electricity," Quarterly Review of Economics and Business, Spring 1971, pp. 7-22; Paul S. Brandon, "The Electric Side of Combination Gas-Electric Utilities," Bell Journal of Economics and Management Science, Volume 2, Number 2, Autumn 1971.

[8]Richard Hellman, Government Competition in the Electric Utility Industry: A Theoretical and Empirical Study (New York: Praeger Publishers) 1972.

has existed between two electric utility firms. While Hellman's is an interesting study and does present price comparisons, it does not develop a rigorous statistical analysis. Therefore, his conclusions regarding price effects of monopoly vs. competition should be examined more fully. Moreover, he does not examine X-efficiency effects generated from competition.

One study examined the average costs of electric utility firms facing direct competition and concluded that firms facing rivalry actually operated at lower average costs than monopolists. This study concluded that average cost is reduced, at the mean, by 10.75% because of competition. This reflects a quantitative value of the presence of X-efficiency gained through competition; or the loss caused by the absence of competition in a regulated environment.[9] However, the price effects of this competition were not developed.

Another study examined price rigidity in this type duopoly but did not examined price effects of competition or the X-efficiency effects of this rivalry.[10]

While some of the above studies do examine competition in a "natural monopoly" environment, they are clearly not concerned with the central issues investigated by this study.

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[9]"An Assessment of X-Efficiency..., op. cit.," p. 107.

[10]Walter J. Primeaux, Jr. and Mark R. Bomball, "A Reexamination of the Kinky Oligopoly Demand Curve," Journal of Political Economy, July/August 1974, pp. 851-862.

THE THEORY

Residential prices of electricity are affected by a number of variables which can be broadly categorized as demand and cost factors.

The income of the buyer is an important determinate of consumption and thus affect price levels. With higher customer incomes, the utility firm is able to exact higher customer prices for its services.

The price of natural gas should also affect prices charged for electric services. For many uses, natural gas can be substituted for electricity; this capability should put downward pressure on electricity prices.

The price of electricity should be affected by consumer density in the service area. Since the number of customers per square mile affects distribution costs, a higher density should be reflected in a lower consumer price and vice versa.

Production costs of the electric utility also affect electricity prices. Costs of fuel and other production expenses (including purchased power) would be included in the costing formula used by those responsible for making the pricing decisions and rate schedules. Higher costs per kilowatt would obviously result in higher residential prices.

In addition to the production expenses, mentioned above, other operating expenses would also affect price levels because higher expense levels would cause firms to charge higher prices. These costs would be also included in the pricing formula used to construct rate schedules.

The composition of customer types should also affect rate schedules. There is a different cost mix in serving residential consumers compared with commercial and industrial consumers. This is an important consideration because those establishing rate schedules must consider the common costs associated with producing electricity for residential, commercial, and industrial uses. One would expect the price to be lower as the proportion of residential consumers increases. These results are supported by previous research by the author.[11]

Climatic factors also affect the demand and price of electricity because seasonal variations cause differences in cooling and heating requirements of customers served by electric firms. These variances affect capacity costs for the supplying firms and affect the price schedules.

Competition should also affect electric rates. If the rivalry is vigorous and if costs are not higher with competition, lower consumer prices should result.

METHODOLOGY

As mentioned earlier, there is very little discussion of electric utility duopolies in the literature even though there actually are cities with competing electric utility firms.[12]

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[11] In a study of average costs of firms of the same type in a very similar sample, the variable for consumption per residential consumer possessed a larger negative coefficient than the coefficient for commercial and industrial consumption per customer. See "A Reexamination of the Monopoly Market Structure for Electric Utilities," op. cit.

[12] F. Steward Brown, then Chief, Bureau of Power of the Federal Power Commission, revealed in correspondence to the author dated July 29, 1969, that direct competition between two electric utility firms existed in forty-nine cities. The data are as of January 1, 1966, for cities with a population of 2,500 or larger.

