ELECTRICITY DEMAND AND THE FINANCIAL PROBLEMS OF ELECTRIC UTILITIES

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The purposes of demand analysis of electricity consumption are two-fold. First, to determine the relative magnitudes of the various economic factors which influence electricity demand and the nature of the time path of response in demand to changes in these factors. Second, to analyze the nature of the response of demand to economic policies and demographic patterns which may be followed in utility service areas and by Federal and State agencies.

1. Economic Factors Influencing Electricity Demand

Recent work by Mount, Chapman, Tyrrell (1), Anderson (2), Halvorsen (3), Houthakker and Verlager (4), and Wilson (5) have provided generally satisfactory answers to the problems posed by the first question. In an approximate ordering, the most important factor seems to be electricity prices, followed by population, and then the remaining factors, including personal and national income and the prices of competing fuels.

The method employed to estimate the magnitudes of the parameters of these factors is termed econometrics. It is the application of regression analysis to economic statistics. Simply stated, an econometric analysis puts a qualitative, verbal logic about the nature of consumer behavior into mathematical language. It seeks to define the best possible predictive model for some set of historical data. Typically, an econometric investigation begins by collecting empirical data on consumption, prices, income, and population for particular sets of customers in a defined collection of geographic areas for a number of time periods. The analysis then employs a computer algorithm to estimate numerical values for all the unknown parameters in the demand relationship. These estimates are the most appropriate for the given data set under a clearly defined statistical criterion.

To date, the best studies seem to be those which have used a basic logic and estimating techniques which are comparable in complexity to the problem being addressed. The best studies employ demand functions which have some time path structure, use a large number of economic variables, separate the three major consumer classes, analyze differences in geographic areas such as states and time series data over many years, and employ statistical techniques of appropriate sophistication.

Tables 1 and 2 show recent estimates by Mount as reported in a study of a National Power Survey Task Force group (6). Table 1 shows the coefficients as they would actually be employed in forecasting. Table 2 is presented for ease of interpretation: it shows the "elasticities" which may be calculated from Table 1. Basically, an elasticity is a ratio of percentage changes: approximately the percent change in demand which would eventually follow from a one percent change in an explanatory variable. The value of -1.17 in Table 2 for the long run elasticity of residential demand with respect to its price implies that if other factors are unchanged, a one percent increase in residential price would cause in the long run a 1.17 percent decrease in residential demand. Also shown in Table 2 is the conclusion that 27 percent of the long run response would occur in the first year with declining but proportional responses in later years. It should be emphasized that elasticities are attributes of a demand model and cannot themselves be used in forecasting. For forecasting purposes, the coefficients shown in Table 1 must be used in association with forecasts of future values of the explanatory factors.

Table 1. Estimated Demand Models for Electricity

	Explanatory Variable[a]	Class of Customer					
		Residential		Commercial		Industrial	
1.	Quantity demanded in the previous period	.734	(42.8)[b]	.554	(22.3)[b]	.727	(33.5)[b]
2.	Number of customers	.270	(13.3)	.412	(9.4)	.178	(7.0)
3.	Real income per capita	.163	(6.4)	.101	(1.9)	.088	(1.1)
4.	Price of electricity	-.311	(14.9)	-.544	(11.3)	-.272	(6.8)
5.	Price of gas	.008	(.8)	0		0	
6.	Price of fuel oil }	.163	(2.7)	.288	(2.1)	.025	(2.0)
7.	Price of coal }					.030	(1.7)
8.	Price of electric appliances or machinery	0		0		-.043	(.2)
9.	Unit labor cost	-		.452	(4.1)	.283	(1.8)
10.	Wholesale price index	-		1.151	(3.5)	1.399	(3.9)
11.	Gross national product	-		-		.137	(1.7)
12.	Degree of urbanization	-.003	(4.0)	-.004	(2.2)	.003	(1.8)
13.	Price ratio for electricity[c]	.032	(1.9)	.039	(1.1)	-.008	(.4)
14.	Proportion of customers in the residential sector	.080	(.3)	2.238	(3.1)	-	
15.	Proportion of customers in the industrial sector	-		-4.125	(1.5)	-25.307	(5.0)

a/ All variables in dollar units are deflated. Variables numbered 12, 14 and 15 are not transformed to natural logarithms.

b/ The absolute values of the ratio between the estimated coefficient and standard error are given in parentheses.

c/ This is the ratio between the marginal and average prices.

