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RESIDENTIAL ELECTRICITY ELASTICITIES

IN THE LOWER PENINSULA OF MICHIGAN

VOLUME 2

Prepared For:

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APPENDIX A

LITERATURE REVIEW

The purpose of the literature review in this study is to summarize the results of previous studies and to shed light on various estimation problems and on refinements that have been made in response to these problem areas. The literature review is thus intended to provide the background for a properly specified model of electricity demand in the Consumers Power and Detroit Edison service areas. The analysis begins with an issue-by-issue format with examples of the problems encountered in representative studies. Included in this first section are discussions of techniques that have been suggested or utilized to counter the problems as perceived in earlier studies. A study-by-study discussion of results obtained in the studies reviewed is to be found in the latter part of this appendix.

It is the basic purpose of the literature review to examine the results obtained by various investigators and to establish a framework within which the differences in estimated elasticities can be analyzed. The framework of the following analysis consists of a fourfold categorization of characteristics of a typical study. The four characteristics considered are (1) sample type (cross-section, time-series, or combined cross/section-time-series), (2) spatial aspects (primarily degree of dissaggregation), (3) equation specification, and (4) equation estimation techniques.

Table A-1 indicates the diversity of results obtained in several studies. As can be seen, the long-run price elasticities range from -0.48 to -1.75

and long-run income elasticities from +0.18 to +1.64.* These price elasticities overlap the regions that economists denote as elastic and inelastic. Clearly, a consensus pertaining to the relative sensitivity of electricity consumption to price or income variations cannot be arrived at by a cursory examination of the results presented in Table A-1.

Also indicated in Table A-1 are several short-run elasticity estimates, which again exhibit some diversity. Although these short-run elasticities are characterized by a range of values, it remains true that they are consistently smaller (in absolute value) than the long-run counterparts. This result is primarily due to the estimation procedure utilized,** but the result is consistent with expectations. Since electricity demand is a derived demand, its use is associated with a stock of electricity-consuming appliances. Thus, changes in the level of electricity consumption are associated with changes in the utilization rate of a given stock of appliances, changes in the stock appliances, or changes in both.

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* Omitting the implausible negative elasticity obtained by Wilson. This negative income elasticity would imply that electricity is an "inferior" good, meaning that as income increases, the consumption of electricity decreases. Such a conclusion is not supported by any other known study nor by intuition.

** Short-run elasticities are normally estimated in time-series regressions of the form:

$$\ln Q_t = a + \alpha_1 \ln Q_{t-1} + \sum_{i=2}^{n} \alpha_i \ln X_{i,t} + \mu_t$$

Table A-1

Summary of Selected Previous Elasticity Studies

Author	Type	Data	Price	Long-Run Residential Elasticities: Price	Long-Run Residential Elasticities: Income	Short-Run Residential Elasticities: Price	Short-Run Residential Elasticities: Income
Published Studies							
1. Mount et al.	Combined	1947-1970; State	A	-1.30[a]	+0.30[a]	-0.35	N.E.
2. Anderson (1)	Cross-Section	1960; State	M[b]	-0.91	+1.13	N.E.	N.E.
3. Anderson (2)	Cross-Section	1960/1970; State	A	-1.12[c]	+0.80[c]	N.E.	N.E.
4. Halversen	Combined	1961-1969; State	A	-1.15	+0.51	N.E.	N.E.
5. Wilson	Cross-Section	1966(?)[d] ; City	A	-1.33	-0.46	N.E.	N.E.
6. Fisher & Kayser	Combined	1946-1949 and 1961-1957, State	A	N.S.	N.S.		N.S.
7. Houthakker, Verleger, & Sheehan	Combined	1961-1971; State	M[e]	-1.02	+1.67		
8. Asbury (1)	(Simultaneous Supply Demand Model)	1959/1965/1970; State	A[f]	-0.89[g]	+0.18[g]	N.E.	N.E.
9. Asbury (2)	Cross-Section	1959/1965/1970; State	A	-1.03[g]	+0.20[g]	N.E.	N.E.
10. Griffin	Time-Series	1951-1971; Nation	A	-0.52	+0.88	-0.06	+0.05
Unpublished Service Area Studies							
11. NERA	Cross-Section						
	a) Net Use	1970; State	M[b]	-0.48	+0.84	N.E.	N.E.
	b) Appliance Decisions Use	1970; Zip Code Areas (Missouri)	M[b]	-1.75	0.00[h]	N.E.	N.E.
1. C.K. Liew	Time-Series	1963-1970; Oklahoma Gas & Elec.	A	-1.00	N.A.	N.A.	N.A.
2. Beauvais	a) Cross-Section	1970; Va. El. & Power Svc. Area	N.A.	N.A.	+0.16	N.E.	N.E.
	b) Time-Series	1947-1970; Va. El. & Power Svc. Area	A	-0.80	N.A.	N.E.	N.E.
3. EAI	Combined	1965-1972; State	M[j]	-0.75	+0.60	-0.023	+0.020
4. Lacy & Street	Time-Series	1967-1975; Alabama Power Svc. Area	A,M	-0.53[k]	+1.64[k]	N.E.	N.E.
5. Crist et al.	Combined	1964-1974; So.Cal. Ed. Svc. Area	A	-1.26	N.R.	N.E.	N.E.

N.E. = Not estimated, N.S. = Not significant, N.R. = Not reported, N.A. = Not applicable.

TEB = typical electric bill.

Footnotes:

a) derived from constant elasticity model
b) cost of second 500 kWh derived from FPC TEB
c) from 1970 regression with average use per household as dependent variable
d) Wilson does not specify year
e) difference in cost between 500 kWh and 100 kWh/month FPC TEB
f) price determined by regression fit of supply model
g) from 1970 results
h) assumed value-income excluded from analyses
i) mean elasticity for period covered
j) difference in cost between 750 kWh and 500 kWh/month FPC TEB
k) termed "intermediate" elasticities by authors.

A customer faced with an increase in the price of electricity (with everything else held constant) is likely to reduce his utilization rate for some or all of electrical appliances and to reduce his stock of electricity-consuming appliances. However, this latter effect is unlikely to occur immediately subsequent to the rate increase (unless extremely large) since it would generally be uneconomical for the customer to scrap his existing appliance and reinvest in an equivalent appliance that utilizes a competing fuel. The likely response is an immediate reduction in the utilization rate followed sometime later by reductions in the stock of electrical appliances as these appliances wear out. Given that the average electrical appliance may have a useful life of 10 to 15 years, this stock adjustment phase is likely to be a gradual affair. Thus, any short-run adjustments are likely to be smaller in magnitude than the associated long-run counterparts.*

** (Cont. from previous page)

where Q_t = current consumption

Q_{t-1} = consumption lagged once period

$X_{i,t}$ = n-1 independent variables

μ_t = error term

In this format, the short-run elasticities are given by the estimated values for α_i (i=2,....,n), and the associated long-run elasticities by

$$\frac{\alpha i}{1-\alpha_1} \quad (i=2,....,n)$$

* The economic definition of the short run is that period of time during which the stock of appliances cannot be changed. Thus, by definition, the short-run response is likely to be more inelastic than the long-run response.

The income elasticities presented in the table, with two exceptions, indicate that as income increases so does consumption of electricity. The economic term for a commodity exhibiting such an income/consumption relationship is a "normal good." The two exceptions to this pattern in the table are Wilson (1971), with an income elasticity of -0.46, and the NERA (1975) result for their Appliance Decisions use of 0.00. As indicated earlier, Wilson's result indicates that electricity is an "inferior" good, a result considered extremely implausible. This unlikely estimate is usually regarded as a problem of misspecification and will be discussed more completely in a later section. The NERA result is not really an estimate since it represents an assumed value applicable to a select group of appliances.

Concerning the range of price elasticities presented (-0.48 to -1.75), a qualification needs to be made. The two extreme points in this range both come from a NERA study, and this occurrence is not surprising in view of the methodology employed in the study. The elasticity of -0.48 is associated with what NERA refers to as "net usage."* Essentially, net usage is defined as that use of electricity by consumers which has no alternative fuel. Therefore, within this category there is no possibility for adjusting the stock of appliances to another fuel source, and hence there are *a priori* reasons for expecting the estimated elasticity for this category to be smaller (in absolute value). Likewise, appliance decisions use is basically defined as that use of electricity for which there are direct

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* NERA separates average customer demand into two components: net use and appliance decisions use.

substitute fuels available. Thus, for this category there exists the possibilities of changing both utilization rates and stocks of appliances. Since the more usual econometric model uses average (total) use per customer, which by definition consists of net use and appliance decisions use, it is to be expected that the price elasticity obtained by this model lies between the estimates for the individual components. It is thus theoretically and intuitively pleasing that NERA price elasticities bracket those from the other more usual approaches. However, the important point to be cognizant of is that the NERA elasticities are not directly comparable to the rest. The remaining range of estimates can best be discussed in terms of specification problems of the particular studies.

Several explanatory variables have exhibited a distinct history of refinement through time, which the review of the literature revealed. Three such particular variables (or classes thereof) of importance include: income variables, prices of competing fuels, and climatological variables. Each of these has been refined in several stages by previous investigators, and the results were utilized in formulating the model used in the current study. In all cases, the goal of the review was to obtain the most theoretically correct form of the estimating model in order to minimize the effects of problems associated with econometric estimation previously discussed.

A. ISSUE ORIENTED ANALYSIS OF RESIDENTIAL STUDIES

1. Theoretical Aspects

This section discusses the results obtained in a number of major studies within the framework outlined earlier. This framework relates to the sample type employed in the study, the spatial aspects of the study, the equation specification utilized, and the estimation procedures employed. By using this framework, the issues involved in properly specifying a model can be more clearly outlined and explored than they would be in a detailed study-by-study critique. Furthermore, the use of this method of analysis permits a compactness of presentation, since studies characterized by similar problems need not be discussed individually. Consequently, the following analysis concentrates on important issues as they appear in representative studies.

a. Sample Type

Table A-1 indicates that, of the studies considered, the majority consist of cross-section or combined cross-section/time-series analyses. The three exceptions, utilizing pure time-series analyses, are the Griffin, the Lacy and Street, and the Liew models. Griffin's model is limited to a time-series format because it is designed to fit into the general macroeconomic environment of the Wharton Long-Term and Industry Model. On the other hand, Liew's analysis is restricted to a time-series investigation due to its particular model specification.

In general, unless necessitated by model limitations, most investigations tend to be cross-sectional or combined cross-section/time-series studies. Most cross-section studies tend to use data available from the general or special censuses, which are, however, rarely conducted annually. The advantage of such data is that they tend to be quite detailed and therefore permit accurate and complete model specification. The disadvantage is, of course, the temporal noncontinuity of the data. The researcher must somehow decide if the data that he has are sufficiently representative of "normal" conditions to be useful. For example, if a census happened to be conducted during a period of wartime mobilization (with associated rationing, etc.), or during other abnormal conditions (such as during the Great Depression or immediately after World War II), true relationships might be masked in this data by rapid adjustments occurring after artificially imposed constraints.