Data from the existing duopoly markets provided the information for assessing the impact of competition upon price levels charged by electric utility firms. In the duopolistically competitive cities, there was actual duplication of electric facilities. The usual arrangement was that a privately owned electric firm competed with a municipally owned firm. Supply conditions were such that the consumer had a choice of being served by one firm or the other. In the Texas and Missouri cities, for example, a customer could switch from one firm to the other at will. In Portland, Oregon, on the other hand, new customers could take service from either company. However, once they had selected a firm they could not switch from one electric supplier to the other. Cities where territories are allocated and duplication of facilities does not exist were not included in the study.[13]

It was not possible to obtain data for the individual cities served by privately owned firms. This difficulty was caused because privately owned electric utilities do not allocate or report sales and revenue data according to the individual cities in which they operate; therefore, the data necessary for an adequate examination of privately owned firms are not available. Since privately owned firms usually serve several cities

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[13] A case study of competition between two electric firms in a single city is presented in Walter J. Primeaux, Jr., "A Duopoly in Electricity: Competition in a 'Natural Monopoly'," The Quarterly Review of Economics and Business, Vol. 14, Summer 1974, pp. 65-73.

and face competition in some communities and not in others, published data for privately owned firms are not useful for this study.[14]

For the above reasons, and because privately owned firms are generally regulated by state regulatory commission,[15] it was decided to focus attention on cross section data for two subsets of municipally owned firms, each firm operating in a different city. Firms in the duopoly subset established prices in the face of rivalry, the other group set prices in a monopoly environment and competition did not affect price levels. Data from these two subsets of firms would indicate relative price levels of firms in monopoly and duopolistically competitive markets.

Generally, a "matched" firm without competition was selected for every firm with competition. The criteria used to select the matched firms were as follows: First, to the extent possible, the matched firm should be from the same state as the firm with which it would be paired. Second, the matched firm should be approximately the same size as the firm with which it would be paired; if no such firm existed in the relevant state, a larger firm was accepted; competitive firms were never matched with smaller firms. Third, to the extent possible, types of

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[14] Price data for block rates of privately owned firms are presented in Typical Electric Bills (Washington: Federal Power Commission). However, operating data published by the Federal Power Commission, which could be useful for an examination of privately owned firms, are not allocated to the individual cities in which the firms operate. Thus, they are not useful in this study.

[15] This analysis does not attempt to answer any questions concerning the effectiveness of utility regulation. Since municipally owned utility prices are controlled, if at all, by some local commission, regulatory affects are minimized by following this procedure.

power sources should be identical for both matched firm and the competitive firm.

The matching procedure was used to select a noncompetitive subset to be compared with the duopolistically competitive subset. The matching was undertaken because, first, it was thought that it would reduce heteroscedasticity and the variance in the error term in regressions. Second, if the matched firm was selected from the same state as the firm with competition, some interstate price differences not picked up by the estimating equations might be eliminated. Third, if the matched firms were at least as large as the competitive firms, any price differences due to scale effects not picked up by the estimating equations would tend to bias the results of the analysis in favor of those cities without competition. Hence the results of the study are more conservative.[16] Fourth, if the types of power sources for the competing and noncompeting firms were matched, price differences due to supply characteristics which may not have been picked up by the estimating equations would tend to be eliminated.

It was not possible to adhere to the guidelines for matching firms in all cases. Municipally owned firms from the cities listed in column one of Table 1 filed F.P.C. reports and operating data are published in Statistics of Publicly Owned Electric Utilities in the United States. These firms

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[16]In some cases the bases of the matching were more important in the "A Reexamination of the Monopoly Market Structure" study than in this paper. The sample in this investigation is not identical to that in that study; however, the same basic sample was used. It was necessary to eliminate some firms contained in that study, because data were not available for the variables used in this analysis. The unmatched data in Table 1 resulted from the elimination of some firms for reasons mentioned above but retaining the matched city.

constitute the subset of competing electric enterprises. Other competing publicly owned firms were eliminated because data were not available.[17] Data from 1967 were used because a previous study indicated that this was a stable year for making comparisons;[18] moreover, it was feared that more recent data may have been affected by inflation.

Column two of Table 1 presents the cities from which the matched municipally owned monopoly firms were selected. As indicated, it was not always possible to select matched firms from the same state for all competing electric companies. Table 1 also presents the relative size of the firms in terms of kilowatt-hour sales. The crucial matching test with respect to size involved the sales volume (annual KWH) of the competitive and noncompetitive firms.