Table 2. Estimated Long-Run Elasticities for Electricity Demand

Explanatory Factor	Class of Customer		
	Residential	Commercial	Industrial
1. Number of customers	1.01	.92	.65
2. Income per capita	.61	.23	.32
3. Price of electricity	-1.17	-1.22	-1.00
4. Price of gas	.03	.00	.00
5. Price of fuel oil	.61	.64	.09
6. Price of coal			.11
7. Gross National Product[a/]	-	-	.50
Proportion of the response occurring in the first year	.27	.45	.27

a/ Income per capita is a measure of affluence within each state, whereas the gross national product is a measure of national affluence. Both are included in the model for the industrial sector.

2. Demand Forecasts

In developing a demand forecast, the investigator must resolve the problem of sources of forecasts of explanatory variables. Should he make his own prediction of population, income, and GNP growth or use those of specialists in those fields? In general, we believe that objectivity requires the use of independent forecasts. Population and real income per capita projections for each state were taken from the Bureau of Economic Analysis (7). These projections imply overall growth rates of 1.4 and 2.9 percent per year for population and real income per capita, respectively, although actual projected growth rates vary considerably between states. The number of customers is specified as a fixed proportion of population in each state. The per capita income growth assumptions correspond to a four percent increase of real GNP per year. The real prices of gas, fuel oil and coal are specified to increase at rates of seven, nine and seven percent per year, respectively, which are in general agreement with the rates anticipated by the recent MIT Energy Laboratory Study (8). This in turn is assumed to lead to an increase of five percent per year in the real price of electricity. All other variables in the models are held at their 1972 levels. For variables measured in money units such as unit labor costs, this implies that their growth is the same as the rate of inflation.

Under these specifications, consumption levels for the three consumer classes in each state can be projected to 1980. Other consumer classes are accounted for by assuming that this consumption is a fixed proportion of total consumption in each state. A similar assumption is made to cover transmission losses. In this way, the total quantity of electricity generated in each of the different NERC (National Electric Reliability Council) regions can be forecast. The regions are as shown in Figure 2. In Table 3 the results are reported. Also shown are current forecasts by the NERC Councils (9).

We believe that the exponential growth plans of the utilities indicated in the NERC projections are incorrect, and predict substantially higher growth than will in fact occur. The only mechanism by which 7.5 percent growth could be approached would be by declining real prices of electricity comparable to the real price declines of the 1950's and 1960's. In an era of increasingly scarce and expensive fuel and rising environmental protection costs, this is simply unrealistic. We note further that fertility rates in the United States have been below the "zero population growth" rate for two years, a pattern which if continued has important implications for demand growth in the remainder of the century.

Turning again to Table 3, we may translate the demand analysis forecast of 2.2 trillion KWH into approximate capacity additions. If we assume a national aggregate system load factor of 62.5 percent, and a reserve margin averaging 20 percent, it follows that the demand analysis suggests a capacity increment from 1972 to 1980 of 105,000 MW. If $325 per KW is a representative cost, the implied investment is $34 billion. Obviously this estimate is dramatically less than the hundreds of billions of dollars which are the present basis for planning (10).

3. Past and Future Crises

As we now know, energy conservation efforts by electric utility customers were instrumental in avoiding serious rationing last winter. Figure 1 shows the dramatic reduction in power use in the crisis period.

Table 3. Demand Forecasts, Billion KWH

Region[a]	Actual Generation 1972	Predicted Generation 1974 Electric Councils	Predicted Generation 1974 Demand Analysis	Predicted Generation 1980 Electric Councils	Predicted Generation 1980 Demand Analysis
NPCC	170.2	189.1	181.4	283.0	207.4
MAAC	140.7	164.2	146.5	246.6	162.8
SERC	350.0	423.0	384.9	679.7	450.6
ECAR	308.0	324.6	331.6	493.9	378.3
MAIN	129.8	149.4	139.7	227.9	159.8
SWPP	137.7	152.8	155.2	252.9	182.3
ERCOT	106.1	122.0	124.2	208.9	146.4
MARCA	62.2	71.3	68.2	111.1	78.0
WSCC	330.4	384.7	372.4	565.5	445.1
TOTAL U.S. [b]	1,735.1	1,981.2	1,904.2	3,069.7	2,210.7

a/ See Figure 2.

b/ Excluding Alaska and Hawaii.