A solution to this problem of representativeness is to pool or combine cross-sectional data across a period of time. By doing so, the time period spanned will contain enough observations so as to be representative of normal conditions. Nevertheless, the use of this combined approach is not without its cost. As mentioned earlier, very detailed data tend not to be collected on an annual basis. Therefore, a combined cross-section/time-series approach may necessitate a less well-specified model or require that interpolations be made for intervening years. Alternatively, instrumental variables may be employed as proxies for the missing data.

Even with a combined approach, the investigator may still be faced with problems of uncertainty as to the representativeness of the time period. For example, it is unlikely that any investigator would consider the period 1930 to 1950 as representative of normal times. The long drawn-out depression, characterized by massive unemployment and excess capacity in the economy, immediately followed by World War II and its full employment, rationing, nationalization, etc. is certainly not "normal." Estimates obtained from an investigation based on data from this period would be suspect and of limited use.

Furthermore, there is always the possibility of changing relationships over time. Both Asbury's (1974) and Liew's (1972) studies present evidence of this phenomenon. Asbury performed the same regression analysis for three time periods and obtained the following price and income elasticities:

Year	Price Elasticity	Income Elasticity
1959	-0.87	0.40
1965	-0.92	0.38
1970	-1.03	0.20

Thus, Asbury's results would indicate that the demand for electricity is becoming more sensitive to price changes and less sensitive to income changes.

On the other hand, Liew's study, based on a time-series analysis, obtained the following elasticities:

Year	Price Elasticity
1953	-1.13
1954	-1.03
1955	-1.08
1956	-1.17
1957	-1.29
1958	-1.30
1959	-1.24
1960	-1.11
1961	-1.04
1962	-1.00
1963	-0.86
1964	-0.82
1965	-0.85
1966	-0.89
1967	-0.98
1968	-0.86
1969	-0.76
1970	-0.64

Here the indication is that the demand for electricity is becoming less sensitive over time. This is the opposite of Asbury's results, but the studies are not strictly comparable. Asbury's study is intended to explain average total use per customer, whereas the University of Oklahoma study is concerned only with the new demand for electricity. The results in this study are interpreted by its author as being reflective of the increased effectiveness of advertising and increased convenience of electrical appliances. Taken in this light, the two results are not as contradictory as they initially appear. It is entirely possible that non-price incentives are becoming more important in the new demand for electricity, but that the sensitivity of utilization of existing, and hence "locked in," demand to price changes is increasing, as Asbury suggests.

Nevertheless, the possibility of changing elasticities over time is one that, if not explicitly dealt with, should at least be implicitly accounted for by the use of the most recent data possible.

b. Spatial Aspects

Most econometric studies tend to use the state as the unit of observation. The rationale for this choice is simple--easy accessibility and consistency of reporting. Most United States Government surveys and censuses aggregate data to the state level. Those data, collected for cities, counties, and standard metropolitan statistical areas (SMSAs), are generally not gathered annually, but rather at 5- or 10-year intervals.

Two immediate problems arise with the use of state data. On the theoretical side, the use of state data represents somewhat of a misspecification. Economic theory is oriented toward the concept of the marketplace. In this regard, the service area of a utility is probably a closer unit of observation coinciding with this concept.

Furthermore, utilizing state data aggravates a statistical problem known as aggregation bias. The problem arises any time non-micro (i.e., individual) data are utilized. For example, consider the states of Washington and California. Washington has a smaller population than California, but a higher average per customer use of electricity. However, aggregation by states (in a regression designed to explain average consumption) causes the Washington customers to be given the same relative importance as the California customers, when, in fact, they are of lesser importance since there are fewer of them. Any time data are aggregated, a possible bias may enter and the direction of the bias is not clear. Therefore, the bias present in the price and income elasticities cannot be determined without analysis of the micro-data, an obviously insurmountable task when dealing with aggregated state data for the entire country.

In general, a less aggregative approach is preferable to a more aggregative approach since the amount of aggregation bias will tend to be less. However, some researchers have argued that some aggregation is desirable.

The argument is based on the assumption that aggregation will tend to "wash out" any transitory components of the independent variables that may bias elasticity estimates. This argument has particular appeal in relation to income variables in light of Friedman's "permanent income" hypothesis of consumption.*

In light of the arguments against aggregate data and those related to the economic concept of the marketplace, it appears that the optimal approach to elasticity estimation lies with the use of micro-data from the service area of a utility. From this optimal approach, one can rank the alternatives in terms of their decreasing appeal. In other words, aggregation of company micro-data into divisions or regions represents a preferable treatment to aggregation of company average (and hence already once aggregated) data into statewide average figures.

The use of state data represents a tradeoff between aggregation bias and the convenience and detailed coverage associated with it. Since statewide demographic data are the norm for federal and state agencies, and since Edison Electric Institute and the Federal Power Commission also aggregate to the state level, the convenience of this approach is as great as its cost is small. However, in a study for an individual company or companies, the use of micro-data or regionally aggregated micro-data is warranted.

There are possible problems associated with the use of micro-data nonetheless. For example, the argument in reference to transitory and permanent components of income in relation to consumption patterns is a

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*Friedman, M., A Theory of Consumption Functions, Princeton University Press, Princeton, N.J., 1957.

relevant argument. Aggregation may solve this problem, but other approaches, such as a several-year moving average of income, will also capture the "permanent" effect without introducing aggregation bias.

c. Equation Specification and Variable Definitions

Variations in the elasticity estimates obtained by previous investigators can largely be explained by considering three problem areas associated with an econometric model: (1) omitted variables, (2) high correlation between independent variables (multi-collinearity), and (3) specification of the variables used. Basically, an omitted variable will induce bias in the coefficient(s) of the included variable(s) if it is correlated with the included variable(s). The problem of multi-collinearity results in the coefficients of individual independent variables being statistically non-significant if the two variables happen to be highly correlated with each other.

1. Omitted Variables

An example usually cited as a typical problem of omitted variables is the negative income elasticity of -0.46 obtained by Wilson. As indicated earlier, this result indicates that electricity is an "inferior" good, an extremely implausible results. Wilson attributed the result to a preponderance of federal power projects (and associated low wholesale prices) in low-income areas. Later writers have generally concluded that this result occurred due to Wilson's failure to control adequately for housing characteristics. In general, more urbanized areas tend to have higher measured incomes (due to higher costs of living) and lower electricity consumption (due to the dominance of apartments and other physically smaller dwelling units). Thus, a failure to control for the housing characteristics results in a negative correlation between income and consumption. In technical terms, the omission of a housing characteristic variable (which is correlated with income) has biased the income coefficient.

2. Multi-collinearity

Examples of the effects of multi-collinearity are more difficult to document. This is due to the fact that researchers generally tend not to report the basic correlation matrix. However, it is easy to suggest a possible example of such an effect. Anderson (1972) has included both a summer and winter temperature variable in his analysis: average July temperature and average January temperature. Anderson's results indicate that neither variable is particularly significant taken by itself. However, since these variables represent historical average values, one would expect summer and winter temperatures in a region to be fairly correlated. Thus, Northern states tend to have warm summers and cold winters, whereas Southern states tend to have hot summers and cool winters. The interseasonal range of temperatures tends to be similar in most regions, with the level or midpoint of the range a function of the geographical location of the region. Therefore, given this correlation, neither climatic variable may be statistically significant.

3. Specification of Variables

The third major problem area to be discussed in this subsection is concerned with specifications of variables, both dependent and independent. The specification problem concerns not only the variables to be included, but also the construction or definition of those variables included. For organizational purposes, it is useful to analyze the problem in terms of (1) dependent or explained variables and (2) independent or explanatory variables.

a. Dependent Variables

Most electricity-demand studies can be categorized as energy-use models or saturation models. In the former, average use per customer is the dependent variable, and its use in this role has been historically consistent. However, the saturation models derived their approach from estimating problems associated with one of the earliest major studies by Fisher and Kaysen (1962). The authors used the percent change in the stock of four appliances (washing machines, refrigerators, irons, and electric ranges) as the dependent variable. The problem with this approach was that this variable exhibited a strong growth trend over time. Since three of the independent variables in this model (percentage of new wirings, population growth, and number of marriages) also exhibited similar growth trends, a large amount of time-trend-dominated multi-collinearity was present, which precluded effective estimation of the coefficients of the other variables, i.e., price and income.

As Wilson demonstrated in his study, "Residential Demand for Electricity," the proper variable (at least in terms of minimizing estimation problems) in an appliance study is the saturation of the appliance and not the change in the stock. This use of saturation effectively solves the problem of the time-dominated collinearity and permits identification of causal relationships.

However, the use of the saturation variable is not without some problems. Wilson and most other investigators utilize linear and log-linear estimation procedures. In this regard, it has been shown that saturation levels generally follow an "S-shaped", or logistic curve. (See Figure A-1 below). Thus, these types of estimation procedures only provide linear approximations to the true relationship. The extent or direction of bias caused by this approximation procedure is unclear.

b. Independent Variables

Most of the specification problems incurred with electricity demand studies have been related to the independet or explanatory variables. Included have not only been questions related to the establishment of the proper variables for inclusion in the model, but also problems of the proper form or construction of the variables. In general, specification problems have been encountered in six general areas: (1) price of electricity, (2) income, (3) competing fuels, (4) cost-of-living adjustments, (5) climatic variables, and (6) housing characteristics. Each category is discussed below.