THE REGRESSION MODELS

Ordinary Least Squares regression analysis was used to examine the effects of competition and monopoly on residential prices of firms included in the sample. Price functions were specified for residential prices. These equations made possible the assessment of the effect of market structure differences on prices of electricity.

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[17] Lincoln, Nebraska, and Hagerstown, Maryland are included in the sample even though competition did not exist in those cities in 1967. This was justified because it was believed that any competitive effects would have continued to that year. Hagerstown prevented customers from switching to the competitive firm as of September, 1967. Competition terminated in Lincoln, Nebraska in 1965. The inclusion of all competitive firms would have required the use of unpublished data which the F.P.C. considered too incomplete to justify publication.

[18] Patrick C. Mann and John L. Mikesell, "Tax Payments and Electric Utility Prices," The Southern Economic Journal, July, 1971, p. 71.

The price schedules for firms selling to residential consumers are determined by demand variables, as well as cost conditions, faced by the selling firms. The specification of the residential price function is a reduced form equation:

$$P = A + B_1 INCOME + B_2 \%RES + B_3 EXKWH + B_4 PRCOST + B_5 CLIMI + B_6 CLIMII + B_7 CLIMIII + B_8 DCOM + B_9 GAS + B_{10} DENSITY$$

Where all variables are in linear form and P, the dependent variable, is a price variable which consists of several different definitions, depending upon the equation specified.

Price Variables (Dependent Variables)

MP_1 = Marginal price between the 250 KWH typical electric bills rate and the 500 KWH typical electric bills rate.

MP_2 = Marginal price between the 500 KWH typical electric bills rate and the 750 KWH typical electric bills rate.

MP_3 = Marginal price between the 750 KWH typical electric bills rate and the 1000 KWH typical electric bills rate.

Y_1 = Average residential price; sales revenue/KWH sold.

Cost and Demand Variables (Independent Variables)

INCOME = Mean county estimated buying income per household.

GAS = Average gas price-state.

DENSITY = Number of customers per square mile.

%RES = Ratio of total residential sales to total commercial and industrial sales.

EXKWH = Operating and maintenance expense per KWH.

PRCOST = Production expenses per KWH.

CLIMI = A regional climatic dummy variable for the corn belt area.[19]

CLIMII = A regional climatic dummy variable for the Dakota-New England area.

CLIMIII = A regional climatic dummy variable for the humid Northwest area.

DCOM = The dummy variable, 1 if duopoly, 0 if monopoly.

Data sources and a more extensive discussion of the variables are presented in the Appendix. As developed in the theory section, the coefficient on the %RES variable and the DENSITY variable should be negative and the coefficient on all other variables except DCOM should be positive. The appropriate sign for the climatic dummy variables is not obvious. The omitted dummy variable is for the cotton belt, so the signs on these dummy variables would reflect relative price levels with those in the cotton belt climatic region.

The appropriate sign on the competition dummy variable is also not obvious. If competition causes lower electricity prices the sign should be negative; however, if competition results in higher electricity prices, the sign should be positive.

RESULTS

The residential equations were estimated by using cross section data as outlined in the earlier section on methodology.

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[19] A more detailed description of the climatic variables is presented in the Appendix.

Table 2 shows the best specification of the equations using either the average price or marginal prices as the dependent variables.[20] T statistics appear in parentheses below the coefficients in Table 2 and the equations are in linear form. The signs for all variables included in the four equations in Table 2 conform to expectations.

Interestingly, the signs of the coefficients of the competition dummy variable for the equations in Table 2 are all negative indicating that competition caused the price of residential electricity to be lower with competition, regardless of whether a marginal or average price variable is used as the dependent variable.

The coefficient on the competition dummy variable for the MP_1 price is negative but not statistically significant; however, the coefficient on the competition dummy variable for the MP_2, MP_3 and Y_1 prices are all negative and statistically significant. The low $\bar{R}^2$ and the insignificant t statistics on the competition dummy variable in the MP_1 equation in Table 2 probably reveal that for small blocks of consumption demand and cost variables are less important than social considerations in establishing electricity prices.