Sources: (6) and (9). Actual U. S. generation by utilities in 1973 was 1,848.5 billion KWH.

FIGURE I. POWER GENERATION AND CONSERVATION: ELECTRIC POWER PRODUCTION BY UTILITIES, 1973-74 AND 1972-73

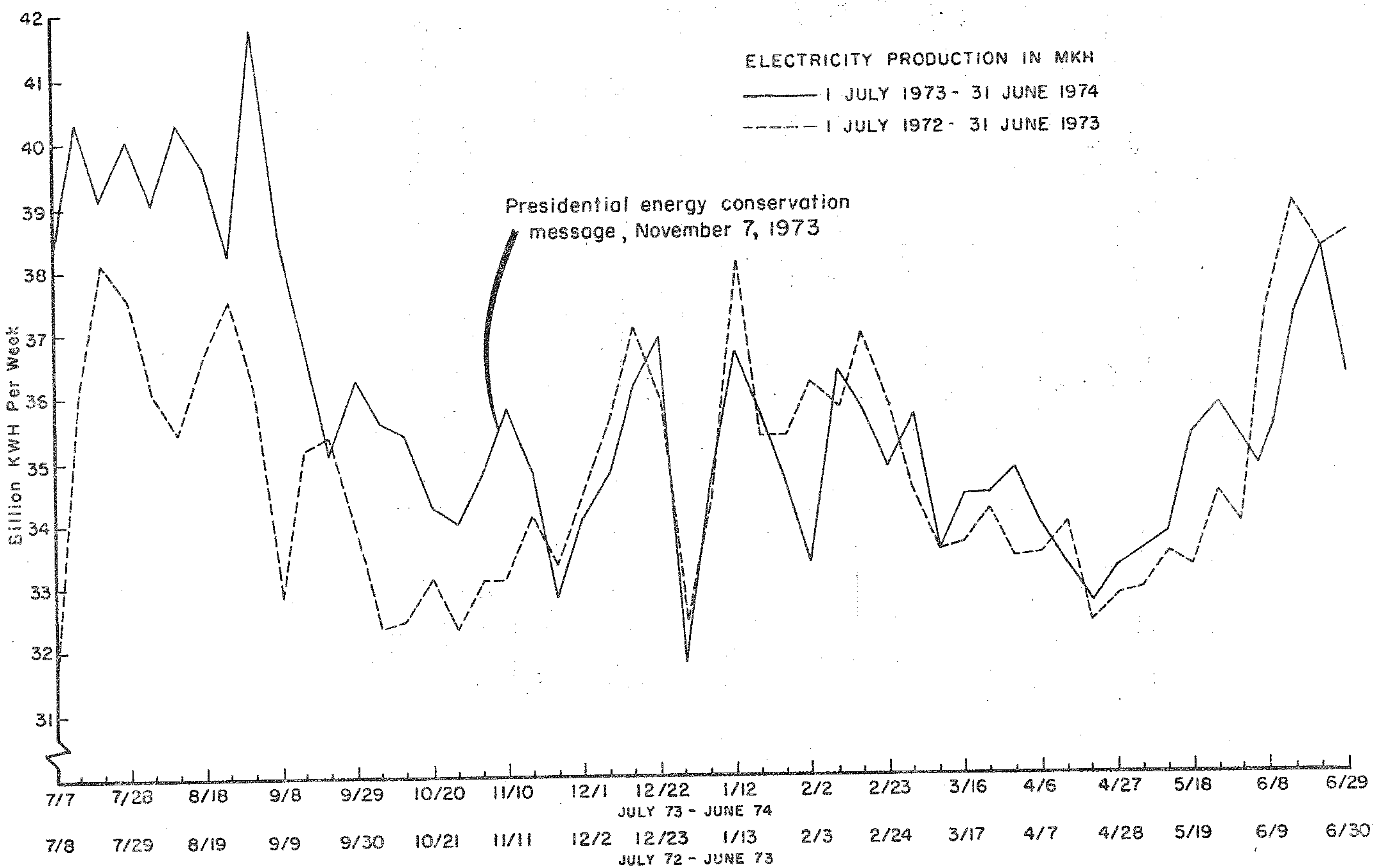
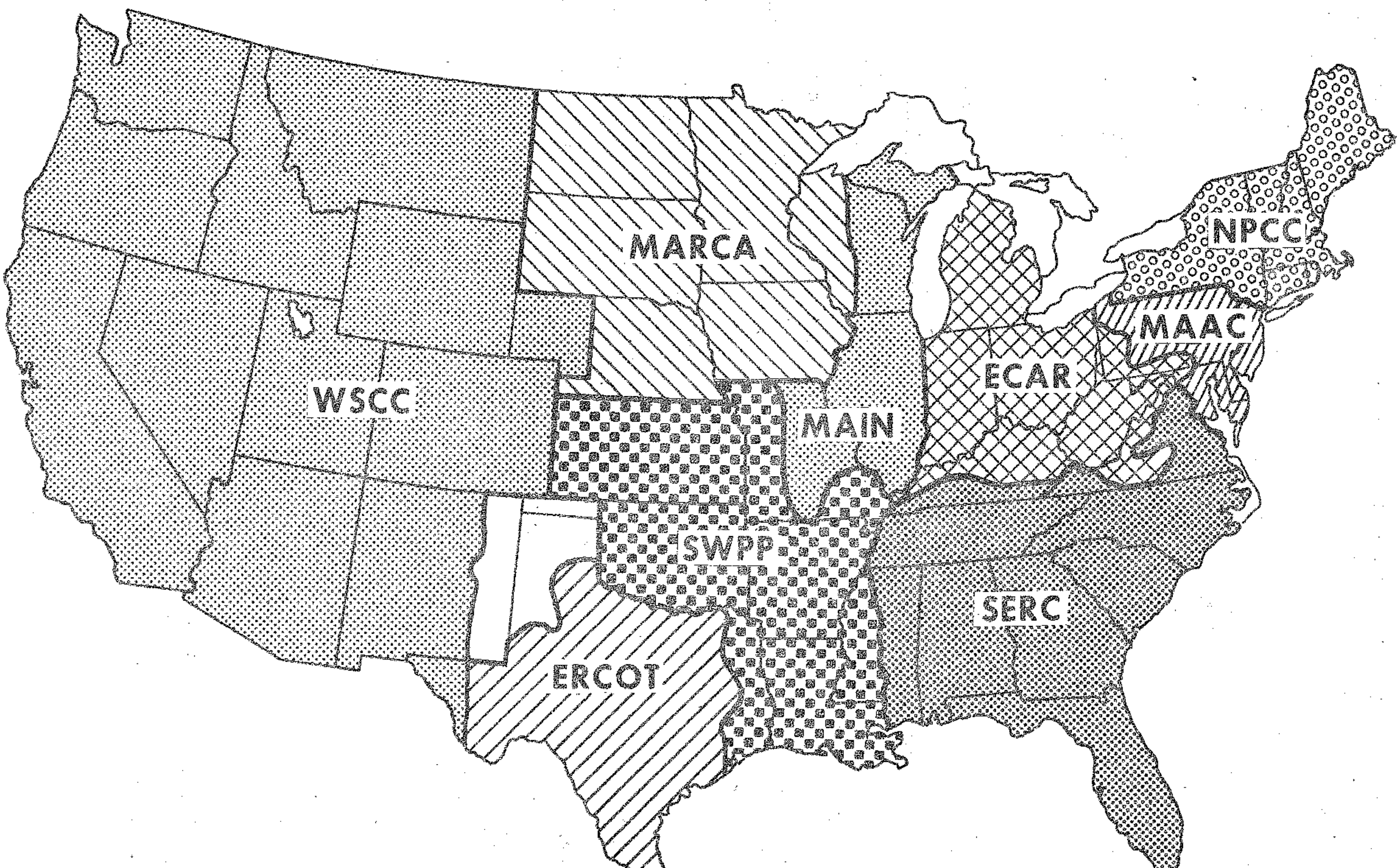