(1) Price of Electricity

Of particular importance in econometric modelling has been the choice of the proper price variable. Economic theory is founded on marginal deci-

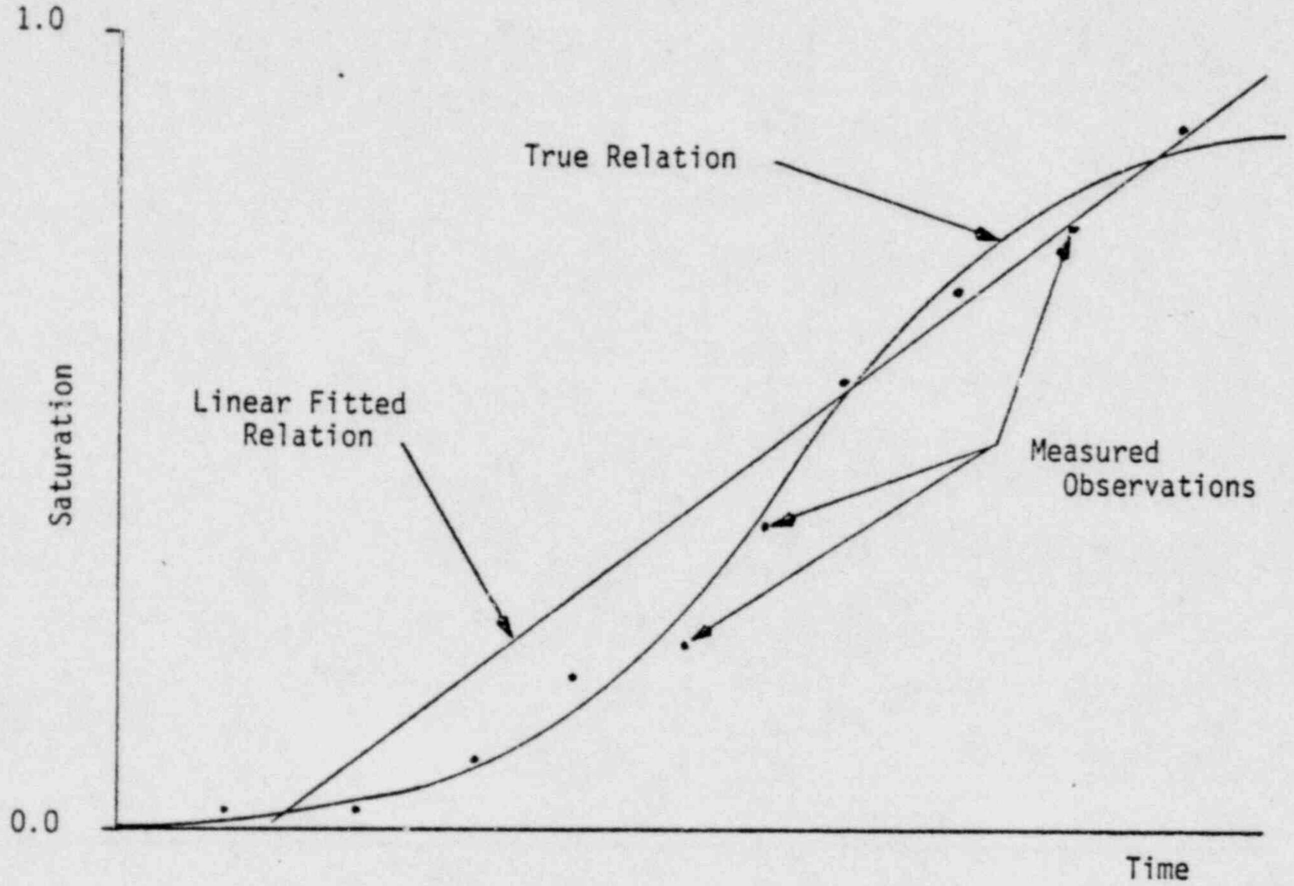

Figure A-1. Comparison of fitted and actual saturation relationships.

sions and hence marginal price. Due to the existence of declining block structures (or so-called inverted rates for that matter), there is no unique marginal price. A customer in one block faces a different marginal price than a customer in another block.

In the face of this ambiguity, numerous investigators have utilized average price instead. The extent of this utilization can be determined by examining Table A-1. However, in spite of this pervasive use of average price, many writers have pointed out that this definition of a price variable is somewhat meaningless due to problems of simultaneity. In other words, economic theory postulates that quantity demanded is a function of price; however, any two-part tariff* or one-part multi-block tariff makes the average price a function of the quantity demanded. Consider, for example, a two-part tariff consisting of a $2.00 per month fixed charge (customer charge, minimum bill, etc.) and a single-block energy charge of 3.0¢ per kWh. If customer A consumes 200 kWh per month and customer B 300 kWh per month, then the average price per kWh is 4.0¢ for A and 3.67¢ for B, even though the marginal price faced by both is the same, i.e., 3.0¢ per kWh. This problem of simultaneity and the consequent use of average price biases price elasticity estimates upward (i.e., toward more elastic estimates).

Three primary methods have been suggested or utilized as means to avoid this problem of simultaneity: (1) use of Federal Power Commission typical electric bills (TEB), (2) a simultaneous supply/demand model in conjunction with a two-stage least squares estimating procedure, and (3) a method suggested by Taylor to include both an average and a marginal price.

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* A two-part tariff consists of a fixed customer fee plus a variable running or energy charge (which may be single or multi-block).

Wilson simply utilized the TEB for 500/kWh month as his independent price variable. Since 500 kWh per month is about the national average, this TEB is intended to yield a good measure of the interstate variation in the price of electricity. Asbury has pointed out, however, that the 500 kWh/month TEB is particularly deficient in that it involves unrealistically high estimates of electric consumption for water heating. To the extent that the actual use of electric water heaters across the country varies, the use of the TEB will bias elasticity estimates.

Addressing this problem associated with TEB, both Anderson (1972) and Houthakker et al. (1973) proposed "marginal" prices derived from the TEB. Anderson used the cost of the second 500 kWh/month and Houthakker et al. utilized the difference in cost between 500 kWh and 100 kWh per month. While these measures no doubt represent improvements, they are still subject to aggregation bias. In this respect, it has been suggested that if aggregate consumption data are utilized, then some weighted-average, marginal-price variable is the appropriate variable. Harberger (1974) has suggested that the average price paid might be a closer estimate of the relevant weighted average marginal rate than the construction of marginal rates from block differences in the TEB. Nonetheless, the general consensus leans toward the concept of a marginal price even if its adequate representation remains a difficult task.

Taylor's method, which is detailed in the Bell Journal of Economics (Spring 1975), consists of including both an average and a marginal price. Taylor's average price is the average price of electricity for consumption up to but not including the last block consumed in, with marginal price defined as the rate charged in the last block consumed in. Essentially, the methodology is designed to discriminate between the income and substitution effects resulting from a price change; the average price variable should pick up the income effect, and the marginal price variable, the substitution or pure price effect. No known published studies have utilized Taylor's methodology.

A third method utilized to avoid the problems of simultaneity has been estimation of a simultaneous supply/demand model. Asbury used this approach in his paper. The methodology of the simultaneous supply/demand approach* consists of estimating a supply model with the price of electricity as the dependent variable. The fitted values for the price variable are then used in the demand model as the relevant independent price variable. In this manner, the simultaneous relationship between quantity and average price is eliminated, allowing consistent estimates to be obtained. Asbury also estimated his model using ordinary least squares with average price as the independent variable. His apparent purpose is to estimate the distortion that results from ignoring the simultaneity problem. Somewhat reassuring from a practical modeling standpoint is the fact that the results obtained from this two-stage least squares analysis did not differ significantly from Asbury's ordinary least squares regression using average price although the own-price elasticity estimate shifts from the elastic range into the inelastic range. The indicated own-price, cross-price, and income elasticities for each were:

	Own Price	Cross Price	Income
Ordinary least squares	-1.03	0.31	0.19
Two-stage least squares	-0.89	0.34	0.18

* Also referred to as two-stage least squares (2SLS).

These results would seem to indicate that the use of average price, while extensively criticized on theoretical grounds, may not be quite as inappropriate as generally claimed. It should be noted again that the use here of average price has resulted in upward bias own-price elasticities.

The resolution of the proper price variable is still not 100 percent clear. Economic theory calls for the marginal price; however, as indicated there are problems associated with deriving an adequate empirical representation of marginal price. Nonetheless, it has been effectively demonstrated that the use of average price results in upward biased own-price elasticities, which at best should be viewed as upper limits to the range of the true elasticity.

(2) Income

Although the specification of the price variable has represented the most difficult problem in econometric modelling of electricity demand, the use of a proper income variable has also merited some discussion. Studies typically use either median family or per capita income. The alledged advantage of these variables, other than the obvious ease of collection, is the previously discussed relation of aggregation and elimination of transitory components of income. Friedman's "permanent income" hypothesis maintains that consumption is related, in a meaningful way, to the notion of "permanent" or normal income. Since measured income consists of a permanent and a transitory component, statistical techniques may not be able to detect the relationship between consumption and permanent income; hence, the argument for aggregation of data, by which it is claimed the transitory effects will be washed out, leaving one with a measure of permanent income. As noted earlier, aggregation bias may be serious enough to outweight this alledged benefit.

(3) Competing Fuels

Econometric models almost universally use the average price of natural gas as the price variable for alternative fuels. This price measure may result in biased estimates for cross-price elasticities for several reasons. First, the same argument applicable to electricity prices (i.e., marginal versus average, and the associated bias problems) applies equally well to gas, since it is also sold under declining block tariffs. Furthermore, a proper specification might require the inclusion of both an average and a marginal price in order to isolate the pure price effect.

Additionally, the relevant competing fuel may not even be natural gas. Asbury points out that, in New England, low sales of electricity coexist with high natural-gas prices, a condition contrary to expectations. However, he further notes that the explanation is due to the relatively low price of heating oil.* Thus, for New England and possibly other regions of the country, heating oil and not natural gas is the relevant alternative fuel. Consequently in estimating his model, Asbury constructs a price variable that is essentially a weighted average of natural gas and heating oil. As a test of the procedure, he repeats the analysis, changing only the price of the alternative fuel, restricting it to only natural gas. The results are presented below:

Type of Alternative Price Variable	Cross-Price Elasticity Obtained 1959	1965	1970
Natural gas only	0.19	0.14	0.17
Weighted average of gas and oil	0.30	0.30	0.31

* Asbury's data predate the 1973 Arab-Israeli War and resultant quadrupling of oil prices.

The results are somewhat striking though not unexpected. As can be seen, the use of natural gas alone results in downward biased cross-price elasticities and underestimates the role of competing fuels in determining electricity demand.

Another study that explicitly treats this problem of competing fuel price is that of Anderson (1973). Rather than constructing a composite price variable, Anderson elects to enter several competing fuel prices. In particular, he considers gas, oil, bottled gas, and coal as alternative energy sources. Anderson's direct estimates for the cross-price elasticities (with respect to electricity) for 1970 are:

Fuel Type	Cross-Price Elasticity
Gas	0.30[a]
Oil	0.27[a]
Bottled gas	0.00[a]
Coal	0.12[a]

a. Not significant at 0.05 level.

Even though Anderson's results are not overly significant (a result partially induced by the large number of independent variables), it is important to note that the elasticities indicate that fuels other than gas compete with electricity.

(4) Climatic Conditions

Recent researchers have placed increasing emphasis on properly specifying climatic variables in their analyses. Somewhat surprisingly, a number of earlier studies only included an indicator of winter climate conditions, such as degree-days or mean December (or January) temperatures. Once again, Anderson seems to have pioneered with the inclusion of a summer temperature variable. This logical extension is intended to capture the effects of the increasing growth in air-conditioning demand.

Some refinements of climatic-variable specifications have been suggested but apparently remain untried. Included in these are the use of a wind-chill index for the winter variable (since increased wind induces a greater heat loss from a structure, and hence a greater space-heating demand) and a temperature humidity index for the summer variable (THI represents a better measure of discomfort than temperature or cooling degree-days and hence is more reflective of air-conditioning demand).