The four equations in Table 2 reflect that the impact of competition on residential electricity prices is quite significant. As mentioned

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[20]The GAS variable and DENSITY variable were not statistically significant and did not increase the explained variance when they were included in the equation. Density effects were actually picked up in the interaction variable, see footnote 16.

The gas price data were state average prices. Since the sample included a larger number of relatively small cities, it was impossible to obtain gas price data for those individual cities. Perhaps this explains why the gas variable was unimportant and frequently had the wrong sign on the coefficient.

earlier the marginal price of moving from the 250 KWH block to the 500 KWH block (MP_1) is statistically insignificant. However, the marginal price of moving from the 500 KWH block to the 750 KWH block (MP_2) is lowered by $1.34 because of competition and the marginal price of moving from the 750 KWH block to the 1000 KWH block (MP_3) is lowered by $2.25. The average price (average revenue) is lowered by $6.3133 per 1000 KWH because of competition.[21] At mean prices for the sample, these decreases amount to sixteen percent and nineteen percent respectively for the marginal price. The average price (Y_1) was lowered by thirty-three percent.

Interaction variables were used to determine whether the effect of competition had influenced the slope coefficients of the economic variables. These variables were constructed by multiplying the competition dummy variable by the economic variables in the equation.

Only the interaction variable (%RES*D) constructed by multiplying the competition dummy variable by the %RES variable was statistically significant indicating that only the slope coefficient of that variable was affected by competition. Table 3 presents the statistics necessary to test the hypothesis that all coefficients of the interaction variables were zero, except the variable for %RES. The results show that the

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[21] To ensure that the results were not caused by the inclusion of very large firms not facing competition, the equations were reestimated excluding the four monopoly cities considerably above mean size. No important differences appeared. The signs on all variables were consistent with those in equations including the whole sample. The effects of the elimination of these observations on the competition dummy variable were very slight. The MP_2 price was lowered by $1.59 instead of $1.34; the MP_3 price was lowered by $2.36 instead of $2.25; and the Y_1 price was lowered by $7.17 instead of $6.31. Consequently, inclusion of the four largest cities did not bias the results in favor of competition; indeed, the effect was the other way around.

hypothesis cannot be rejected (that is, the calculated F value of .18797 is less than the F-table value for 27 degrees of freedom in the denominator and 3 degrees of freedom in the numerator). Thus it was necessary to modify the basic equation only by adding the %RES*D interaction variable to reflect the effects on price of competition. As mentioned earlier, the competition dummy variable was not affected by competition for the MP_1 equation; all interaction variables in the equation for this price variable were similarly unaffected by competition.

The change in slope coefficients for all but equation (1) in Table 2 indicates that price is affected by market structure differences because of some characteristic which is different in the competitive subset of firms compared with the monopoly subset. This change reflects the increased distribution costs of residential consumer sales with competition. This effect is due to the lower customer density with competition which causes upward pressure on costs and prices as utility firms must provide distribution facilities through a given area to serve fewer customers than if monopoly existed.[22]

The change in the slope coefficient of the %RES variable reveals that for the duopoly firms, price tends to be higher as the ratio of total residential sales to total commercial and industrial sales increases.

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[22]As mentioned in footnote 14, the DENSITY variable, reflecting the number of customers served per square mile, was used in the equation to pick up the effects on price of density differences. However, this variable did not add the explained variance because this difference between the two sample subsets is reflected in the interaction variable.

Computations show that the duopoly price is lower as long as the ratio is $\leq$ .43 for the MP_2 price. The duopoly price will also be lower than the monopoly price as long as the ratio of total residential sales to total commercial and industrial sales is $\leq$ .42 for the MP_3 price. The average price, Y_1, will be lower under duopoly than under monopoly as long as the ratio is $\leq$ .45.

CONCLUSIONS

Prices of electricity are lower with competition than in a monopoly market structure. These price differences are substantial. The marginal price between the 500 and 750 KWH blocks is lower by sixteen percent because of competition; the marginal price between the 750 and 1000 KWH blocks is lower by nineteen percent because of competition; and the average price (average revenue) is lower by thirty-three percent because of competition. These results provide a measure of the effect of monopoly on the prices consumers pay and an assessment of the effect of competition as a regulator of utility rates.