FIGURE 2. REGIONAL ELECTRIC RELIABILITY COUNCILS



Electricity sales throughout this past summer have continued their general pattern of no-growth. We believe current reality is more instructive than is generally recognized, and find the general nature of current conditions to fit comfortably with our findings of modest future growth.

Two questions about demand forecasting remain to be addressed: (1) Will higher oil, coal, and natural gas prices accelerate future growth? (2) How will pricing policies affect growth? The overall impact of higher fossil fuel prices on electricity demand is probably negative. Fuel purchases were about one-fourth of total costs in 1972 and are probably about one-third today. As they are passed along to customers, the increased rates are a negative force on sales. Obviously, however, the direct effect is positive in that higher oil, coal, and natural gas prices reduce the price spread between these fuels and electricity. A key to the overall impact is in the long run elasticities in Table 2. They indicate that the impact of competing fuel prices is much less than the effect of electricity prices. Considering the likely range of future cost increases for fossil and electric energy, we conclude that the most likely consequence of higher fuel prices is to retard demand growth, and this is in fact a characteristic of the demand analysis results.

The situation with respect to pricing policies is less clear. Mount's analysis of historic data shows no apparent relationship between the slope of rate schedules and aggregate use when examining state data over a period of years for each consumer class (6). This is not to say the subject will not continue to be of lively interest because of its implications for income distribution. Rather, our tentative conclusion is that reducing inter-class and intra-class differences in prices paid will not noticeably affect demand growth. This is not to say that if one utility flattens rates and others do not that competition will not result for industrial customers. Rather, the conclusion is that aggregate demand will not be affected.

It should be clear that we believe capacity expansion is not a major financial problem for electric power generation. In fact, expansion programs based upon exponential growth plans are likely to cause major problems. We envision the possibility that significant excess capacity financed at current high interest rates may place a serious burden on many utilities.

Given the estimates of price responses in Tables 1 and 2, it is evident that short run price effects are inelastic but long run effects are elastic. This means that rate increases greater than the general inflation will bring additional revenue in the short run (say, one to three years), but inevitably mean revenue deterioration in the long run. Hence we conclude that some utilities may see absolute declines in sales of kilowatt-hours, and reduced revenue measured in real, deflated dollars.

4. Remedies

It seems to us that one or more large urban utilities are faced with a solvency problem rather than an expansion problem. Consider these possibilities: regional population decline, high unemployment and low industrial production in the same region, continued inflation, higher coal and oil costs, high interest rates, accelerating electric rate increases, and the emergence of bill collection as a significant problem. Utility and regulatory personnel should be considering today the problems posed by the possible future insolvency of private urban utilities.

Many of the policy recommendations under current consideration are desirable because they promote economic efficiency with respect to the operation of electric utilities. Including construction costs in the rate base, employing a future year as the test year in rate analysis, and reformed rate hearing procedures, for example, are policy changes of value.

However, the major problems for many utilities will remain after the adoption of these policies. What should be done if bankruptcy seems impending? Can service be terminated? Hardly. One possible remedy is the assumption of ownership by municipal, State, or Federal authorities. This might provide an opportunity to organize governing bodies to include employees and representatives of residential, commercial, and industrial customers. It would have the financial advantage of potential exemption from property and income taxes as well as possible tax exempt bonds.

Another alternative is increased subsidies. The commonly discussed possibilities here include tax exempt investor owned utility bonds, Federal guarantee of utility debt, increased production of power by public authorities for resale to private utilities, and a seven percent investment tax credit. The major advantages of subsidies would seem to be the continuation of current ownership patterns, and, since these mechanisms would permit lower rates than would otherwise be necessary, more electricity would be sold.

However, the adoption of either public ownership or subsidy policies carries strong negative consequences. These remedies do not respond to the economic problems discussed, and this is particularly true with respect to the phenomenon of regional depression. In general, subsidizing public or private utilities must lead to greater levels of consumption than would otherwise develop, thereby further straining our increasingly scarce and expensive energy resources. Finally, if these subsidies become large and pervasive, they will place an additional burden on an economy already stressed by unproductive programs and sectors.

5. Summary

In the aggregate and for many individual utilities, there is no basis for pursuing expansion programs based upon exponential growth plans.

Second, institutional policies which make rate-setting responsive to legitimate cost problems are desirable; this is particularly important with respect to rising fuel, equipment, interest, and environmental protection costs.

Finally, if bankruptcy does seem impending for a utility in a depressed urban area, regulatory and other agencies should not move too hastily to adopt subsidy programs which would cause greater problems in the future.

It is appropriate to conclude with a philosophical observation. Our nation remains richly endowed with natural resources and has a broad and fertile land. We are on the whole a skilled and educated people. There are no technological or economic barriers which prevent us from securing a stable and productive relationship with each other and with our natural resources. Whether we make progress in the coming years or continue our recent habits is partly the responsibility of the electric utility industry and the regulatory agencies.

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