Anderson also presents an interesting argument that could have an important bearing on properly representing the effects of winter climates on the demand for electricity. In discussing the lack of significance of Wilson's climatic variable (heating degree-days), he suggests this result may be due to opposing cold-related influences. Once electric heating has been installed, a colder climate induces more electricity use. But coldness of climate itself may be a deterrent to the purchase of electric heating equipment. Anderson notes that, in a warmer climate, with relatively light heating needs, the differential operating cost of electric versus fossil-fuel heating will be low and other considerations (primarily installation costs) may dominate customer choice. In a colder climate, on the other hand, the differential operating costs may rise to the point where it deters the installation of electric heating equipment and thus reduces average household demand for electricity.

What Anderson seems to be suggesting is that the winter-related demand for electricity is not a monotonic function of the winter-related demand for space heating in general. This is due to the cost characteristics (both installation and operating) of electric versus fossil-fuel space-heating systems. Anderson suggests a climatic/electricity demand relationship of the form depicted in Figure A-2. What this relationship illustrates is that winter- and summer-related demands for electricity are of different characteristics. The demand for electricity for air conditioning rises monotonically with increasingly warmer climates because, for the most part, residential air conditioners have no alternative fuel source and must be electrically powered. Therefore, as the demand for air conditioning increases (caused by warmer climatic conditions), the demand for electricity likewise increases.

However, since space-heating applications do have competing fuel sources, the demand for electric space heating is not a monotonic function of the climatic condition, even though the demand for space heating (regardless of fuel considerations), undoubtedly is. It is the cost characteristics of electric space-heating applications that induce the non-monotonic relationship. As Anderson points out, moderate climates encourage electric heating since the relatively lower installation costs outweigh the higher operating

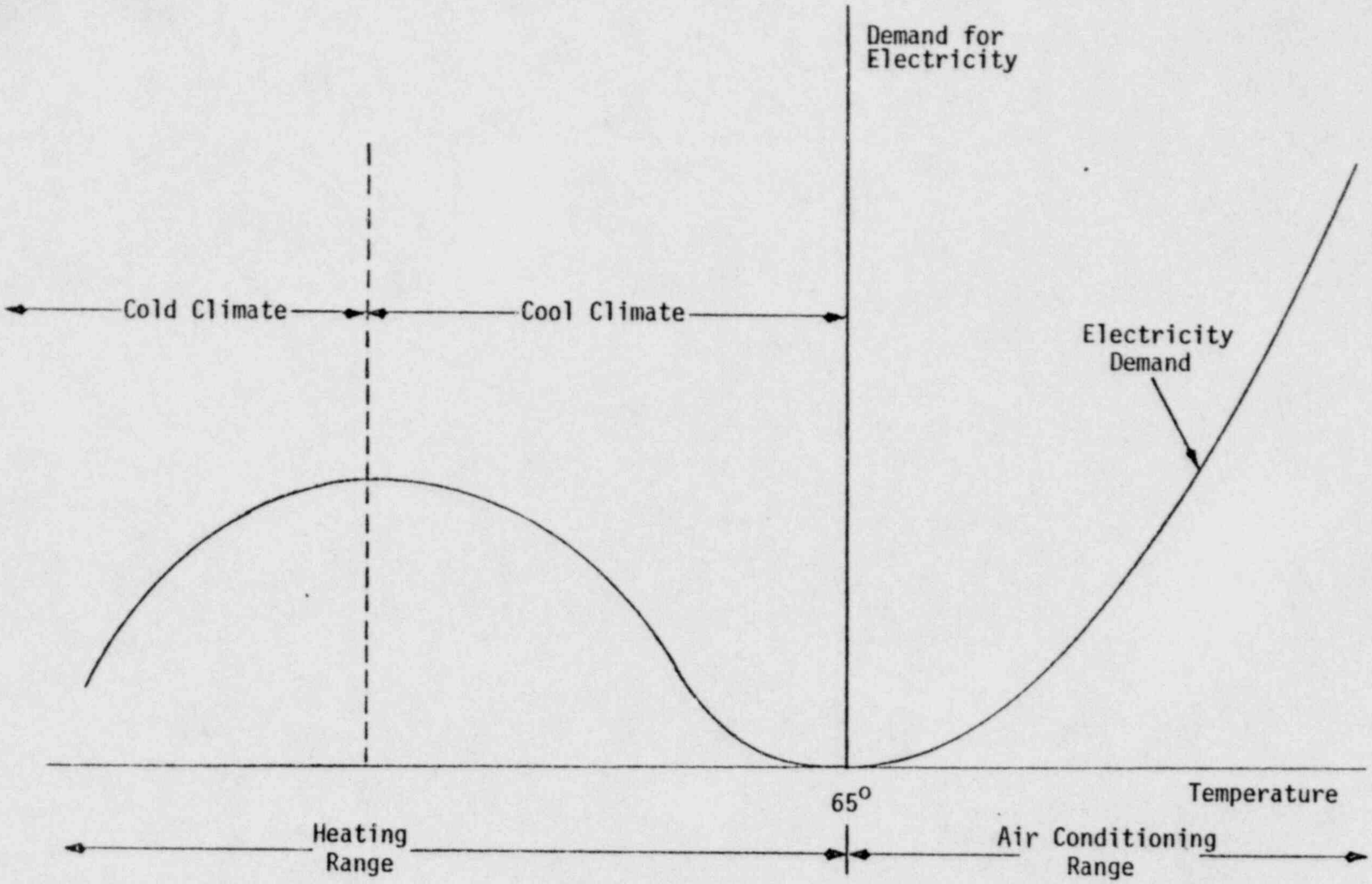

Figure A-2. Demand for electricity as a function of temperature.

costs. On the other hand, more severe climates result in very large operating costs for electric applications, and this outweighs the lower installation costs. Hence, colder and colder climates are characterized by fewer and fewer electric space-heating facilities.

(5) Housing Characteristics

As discussed earlier, failure to adequately control for housing characteristics can result in implausible results. Wilson's negative income elasticity if often cited as an example of this effect. Anderson further points out that it is important to select a housing characteristic variable that is not correlated with any of the other independent variables. In particular, he is critical of the use of average number of rooms per dwelling unit, since it is likely to be correlated with income and hence yield nonsignificant coefficients for both.

Anderson prefers the use of average number of persons per household since it is not likely to be correlated with income. However, the important feature is the necessity of controlling for housing characteristics. In this regard, the scope of the particular study determines the selection of the appropriate variable. In a more aggregated study, such as a national data base with state-by-state observations, a very fine measure of housing characteristics is not possible since it is necessary to account for the vast urban/rural differences characterized by the state-by-state makeup of the nation. However, a more disaggregated study, such as for an individual utility service area, may be characterized by an overall urban (or rural) makeup, and, in this case, a more refined measure of housing characteristics may be required. In this latter case, it may be necessary to control for such things as percent of population living in apartments, or some other measure of population density.

(6) Cost of Living

In addition to the above-mentioned specification problems, there exists another area where little effort has been made. This problem is the failure to control for cost-of-living differences across regions. Economic theory is based on real as opposed to money prices; therefore, a theoretically proper treatment should control for cost-of-living differences across time (normally done by deflating prices and income by the consumer price index) and cost-of-living differences across regions at any point in time (rarely done). This latter difference could be accounted for if a separate consumer price index were maintained for each state (or whatever unit of observation were being used) and if the base-year figures for each observational unit were representative of the regional cost-of-living differences. The Bureau of Labor Statistics (BLS) maintains consumer price indices for 23 United States cities, but the base-year figure for all the cities is 100.0. Therefore, this series is <u>not</u> representative of regional cost-of-living difference.

However, Anderson has utilized some other BLS statistics in designing a regional cost-of living deflator. In particular, he has used the BLS <u>Spring 1970 Cost Estimates for Urban Family Budgets</u>, which is designed to reflect the "annual cost at an intermediate level of living for a family comprising a 38-year old employed husband, wife not employed outside of the home, 8-year old girl, and 13-year old boy" for 39 different cities in the

United States. From these figures, Anderson constructed a state-by-state cost-living deflator. Since only 39 cities are represented, Anderson had to estimate many of the state indices by (unexplained) weighting and inter-city averaging.

It is unclear whether Anderson's attempts in this area have resulted in any distinct improvement in elasticity estimates. Table A-1 indicates that his elasticity estimates are consistent with those obtained by other investigators who have ignored this problem. It is clear that his approach is theoretically correct, but the quality and incompleteness of the data utilized leave doubt as to the usefulness of the attempt.

2. Equation Estimation

In general, the estimation procedures employed by most investigators have been fairly straightforward. The usual practice is to estimate a single demand equation with ordinary least squares (OLS). The estimated equation may be linear (as is one set presented by Wilson), but the dominant form is log linear.

This dominance of the log-linear functional form is explained by the fact that the resulting coefficients can be interpreted as elasticities with no further computation if it is assumed that causal relationships have been properly captured by the model. Thus, for example, if the demand for electricity is assumed to be of the following form (Cobb-Douglas):

$$Q_d = AP^{\alpha}Y^{\beta}$$

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where Q_d is the quantity demand, P the price of electricity, Y the income, and A an unspecified constant, and if the logs of both sides of the equation are taken, the resulting equation can be fitted by ordinary least squares with the elasticities as the coefficients.

$$\ln(Q_d) = \ln(A) + \alpha \ln(P) + \beta \ln(Y)$$

This particular functional form has no particular theoretical basis for preference over other forms, but it does have the above-mentioned computational advantage.

In general, ordinary least squares is a sufficient estimating procedure for single demand equations. However, if a simultaneous supply-demand model is formulated, then a procedure known as two-stage least squares must be utilized. The simultaneous demand/supply model is intended to eliminate the simultaneity problem mentioned earlier with regard to the use of average price. It should be reiterated that, for this study, a simultaneity problem exists and that a simultaneous supply-demand model cannot be formulated since this method is inapplicable to a single utility service area. Therefore, price coefficients should not be interpretted as elasticities for the reasons outlined above and elsewhere.

B. STUDY BY STUDY DETAILED REVIEW

In this part of the appendix, a detailed review of individual studies is presented. The format utilized consists of a fourfold categorization scheme: (1) reference, (2) aim, (3) approach, and (4) conclusion. All of the following studies are analyzed within this framework, except the first one (by Battelle Institute) which reviews those studies forecasting energy consumption between 1960 and 1971. For convenience in utilizing this latter review section, an index page is presented below:

1. Battelle Institute (1969)

Title: Battelle Memorial Institute, Pacific Northwest Laboratories. 1969. A Review and Comparison of Selected United States Energy Forecasts. Richland, Washington.

Aim: This publication summarizes the projections of forecasts of energy consumption contained in 30 reports appearing between 1960 and 1971. No attempt is made to evaluate the base data or methods used in the various forecasts. The following reports, which attempt to predict electricity demand, are summarized in the study:

Group I--Reviewed by Battelle Staff

Atomic Energy Commission. 1962. Civilian nuclear power--A report to the President. U.S. Atomic Energy Commission. 1962 and 1967 supplement.