These results also call for a reexamination of the natural monopoly argument for protection of electric utilities from competition. Fundamental arguments for providing electric utilities with monopoly territories include the proposition that public utility competition results in higher costs of providing services and higher consumer prices. The above analysis shows lower prices rather than higher prices with competition.[23] Although there are other, less objectionable reasons why

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[17]"A Reexamination of the Monopoly Market Structure," op. cit., found lower costs with competition.

electric utilities are not permitted to compete, closer examination may show that they too may really be unimportant. At any rate, it seems that the natural monopoly concept should be reevaluated.

These results also provide some interesting insight into firm adjustments to competition both on the price and on the cost side of their business. Electric utility firms facing competition were forced to lower prices to increase or maintain their market shares in the face of prospects that consumers will transfer their business to rivals unless the offering price is competitive.[24] At mean prices, these decreases amounted to sixteen percent (MP_2), nineteen percent (MP_3) and thirty-three percent (average price Y_1). In contrast, a previous study[25] revealed that for a very similar sample average cost is reduced at the mean by 10.75 percent because of the elimination of X-inefficiency through competition.[26] These results show that firms were unable to recoup all of the price concessions they were forced to grant because of competition; indeed the necessary price concessions exceeded the benefits gained through increased efficiency by a rather wide margin.

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[24] This is consistent with the more extensive discussion in Leibenstein op. cit., p. 207.

[25] See footnote 16.

[26] "An Assessment of X-Efficiency..., op. cit.," p. 107.

APPENDIX

Sources of Data

Price Variables

Data for marginal prices were obtained from Typical Electric Bills (Washington: Federal Power Commission, 1967).

Marginal prices were computed by taking the difference between one rate block and the next largest rate block. The marginal price, therefore, is the price of moving into the next rate category.

The average price or average revenue data were taken from Statistics of Publicly Owned Electric Utilities (Washington: Federal Power Commission, 1967). The average price data were computed by dividing total residential dollar sales by the number of KWH sold to residential consumers.

Cost and Demand Variables

Data for the INCOME variable are the estimated mean buying income per household--county average. These data are from Sales Management, Survey of Buying Power, 1968.

The GAS price variable data were taken from Gas Facts, 1968. The variable was constructed by dividing state total gas sales by MCF sales to obtain an average price per MCF. Data for individual cities included in the sample were unavailable.

The DENSITY variable was constructed by dividing the number of square miles in each city into the number of residential customers served by each firm. Land area in square miles was taken from the U. S. Department of Commerce, Area Measurement Reports, various years. Numbers of customers were taken from Statistics of Publicly Owned Electric Utilities in the U.S.

The %RES variable is the ratio of total KWH sales made to residential consumers. Data are from Statistics of Publicly Owned Electric Utilities in the U.S.

The EXKWH variable is operating and maintenance expense per KWH. Data are from Statistics of Publicly Owned Electric Utilities in the U.S.

The PRCOST variable represents production expense per KWH. This cost includes purchased power costs, in addition to production expense. Data are from Statistics of Publicly Owned Electric Utilities in the U.S.

The climatic dummy variables group firms in the sample from similar climatic areas. The Dakota-New England Area: Winters very cold and snowy, summer mild and rainy. The Corn Belt Area: Winters - moderately cold and snowy, summers hot and rainy. The Cotton Belt: Winters - cool and rainy, summers hot and rainy. The Humid Northwest: Winters - cool and rainy, summers mild and rainy. These classifications are taken from World Book Encyclopedia (Chicago: Field Enterprises, 1950), Vol. 17, p. 8294. A map delineates the various climatic areas of the U.S.; for this study, only the above areas are relevant.