U.S. Senate. 1962. Report of the National Fuels and Energy Study Group on assessment of available information on energy in the United States. Committee on Interior and Insular Affairs, U.S. Senate.

Bureau of Mines. 1962. Patterns of energy consumption in the United States. William A. Vogely, Division of Economic Analysis, Bureau of Mines, U.S. Department of the Interior.

Resources for the Future, Inc. 1963. Resources in America's future. Landsberg, Fischman, and Fisher, Resources for the Future, Inc. Johns Hopkins Press.

Federal Power Commission. 1964. National power survey. Federal Power Commission, U.S. Government Printing Office.

Bureau of Mines. 1968. An energy model for the United States featuring energy balances for the years 1947 to 1965 and projections and forecasts to the years 1980 and 2000. Bureau of Mines, IC 8384, U.S. Department of the Interior.

Robert R. Nathan Associates, Inc. 1968. Projections of the consumption of commodities producible on the public lands of the United States 1980-2000. Prepared for the Public Law Review Commission, Robert R. Nathan Associates, Inc., Washington, D.C.

Group II--Reviewed by Federal Power Commission Staff

Electrical World. 1970. 21st annual electrical industry forecast. Electrical World, September 15, 1970.

Morrison, W. E. 1970. Energy resources and national strength. Presented to Industrial College of the Armed Forces, Washington, D.C.

Stanford Research Institute. 1970. Requirements for southern Louisiana natural gas through 1980. Exhibit in FPC docket No. AR 69-1, Stanford Research Institute.

EBASCO. 1970. Energy consumption and supply trends chart book. EBASCO Services Inc.

Federal Power Commission. 1972. The 1970 national power survey, part 1. Federal Po[illegible]sion, Washington, D.C.

National Petroleum Council. 1971. U.S. energy outlook, an initial appraisal 1971-85. Volume 1. An interim report of the National Petroleum Council.

Resources for Future, Inc. 1971. Trends and patterns in U.S. and world-wide energy consumption: A background review by Joel Darnstadter. Resources for Future Inc. Published in 1972 as appendix to papers presented at RFF Forum on Energy, Economic Growth and the Environment, April 20-21, 1971, Washington, D.C.

Bureau of Mines. 1971. Mineral facts and problems--1970 edition. Bureau of Mines Bulletin 650, U.S. Department of the Interior.

The report classifies the energy projection studies by their assumptions, forecast methodology, and by the actual projections made. Tables 1 through 5 summarize the results for the energy projections that are relevant to the prediction of electricity consumption.

This article is a convenient summary of noneconometric approaches to electricity-demand forecasting. Table 2 demonstrates that the typical methodology of these studies is to extrapolate trends in order to estimate future demands.

Table 1

Energy Projection Assumptions

	Annual GNP Growth Rate (percent)	Population	Price of Fuels	Availability of Fuels	Technology
Group I					
Senate-62	3-1/2 to 4	250,000,000 by 1980	Correspond to Gen. Price, Inc.	No restrictions	Nothing revolutionary
BuMines-62	(a)	1.6 percent annual growth	Relative to other fuels	Adequate	Evolutionary
RFF-63 (b)	Low 3.0; medium, 3.8; high, 4.8	1.55 percent annual growth (base year 1960, 180X10^6)	(c)	(c)	No major changes
FPC-64	(a)	250,000,000 by 1980	(a)	(a)	(a)
Sartorius-67	Continue, 1960-65	(c)	(c)	(c)	Introduction of electric cars
Chase-68	Not given				No electric autos by 1980
BuMines-68	2.5 to 5.5	1.0 to 2.2 percent annual growth	Stability of relative costs	Adequate/some restriction	Evolutionary
Nathan-68	Same as RFF, with some adjustment				1/3 elect. generation nuclear by 1980 and 1/2 from 1980-2000
TET-68	5 (1965-85)	250,000,000 by 1985	Continue trends evolved since 1960	Adequate	No extraordinary change
Group II					
Elec. Ind.-70	4 (1969-1985)	247,000,000 by year 1985, 1.3 percent annual growth, base year 1969	Not available	Not available	Forecast based on electric utility industry reported construction plans through 1976
Morrison-70	4 (1969-2000)	332,000,000 by year 2000, 1.6 percent annual growth, base year 1969	Stability of relative costs	Some restriction domestic supply	Evolutionary/revolutionary
SRI-70				Not available	
FPC-71	4 (1970-1990)	266,000,000 by 1990, 1.3 percent annual rate growth based on year 1970	do	Adequate/some restriction	Evolutionary
NPC-71	do	do	Competitive price relationship	Adequate on world basis	Projections assume no major changes in government policies, and evolutionary technology
RFF-71	4 (1969-2000)	334,000,000 by year 2000, 1.6 percent annual growth, base year 1968	Stability of relative costs	Adequate/some restriction	Evolutionary and revolutionary technology
BuMines-71	4.3 (1968-2000)	334,000,000 by year 2000, 1.6 percent annual growth, base year 1968	Competitive price relationship	Adequate on world basis, some restriction U.S. supply	Forecasts based on specific contingencies, including evolutionary and revolutionary technology

a. Mentions these categories were considered but does not indicate what the assumption was.
b. This work is heavily dependent upon the book "Energy in the American Economy, 1850-1975," by Schurr et al. 1960.
c. No assumption stated for this category.
d. Mention was made that other pertinent data were considered.
Source: Battelle Memorial Institute 1969.

Table 2

Classification of Forecast Methodology

Source Document	Derivation	Scope	Construction
Group I			
Senate-62	Judgment	Complete	Building block
BuMines-62	Projections of least square trends	do	Subdivision
RFF-63	Extrapolation of trends and judgment	do	Building block, energy use subdivision sources
FPC-64	Extrapolation of present trends	Electric only	Building block
Sartorius-67	Extrapolation of trends and judgment	Complete	Building block
Chase-68	Extrapolation of trends and judgment	Complete	Apparently subdivision
BuMines-68	Projection by least square trends and judgment	do	Subdivision
Nathan-68	Extrapolation of trends and judgment	do	Building block, energy use subdivision sources
TET-68	do	Complete	Building block
Group II			
Elec. Ind.-70	Extrapolation of trends	Electricity	do
Morrison-70	Extrapolation of trends and judgment	Complete	do
SRI-70	Extrapolation of past trends	Stationary sources only	do
FPC-71	do	Electricity only	do
RFF-71	Projection by least square trends and judgment	do	do
BuMines-71	Contingency (technological) forecasting	do	do

Source: Battelle Memorial Institute 1969.

Table 3

Projections of U.S. Electric Utilities Fuel Consumption
(Trillions of Btu)

Source	1970	1975	1980	1985	1990	2000
Group I						
BuMines-62			25,489			
RFF-63	13,060		19,380			35,040
FPC-64	15,190		27,566			
Sartorius-67	14,207	20,590	29,890	44,253		
Chase-68			31,000			
BuMines-68	14,547	19,011	24,258			72,291
TET-68	13,473	18,198	24,024	31,251		
Group II						
Morrision-70			31,329		56,235	72,291
SRI (a) -70		22,482	32,044			
FPC-71	17,700		32,500		58,000	
NPC-71	16,695	23,525	32,996	44,363		
RFF-71 (b)			31,329		56,235	93,706[a]
BuMines-71						75,526[a]

a. Totals of fossil fuel and hydroelectric and nuclear power projections.
b. Includes alternative mix of fossil fuels (29,505-49,029); nuclear fuels (40,965-31,327); hydropower (5,056) using heat rate of 8,000 Btu/kWh.
Source: Battelle Memorial Institute 1969.

Table 4

Utility Electric Power Generation[(a)]
(in billions of kilowatt-hours)

Study	1970	1975	1980	1985	1990	2000
Group I						
AEC-62			2,700			
Senate-62			2,700			
BuMines-62			2,739			
RFF-63	1,287		2,084		3,044	4,467
FPC-64	1,484	2,024	2,693			
Sartorius-67			3,086			
BuMines-68			2,739			
Nathan-68			2,641			5,874
TET-68	1,448	1,995	2,581	3,363		
Group II						
Elec. Ind.-70	1,386[(b)]	2,013[(b)]	2,901[(b)]	4,067[(b)]		
Morrison-70			3,110		5,919	9,036
SRI-71		2,163	3,123			
FPC-71 (d)	1,541		3,113		5,922	
RFF-71			3,110		5,920	10,802
BuMines-71						9,036[(c)]

a. Does not include industrial self-generation. NPS estimated this at 127 in 1980 for total generation of 2,820.
b. Residential sales of electricity only.
c. Includes billion kWh alternative mix by type plant: nuclear (3,614.6-5,421.8); fossil fuel (4,789.8-2,982.6); hydropower (632).
d. Includes pumping energy.
Source: Battelle Memorial Institute 1969.

Table 5

Per Capita Electricity Consumption[a]
(in kilowatt-hours)

Study	1965	1970	1975	1980	1985	1990	2000
Group I							
BuMines-62	5,440			11,130			26,700
RFF-63 (b)		6,730		9,100			14,230
Nathan-68 (b)	5,900			11,800			19,800
TET-68	5,440	7,070	8,985	11,080	13,430		
Group II							
Elec. Ind.-70[c]	4,883	6,754	9,278	12,532	16,466		
Morrison-70				12,904		29,915	27,217
FPC-71		7,950		13,780		22,450	
RFF-71				12,790			32,300

a. Electricity is electricity generated; thus it includes losses.
b. Includes industrial self generation.
c. Electric utility sales.
Source: Battelle Memorial Institute 1969.

2. Beaudoin, Browne, Jones, and Lin (1973)

Title: Beaudoin, B., G. Browne, R. Jones, and F. Lin. 1973. Price-Demand Elasticity. New England Power Service Company, Westboro, Massachusetts.

Aim: The aim of this study is to show that demand price elasticities are inelastic, contrary to findings of other studies.

Approach: A questionnaire was sent to all members of the EEI Rate Research Committee. Of the 85 companies to which the questionnaire was sent, 61 had data that could be used. Rate changes and kilowatt-hours sold were classified between residential, commercial, and industrial. The data were requested for the last 10 years.

Simple correlation coefficients between average electricity price and electricity consumption were estimated. These coefficients varied in size when estimated from cross-section data and were generally low in the pooled cross-section analysis. In addition, the correlation coefficient was less significant for residential consumers than for either industrial or commercial, as can be seen from the following table:

Mean Value Time Series Analysis Price-Demand Elasticities

	Total Sample	Correlation Coefficient
Residential	-0.281	-0.229
Commercial	-0.547	-0.453
Industrial	-1.40	-0.527

Conclusion: This study is inadequate for several reasons. The influence of factors other than electricity price is not considered, the statistical techniques employed are crude, and the data are of questionable value, having been taken from a questionnaire sent to companies in the service area. Thus, the estimates are of little value as indicators of the elasticity of demand.

3. Bonneville Power Administration (1973)

Title: Bonneville Power Administration. 1973. Impact Study. Bonneville Power Administration, Portland, Oregon.

Aim: This study is designed to estimate price and income elasticities in the Pacific Northwest region.

Approach: Using data on standard metropolitan statistical areas (SMSA's) and cities in the region, equations are estimated for the saturation levels of a number of appliances and for the demand for electric heat. The saturation equation is of the form:

$$\log S_a = a + b_1 \log PRE500 + b_2 \log PRG50 + b_3 IMF + b_4 TDD$$

where S_a = saturation level of appliance "a"

PRE500 = price of 500 kWh for residential use

PRG50 = price of 50 therms of gas for residential use

IMF = median family income

TDD = average heating degree-days.

The results of estimating the preceding equation by ordinary least squares are presented in Tables 6 and 7. The first set of regressions are based on data from the SMSA's, while the second set are based on data collected from cities.

The own-price elasticities are high relative to other studies, but they do have the plausible feature of declining as the possibilities of substitution with other appliances decline. Unfortunately, this feature is not matched by falling cross-price elasticities. One would expect that the potential for substitution would be reflected in both the own-price and cross-price elasticities. The failure of the estimated elasticities to reflect this presumption may indicate that other alternative fuel prices should have been included in the equation. As a particular example, the space-heating equation should have included some measure of oil prices since oil is an important fuel for space heating.

Second, the income elasticity estimates are uniformly implausible with the exception of the dishwasher equation. In addition, the estimates derived from the two data bases are quite different in most cases. These results could arise from the failure to include variables like housing density and size, which are known to be a source of bias in the Wilson results. Since the Bonneville study appears to be modeled along similar lines to those pursued by Wilson, it is possible that the inclusion of additional variables could improve the estimates of the income elasticities.

In addition to the SMSA work, Bonneville also estimated cross-section equations for 48 states for the years 1960 and 1970. The results for 1960 (with t-values shown in parentheses) are:

Table 6

Saturation of Electric Appliances by SMSA, 1960

Appliance	Constant	Price Elasticity	Cross Elasticity of Gas	Income Elasticity	Temperature Elasticity	R^2
Space heating	7.83	-2.65 (-7.45)	0.58 (3.07)	-0.42 (-0.65)	-0.92 (-7.00)	0.61
Water heating	9.62	-1.94 (-5.39)	1.31 (6.82)	-1.91 (-2.90)	0.02 (0.16)	0.49
Cooking	4.98	-1.13 (-5.36)	0.54 (4.76)	-0.79 (-2.04)	--	0.38
Clothes drying	3.14	-1.04 (-8.76)	0.08 (1.10)	-0.37 (-1.54)	0.28 (5.75)	0.53
Dishwashing	-2.07	-0.61 (-6.31)	-0.22 (-3.47)	1.24 (6.28)	-0.16 (-4.07)	0.59

Source: Bonneville Power Administration 1973.

Table 7

Saturation of Electric Appliances by SMSA, 1970

Appliance	Constant	Price Elasticity	Cross Elasticity of Gas	Income Elasticity	Temperature Elasticity	R^2
Space heating	12.97	-1.80 (-5.97)	1.70 (2.87)	-0.08 (-0.15)	-1.83 (-3.00)	0.66
Water heating	1.24	-1.50 (-6.34)	2.65 (7.13)	-0.42 (-1.25)	-0.12 (-0.31)	0.71
Cooking	- 2.52	-0.25 (-7.33)	0.35 (6.59)	0.13 (2.67)	--	0.67
Clothes drying	- 3.83	-0.16 (-2.29)	0.16 (1.51)	0.49 (4.96)	-0.14 (-1.23)	0.50
Dishwashing	-18.26	-0.01 (-0.15)	0.17 (1.06)	1.89 (13.32)	--	0.75

Source: Bonneville Power Administration 1973.

$$\log ARU = \underset{}{7.86} - \underset{(-8.77)}{1.96} \log PRE\ 250 + \underset{(3.29)}{0.31} \log PRGA + \underset{(0.24)}{0.04} \log IMF$$

$$+ \underset{(1.98)}{0.39} \log TDF - \underset{(2.41)}{0.08} \log MP \qquad R^2 = 0.67$$

$$\log SEH = 19.38 - \underset{(-5.67)}{6.22} \log PRE\ 250 + \underset{(1.99)}{0.89} \log PRGA - \underset{(-1.33)}{1.09} \log IMF$$

$$+ \underset{(1.75)}{0.39} \log TJA - \underset{(-0.6)}{0.01} \log MP \qquad R^2 = 0.58$$

The results for 1970 are:

$$\log ARU = \underset{(-7.26)}{10.30} - 1.63 \log PRE\ 250 + \underset{(3.76)}{0.34} \log PRGA - \underset{(-3.64)}{0.70} \log IMF$$

$$+ \underset{(1.09)}{0.19} \log TDF \qquad R^2 = 0.65$$

$$\log SEH = 13.88 - \underset{(-5.17)}{3.43} \log PRE\ 250 + \underset{(3.74)}{0.97} \log PRGA - \underset{(-2.18)}{1.43} \log IMF$$

$$+ \underset{(1.54)}{0.19} \log TJA + \underset{(0.55)}{0.06} \log MP \qquad R^2 = 0.58$$

With all of the price elasticities significant at the 1 percent level, and

where ARU = average residential use per residential customer

SEH = saturation of electric heat

PRE 250 = price of 250 kWh for residential use

PRGA = average price of gas for residential use

IMF = medium family income

TDF = average difference from 70°

TJA = average January minimum

MP = percent metropolitan.

BPA also estimated demand equations for publicly owned utilities in the area for the years 1966 and 1972. These utilities serve small rural areas, and it is doubtful that the results are of any general interest, particularly since a full set of data was not available. For completeness, however, the results are presented below:

$$\log ARU = 3.05 - \underset{(-7.27)}{0.70} \log PRE1{,}000 + \underset{(2.26)}{0.12} \log TJA \qquad R^2 = 0.59$$

$$\log ARU = 1.81 - \underset{(-10.62)}{0.76} \log PEAR + \underset{(1.32)}{0.06} \log TJA \qquad R^2 = 0.72$$

The results for 1972 are

$$\log ARU = 2.90 - \underset{(-7.44)}{0.59} \log PRE1{,}000 + \underset{(2.03)}{0.09} \log TJA \qquad R^2 = 0.57$$

$$\log ARU = 1.83 - \underset{(-9.85)}{0.67} \log PEAR + \underset{(1.71)}{0.06} \log TJA \qquad R^2 = 0.67$$

where ARU = average residential use

PRE1,000 = price of 1,000 kWh of electricity

TJA = average January minimum

PEAR = average price of electricity for residential use.

Conclusions: These results are reminiscent of the problems with Wilson's earlier work, as explained in the interim report. Consider the average residential-use equation. In 1960, the percent metropolitan variable is included and the income elasticity is positive (although not insignificantly different from zero). In the 1970 equation, the urbanization factor is excluded, and consequently the income elasticity and consequently the income elasticity is significantly negative. It is obvious that the negative income elasticity is in part a consequence of the omission of the environmental variable. Unless good theoretical reasons can be found why the income elasticity is negative, the presumption is that income's correlation with other excluded variables is responsible for its negative elasticity.

4. Chapman, Mount, and Tyrell (1972a)

Title: Chapman, D., T. Mount, and T. Tyrell. 1972. Electricity demand growth and the energy crisis. Science 703-708.

Aim: The aim of this paper is to examine the relationship between population, income, environmental protection costs, electricity demand, and environmental degradation.

Approach: The demand for electricity is treated as a function of population, income, and price. Aggregate demand is found by adding estimates of residential, commercial, and industrial demand, and adding other uses equal to 4.2 percent of total sales, and assuming that transmission losses equal 8.8 percent.

First, the average annual rates of change (in percent) were calculated for various variables. Second, the following elasticities were used. Note that income elasticity is per capita (these elasticities were not estimated in this paper; they were taken as given). Third, the environmental protection costs were estimated for strip-mine reclamation and sulfur emission control. Chapman et al. admit the difficulties involved in predicting future changes in these costs and consider five alternative assumptions ranging from the continuation of past rates of decline to an annual increase equal to 5 percent of the 1970 price (see Table 8).

Capacity estimates are then presented for a variety of assumptions about prices, income growth, population growth, and environmental protection costs. These estimates are reproduced in Tables 9 and 10.

Conclusions: It should be recognized that the Chapman et al. predictions are informal guesses about prices, income, and population combined with similarly informal estimates of the relevant elasticities. While the predictions may be of some interest in indicating the range of possible outcomes, little weight should be put on their paper as an actual attempt to indicate electricity consumption.

5. Chapman, Tyrell, and Mount (1972b).

Title: Chapman, D., T. Mount, and T. Tyrell. 1972. Predicting the Past and Future in Electricity Demand. Cornell Agricultural Economics Staff Paper.

Aim: The aim of this article is to explain why many projections of electricity demand, based on extrapolation of past trends, produce over-estimates of future electricity demand, especially in the long run. Also, Chapman et al. present the preliminary results of their projections.

Approach: Chapman et al. claim that many previous studies assume (often implicitly) that electricity demand grows autonomously or that the factors affecting it will continue to behave as they have in the past. However, Chapman et al. believe that the real price of electricity will

Table 8

Environmental Protection Cost Estimates

A. Strip Mine Reclamation

Estimated Cost per Acre	Origin	Source
\$300 - \$3,000	J. A. Corgan, U.S. Bureau of Mines	Newsweek, June 28, 1971
\$230 - \$800	Dept. of Interior	The Economy, Energy, and the Environment, U.S. Jt. Econ. Comm.
\$1,200 - \$2,000	W. H. Miernyk, West Va. Univ.	The Strip Mining of America, Sierra Club
\$5,000	U.S. Environmental Protection Agency	New York Times, Jan. 3, 1972

B. Sulfur Emission Control

Estimated Cost per Ton Coal	Origin	Source
75¢ - \$1.00	National Coal Association	The Economy, . . .
\$2 - \$4	A. V. Slack and H. L. Falkenberry, Tenn. Valley Auth.	Electrical World, Dec. 15, 1971
\$2	O. Hausgaard, N.Y. Public Service Commission	Public Utilities Fortnightly, Sept. 16, 1971

Source: Chapman and Tyrell 1972.