TABLE 1
CITIES FROM WHICH MUNICIPALLY OWNED ELECTRIC UTILITIES WERE SELECTED FOR THE STUDY (SIZE IN TERMS OF THOUSANDS KWH SOLD-1967)[a]

CITIES WITH COMPETITION	KWH SALES	MATCHED CITIES-WITHOUT COMPETITION	KWH SALES
Bessemer, Alabama	96,897	Florence, Alabama	408,069
Tarrant City, Alabama	57,014	Scottsboro, Alabama	81,784
Fort Wayne, Indiana	301,026	Richmond, Indiana	357,959
Maquoketa, Iowa	16,531	Algona, Iowa	25,940
Hagerstown, Maryland	102,330	Bristol, Virginia	196,344
Allegan, Michigan	15,775	Niles, Michigan	59,974
Bay City, Michigan	92,518	Wyandotte, Michigan	108,391
Dowagiac, Michigan	20,964	Hillsdale, Michigan	63,027
Ferrysburg, Michigan[b]	130,620	Lansing, Michigan	1,179,935
Traverse City, Michigan	64,094	Sturgis, Michigan	66,935
		Petoskey, Michigan	28,463
Kennett, Missouri	34,281	Rolla, Missouri	45,201
Poplar Bluff, Missouri	58,362		
Trenton, Missouri	24,699		
Lincoln, Nebraska	124,026[c]	Omaha, Nebraska	2,343,826[c]
Cleveland, Ohio	521,191		
Columbus, Ohio	166,771	Springfield, Illinois	501,079
Piqua, Ohio	121,818	Logansport, Indiana	119,687
Springfield, Oregon	166,103	Eugene, Oregon	1,123,796
Greer, South Carolina	42,931	Greenwood, South Carolina	67,829
		Watertown, South Dakota	53,944
Garland, Texas	303,914	San Antonio, Texas	2,913,818
		Springfield, Missouri	583,488

[a] Statistics of Publicly Owned Electric Utilities in the United States (Washington: Federal Power Commission, 1967). Data for municipally owned firms in each city were for the year 1967, unless other years are indicated.

[b] This city is served by Grand Haven Board of Light and Power and Consumers Power Company.

[c] Competition terminated in 1965, therefore, 1965 sales were used for matching cities.

TABLE 2
RESIDENTIAL PRICE FUNCTION
AVERAGE AND MARGINAL PRICES

Equation	Dependent Variable	DCOM	INCOME	%RES	EXKWH	PRCOST	CLIMI	CLIMII	CLIMIII	%RES*D	DF	CONSTANT	$\bar{R}^2$
(1)	MP1	-.1560 (-.5537)	.0001 (.1723)	-2.0517 (-1.7418)**	.1969 (1.5738)**	.0679 (1.0399)	.2272 (.2581)	-.3353 (-.4488)	-.0956 (-.1150)		31	2.2961	.0258
(2)	MP2	-1.3388 (-1.5787)**	.0012 (2.4147)***	-2.7061 (-1.8676)	.0754 (.6729)	.0938 (1.6030)**	1.2842 (1.6266)**	.7966 (1.1856)	1.0967 (1.4727)*	3.1146 (1.6191)**	30	-1.3253	.4679
(3)	MP3	-2.2528 (-2.3593)***	.0015 (2.6258)***	-3.4404 (-2.1038)**	.0258 (.2051)	.1491 (2.2638)***	1.6516 (1.8580)**	.9679 (1.2793)*	1.0101 (1.2048)	5.5529 (2.5637)***	30	-2.1011	.5147
(4)	Y_1	-6.3133 (-1.6893)**	.0037 (1.6431)**	-22.0517 (-3.4534)***	1.0415 (2.1075)**	.7971 (3.0913)**	7.4618 (2.1446)**	3.8107 (1.2869)*	3.6599 (1.1152)	13.8819 (1.6375)**	30	3.1938	.6377

N = 40
t statistics in parentheses
*** significant at .01 level
** significant at .05 level
* significant at .10 level

TABLE 3
F-TEST STATISTICS OF CROSS SECTION DATA
WITH INTERACTION VARIABLES IN THE EQUATION

Regression	Standard Error	Degrees of Freedom	Mean Square Error	Sum of Squared Residuals
Equation 2 in Table 2, including all interaction variables	.73700	27	.54317	14.6657
Equation 2 in Table 2, including only %RES*D interaction	.70644	30	.49906	14.9720
Difference		3		.3063

$$F_c = \frac{\frac{.3063}{3}}{.54317} = \frac{.1021}{.54317} = .18797 < F^{3}_{27} \ (.01) \simeq 4.60$$