Table 9

Selected Combinations of Alternatives of Population and Income Growth and Environmental Protection Pricing Policies

Alternatives	Year	Sales (billion kWh) Residential	Commercial	Industrial	Total Generation
A. Past sales and generation	1960	189.9	113.3	340.0	752.6
	1965	281.0	202.1	433.4	1,051.6
	1970	447.8	312.8	572.5	1,526.2
B. Same population growth, same income growth, prices decline at 1/2 past rates of decline (base projection)	1975	754.9	489.9	825.0	2,369.0
	1980	1,080.1	689.9	1,057.1	3,235.8
	1985	1,545.2	971.7	1,354.5	4,431.1
	1990	2,210.7	1,368.4	1,735.5	6,082.9
	1995	3,162.8	1,927.1	2,223.8	8,371.0
	2000	4,525.0	2,714.0	2,849.4	11,546.8
C. Same population growth, same income growth, prices decline at past rates of decline (maximum generation projection)	1975	915.0	614.5	945.8	2,833.1
	1980	1,586.7	1,085.4	1,389.2	4,648.8
	1985	2,751.4	1,917.3	2,040.5	7,679.1
	1990	4,771.0	3,386.6	2,997.3	12,767.5
	1995	8,273.2	5,982.1	4,402.7	21,355.3
	2000	14,346.1	10,566.7	6,467.0	35,916.2
D. Zero population and income growth reached in 2000, 1970 prices maintained (an increase to a stable plateau)	1975	615.0	388.0	713.0	1,964.1
	1980	696.9	424.2	775.0	2,170.2
	1985	767.7	454.5	826.6	2,345.0
	1990	822.1	477.3	865.2	2,477.5
	1995	855.6	491.1	888.6	2,558.4
	2000	865.5	495.1	895.4	2,582.1
E. Same population growth, zero economic growth in 2000, prices rise at 2% of 1970 prices (demand rises, peaks, and declines)	1975	523.1	326.3	598.4	1,657.1
	1980	517.0	304.4	560.3	1,581.4
	1985	508.2	291.5	527.3	1,518.8
	1990	495.8	276.6	497.5	1,453.5
	1995	479.3	261.9	470.1	1,386.4
	2000	458.8	247.9	444.1	1,317.2

Source: Chapman and Tyrell 1972.

Table 10

Total Generation and Required New Plants in 2000:
Alternative Assumptions of Population, Income, and Environmental Protection Cost

Alternative Assumptions			Total Generation (trillion kWh)	Equivalent 1,000 MWe Plants (new; 80% load factor)
Population Growth	Income Growth	Electricity Cost		
Same	Same	Past decline rates	35.916	4,913
Same	Same	1/2 past decline rates	11.547	1,432
Same	Same	Constant at 1970 level	3.952	347
Same	Same	Annual increase at 2% of 1970 level	1.665	20
Same	Same	Annual increase at 5% of 1970 level	0.733	-113
Same	ZIG	Past decline rates	28.226	3,814
Same	ZIG	1/2 past decline rates	9.104	1,082
Same	ZIG	Constant at 1970 level	3.134	230
Same	ZIG	Annual increase at 2% of 1970 level	1.317	-30
Same	ZIG	Annual increase at 5% of 1970 level	0.579	-135
ZPG	Same	Past decline rates	29.589	4,009
ZPG	Same	1/2 past decline rate	9.512	1,141
ZPG	Same	Constant at 1970 level	3.255	247
ZPG	Same	Annual increase at 2% of 1970 level	1.372	-22
ZPG	Same	Annual increase at 5% of 1970 level	0.604	-132
ZPG	ZIG	Past decline rates	23.299	3,110
ZPG	ZIG	1/2 past decline rates	7.500	853
ZPG	ZIG	Constant at 1970 level	2.582	151
ZPG	ZIG	Annual increase at 2% of 1970 level	1.085	-63
ZPG	ZIG	Annual increase at 5% of 1970 level	0.477	-150

Source: Chapman and Tyrell 1972.

reverse its post-World War II sharp downward trend and begin to rise because of environment protection costs and decreasing fuel supplies. Also, Chapman et al. believe that previous studies may well have overestimated population growth rates. For both of these reasons, previous studies have probably overestimated growth of electricity demand, making projections too high, especially in the long run.

Chapman et al. make their projections using the following model:

$$Q_{ijt} = A_{ij} [Q_{ij(t-1}]^{\theta i} * [PE_{ist}]^{\alpha i} * [N_{jt}]^{\beta i} * [v_{jt}]^{\gamma i} * [PG_{ij(t-1)}]^{\sigma i}$$

where θi, αi, βi, γi, σi = short-run elasticities

i = consumer class

j = region

t = year

Q = demand for electricity

A = constant

θ = time response parameter

PE = average price of electricity

PG = average price of gas

N = population

Y = per capita income.

Chapman et al. suggest the following estimates of the elasticities given in the equation:

Consumer Class	Elasticity: Electricity Price	Population	Income	Gas Price	First Year Response (Percent)	Years for 50 Percent of Total Response
Residential	-1.3	+0.9	+0.3	+0.15	10	8
Commercial	-1.5	+1.0	+0.9	+0.15	11	7
Industrial	-1.7	+1.1	+0.5	+0.15	11	7

Using these elasticities, projections of electricity demand can be made by use of the preceding equation. Chapman et al. employ a variety of assumptions about the future time paths of prices, incomes, and population. As a representative example, Table 11 bases the projections on estimates of population and income growth prepared by the Bureau of Economic Analysis and on an assumption that prices remain at their 1970 levels.

Conclusions: The elasticities used to obtain the forecasts are presumably estimated from a pooled cross-section study. However, details of the estimation procedure are not included in the paper. The notable features of these assumed elasticities are the high own-price elasticity, the low-income elasticity, and the extended lag structure. It is difficult to believe that only 50 percent of the total response to a price change occurs within 7 to 8 years. It is not possible to examine the source of these results since the statistical procedures employed are not discussed, raising doubt about the elasticity estimates and forecasts.

6. Doctor et al. (1972)

Title: Doctor, R. D. et al. 1972. California's Electricity Quandry: III, Slowing the Growth Rate. Rand Corporation: R-1116-NSF/CSA.

Table 11

C-T-M Projections Electricity Demand[a]

Area	Electricity Demand (MkWh) 1970	1975	1980	1985	1990	1995	2000
				Residential Demand			
New England	20,900.0	31,733.7	42,246.4	51,858.4	60,529.6	68,495.2	75,994.9
Mideast	69,146.0	100,351.0	129,657.1	155,928.6	179,365.1	200,764.2	220,864.0
Great Lakes	79,687.0	110,721.4	139,381.8	166,671.1	191,007.4	213,706.6	235,384.2
Plains	35,339.0	49,549.8	62,558.2	74,049.1	84,223.4	93,471.7	102,123.9
Southeast	129,124.0	202,016.5	272,694.1	336,848.4	394,286.7	446,574.9	495,391.5
Southwest	40,127.0	61,098.3	81,273.6	99,686.9	116,378.9	131,778.9	146,376.1
Rocky Mountains	9,652.0	12,842.5	15,795.9	18,572.1	21,249.3	23,866.1	26,454.3
Far West	63,820.0	81,279.3	98,599.3	115,467.0	131,860.8	147,950.2	164,024.0
United States	447,795.0	649,592.4	842,806.1	1,019,081.6	1,178,901.0	1,326,647.0	1,466,544.0
				Commercial Demand			
New England	14,643.0	22,546.0	30,840.3	39,148.1	47,410.6	55,799.5	64,453.8
Mideast	57,636.0	79,827.4	103,129.0	126,737.3	150,476.4	174,782.6	199,969.4
Great Lakes	53,911.0	80,329.4	108,139.0	136,017.4	163,702.7	191,792.7	220,749.2
Plains	21,406.0	30,375.9	39,663.0	48,934.9	58,153.1	67,499.6	77,109.3
Southeast	63,556.0	96,842.8	132,157.8	167,914.3	203,815.9	240,472.1	278,332.0
Southwest	33,623.0	47,667.9	62,652.6	78,141.6	94,053.6	110,588.8	127,900.1
Rocky Mountains	10,356.0	14,273.2	18,474.5	22,925.2	27,639.5	32,644.4	37,960.4
Far West	57,554.0	78,612.2	102,300.1	127,479.1	153,682.2	181,191.9	210,218.7
United States	312,750.0	450,474.8	597,356.1	747,297.6	898,933.8	1,054,771.0	1,216,752.0
				Industrial Demand			
New England	18,161.0	20,136.2	22,897.8	26,100.4	29,578.1	33,285.7	37,194.1
Mideast	94,108.0	107,519.6	123,566.9	141,013.1	159,293.4	178,356.0	198,167.6
Great Lakes	123,395.0	127,440.1	139,361.6	155,343.8	173,705.3	193,840.3	215,382.5
Plains	30,703.0	38,085.8	45,549.8	52,938.6	60,241.7	67,563.8	74,978.0
Southeast	160,003.0	193,056.1	229,185.7	267,079.3	306,206.7	346,648.6	388,467.9
Southwest	50,853.0	69,864.1	88,833.6	107,463.4	125,041.4	144,249.6	162,912.2
Rocky Mountains	16,642.0	17,973.4	20,065.0	22,706.8	25,779.2	29,180.9	32,849.0
Far West	78,657.0	90,713.8	106,143.1	123,504.7	142,425.2	162,457.5	183,594.9
United States	572,522.0	664,791.1	775,603.4	896,249.8	1,023,071.9	1,155,582.0	1,293,544.0
				Total Demand			
New England	55,261.4	76,573.9	98,768.0	120,502.9	141,506.3	162,150.2	182,794.4
Mideast	233,765.1	304,384.5	377,021.4	448,252.3	517,504.7	586,029.1	654,864.1
Great Lakes	267,272.7	331,230.6	402,981.6	476,353.5	549,552.0	622,312.6	698,376.5
Plains	90,421.2	122,023.8	152,795.1	181,903.8	209,507.2	236,305.3	262,854.4
Southeast	365,732.3	510,118.4	657,496.9	800,400.0	937,768.7	1,071,942.0	1,205,254.0
Southwest	129,966.1	186,311.3	242,768.4	297,559.4	360,733.7	403,241.8	455,935.3
Rocky Mountains	38,252.6	47,073.0	56,726.1	67,029.1	77,953.3	89,461.8	101,543.2
Far West	210,632.6	263,287.4	323,315.8	385,978.0	450,651.4	517,696.4	587,403.0
United States	1,391,312.0	1,641,601.0	2,311,872.0	2,777,978.0	3,235,174.0	3,690,136.0	4,149,043.0

a. Detailed estimate of electricity demand (in million kilowatt-hours). The BEA population projection and constant price assumption are used. Total demand includes other uses, as for subways, street lighting, and so forth. The estimated transmission loses (average about 9 percent) are added to the demand in order to derive the generating requirements.

Aim: One purpose of the Doctor (1972) article is the projection of future electricity demand in California up until the year 2000, taking into consideration different assumptions about behavior of the relative price of gas and electricity.

Approach: The following equations, whose coefficients are taken from Anderson (1972), are used to take into account the effect of prices on electricity demand:

$$QE = A_1 \, CE^{-0.85} \, CG^{+0.21}$$

where QE = quantity of electricity consumed

CE = cost of electricity

CG = cost of gas

A_1 = net effect of variables not shown (climate, urbanity, etc.), and

$$QE = A_2 \, CE^{+0.08} \, XCG^{-2.31}$$

where QG = quantity of gas consumed.

The time path assumed for future energy prices is given in Table 12. Two projections are then made. One assumes an increase in relative prices; the other allows for the price effects.

These estimates are of some interest. The rapid rise in the price of gas assumed in the study will have a marked effect on gas consumption, but the low value of the cross-price elasticities means that only a small part of the decline in the demand for gas will be reflected in increases in the demand for electricity. As an example, the estimated elasticities suggest

Table 12

Projections of California Electricity Demands

Year	Electrical Energy Consumed: No Increases in Relative Prices (billion kWh)	Electrical Energy Consumed: Increases in Relative Prices[(a)] (billion kWh)	Percent Difference
1970	124.0	124.0	0
1975	171.4	164.5	-4
1980	234.5	210.8	-10
1985	328.4	277.9	-15
1990	420.0	336.1	-20
1995	545.4	412.3	-24
2000	679.0	485.5	-29

a. Prices increase according to the schedule shown in Figure 2-1.
Source: Doctor et al. 1972.

that a 10 percent rise in the price of gas will reduce gas consumption by only 2 percent. The results would tend to suggest that consumers respond to higher electricity or gas prices by reducing total energy consumption rather than substituting between gas and electricity. The author suggests that this type of behavior may well be important for space and water heating while gas-electric substitution is more pronounced in other appliances.

Conclusion: The limitations of the study are due to reliance of the elasticity coefficients obtained from Anderson (1972) and the assumptions about relative price changes to the year 2000 reported in Table 12.

7. Felton (1965)

Title: Felton, J. R. 1965. Competition in the electric energy market between gas and electricity. Nebraska Journal of Economics and Business 4: 3-12.

Aim: Felton (1965) measures the cross-price elasticity between electricity and gas consumption by correlating gas-electric price ratios with gas-electric sales ratios for each state for 1961.

Approach: Although the statistical procedures are not clearly stated, it appears that Felton estimates an equation of the following form:

$$[Q_G - Q_E] = a[P_e - P_G] + \mu$$

where Q_G, Q_E = the logarithms of gas and electricity sales

P_e, P_G = logarithms of the average prices of gas and electricity.

The coefficient "a" can therefore be interpreted as the elasticity of product substitution, measuring the percentage change in factor substitution for the percentage change in factor prices.

Felton's results are reproduced in Table 13. The elasticities are typically quite high, in constrast to measures of cross-price elasticities obtained by the conventional demand equation approach. However, Felton does not include any other variables in his analysis, and hence the estimated elasticities are likely to be biased by the correlation of the price ratio with the omitted variables. A particular example of this phenomenon mentioned by Felton is the influence of labor costs on industrial location. Textile mills, he suggests, locate in the South because of the low labor costs, and the low gas/electric ratio in these states in the industrial categories may well be due to textile machinery being predominantly electrical.

Conclusion: In summary, Felton's study indicates relatively high elasticities of product substitution in all categories of electricity and gas consumption. However, the weaknesses (absence of other variables to explaining demand, such as income) and limited scope of the study greatly reduce its value.

8. Fisher and Kaysen (1962), Chapter 1

Title: Fisher, F. M. and C. Kaysen. 1962. The Demand for Electricity in the United States. North-Holland Publishing Company, Amsterdam.

Aim: In the first chapter, Fisher and Kaysen attempt to estimate the short-run utilization of electricity-using appliances.

Table 13

Relationship Between Gas-Electric and Sales Ratios For Major Customer Classes, 1961

	Customer Class		
	Industrial	Commercial	Residential
Coefficient of Correlation (R)	-0.534(b)	-0.692(b)	-0.795(b)
Coefficient of Determination (R^2)	0.285	0.479	0.632
Elasticity of Product Substitution ($E_{sg/e}$) with a Gas-Electric Price Ratio (G_p/E_p) (a) of:			
19.00	-1.10	-1.09	-1.12
10.00	-1.20	-1.18	-1.27
8.00	-1.26	-1.24	-1.36
6.00	-1.38	-1.35	-1.54
5.00	-1.50	-1.45	-1.72
4.00	-1.71	-1.64	-2.10
3.50	-1.90	-1.80	-2.50
3.00	-2.24	-2.08	-3.33
2.50	-2.98	-2.65	-6.22

a. Gas measured in therms and electricity in kilowatt-hours.
b. Significant at the 1 percent level.
Source: Gas Facts (1962, American Gas Association, New York), pp. 100 and 118; Statistical Yearbook of the Electric Utility Industry for 1961 (1962, Edison Electric Institute, New York), pp. 30 and 42.
Source: Felton 1965.

Approach: The demand for electricity (which is complementary to the stock of electricity-using equipment) is broken down as follows:

$$D_t = \sum_{i=1}^{n} K_{it} W_{it} \ (t=1, \ldots, T)$$

where D_t = total metered use of electricity by the community during t

T = total number of time periods investigated

K_{it} = parameters representing the intensity of use of the W_{it} during i_{th} period of time. (The units are kilowatt-hours per unit of white good per time period.)

Obviously, the K_{it} will vary over white goods and within the white goods in response to economic stimuli like personal income, the price of electricity, etc. Since the stock of white goods owned by the community is assumed fixed, the price of gas (the principle substitute for electricity in appliance use) should have no influence in the short run. Similarly, the influence of outside white good substitute prices should be minimal. The assumption is that there is no single, really important, direct substitute for electricity. It is assumed that

$$K_{it} = F^{i} (P_t, Y_t)$$

where P_t = average price of electricity per kWh

Y_t = per capita income.

More specifically, it is assumed that

$$K_{it} = A_i \, P_t^{\alpha i} \, Y_t \, B_i$$

with A_i, α_i, and B_i constant parameters. Standardizing is accomplished by defining one unit of the i_{th} white good as that amount of it that consumes 1 kilowatt-hour in an hour of normal use (W_{it}). Thus,

$$D_t = \sum_{t=1}^{n} A_i \, P_t{}^{\alpha_i} \, Y_t{}^{B_i} \, W_{it}$$

which is easily transformed into

$$D_t = \sum_{t=1}^{n} C_i \left(\frac{P_t}{\bar{p}}\right)^{\alpha_i} \left(\frac{Y_t}{\bar{y}}\right)^{B_i} W_{it}$$

where $C_i = B_i \, \bar{p}^{\alpha_i} \, \bar{y}^{B_i}$, and $\bar{p}$ and $\bar{y}$ are the arithmetic means of P_t and Y_t over the periods T (i.e., Y_t and P_t are measured as multiples of their means).

Now, if $P_t = \bar{p}$ and $Y_t = \bar{y}$, then $C_i = K_{it}$. C_i can thus be interpreted as the number of hours the community uses each unit of the i_{th} type of white good when price and income are at their respective averages. C_i is hence approximately equal to the average number of hours per time period that a unit of the i_{th} type of white good is in normal use.

The last equation above is approximated by assuming that α_i, P_t, and C_i are constant over appliances. Thus,

$$D_t = C \left({}^{P}t/\bar{p}\right)^{\alpha} \left({}^{Y}t/\bar{y}\right)^{B} \sum_{i=1}^{n} W_{it}$$

The authors show that C, α, and B will be appropriately weighted averages of the C_i, α_i, and B_i, respectively.

In log form (the primes denote logs), this becomes

$$D_t^{'} = A^{'} + P_t^{'} + B\, Y_t^{'} + W_t^{'} + U_t$$

where $A = C(\bar{p})^{-d}(\bar{y})^{-B}$

$$W_t = \sum_{i=1}^{n} W_{it}$$

If good estimates of W_{it} were available, W_i could be subtracted from both sides and $(D_t^{'} - W_t^{'})$ could be estimated by regression on $P_t^{'}$ and $Y_t^{'}$. The authors provide a lengthy discussion of why this would probably best be done by taking first differences of both sides. In summary:

1. It may serve roughly to remove serial correlation.
2. It may reduce multicollinearity by reducing correlation between real electricity price and real income.
3. Past values of Y_t and P_t also influence W_t and hence D_t.
4. It is plausible to regard the first-differenced regression as the fundamental short-run reaction, as it eliminates slow-moving factors that are roughly constant over successive years. Long-run influences, provided they increase slowly or in a roughly exponential trend over time (like the "demonstration effect" of new white goods), are removed by being placed in the constant term by first differencing.
5. Roughly speaking, first differencing can be expected to remove influences on electricity demand the effects of which,

while they differ over states, are constant over time. This will enable clearer isolation of important differences among the state regressions for the discussion of electricity consumption as a process over time. First differencing does mean, however, lower correlations and higher standard errors--the price of honesty in procedure.

Because good estimates of W_{it} are not available, additional assumptions are necessary. If the stock of white goods in each state grew exponentially (or with random fluctuations around an exponential trend), ignoring W_t as an explicit variable in the first-differenced regression of D_t' on P_t' and Y_t' would give unbiased estimates of α and B by placing the trend in the constant term. The demonstration effect and exponential population growth are cited as factors favoring the plausibility of this assumption, and it is accordingly adopted.

Because the state is the smallest unit for which full information covering the entire United States is more or less available for all variables, it is chosen as the unit of observation. The time period covered is 1946 to 1957. Kilowatt-hour sales to residential or domestic consumers are obtained from the Edison Electric Institute's annual statistical bulletin. Money price was revenue divided by quantity sold. Money incomes per capita are taken from the Commerce Department's estimates in Personal Income by States Since 1929 for the period 1946 to 1953 and an August 1958 issue of the Survey of Current Business for 1954 to 1957. Real income is obtained using the consumer price index as a deflator.

The constant "k" estimated in the regressions is an estimate of the exponential trend in the demand for electricity not accounted for in the explicitly included variables. "Autonomous growth rate" is the same figure in terms of percentage growth per year. The chief source of this growth is the growth of the stock of white goods. The growth rates from 6.8 to 17.5 percent are what the authors deem a plausible geographical spread.

The results bear out the expectation that the approximate equation estimates would work best in the case of low growth and worst in a community with a high growth in electricity demand, since the composition of the stock of white goods could not be expected to remain constant in the latter case.

While the significance level of the estimates in general is too great to be due to chance, it is nevertheless true that it is not greatly impressive. However, the random component of short-run electricity demand is expected to be relatively large. The following features are observed:

1. No price or income elasticity is greater than unity, and practically all the price elasticities are negative. Most are reasonably near zero.
2. Greater urbanization seems to be associated with greater income elasticity and slightly more negative price elasticity, with the first of these tendencies being very much stronger. Percentage urban population is obtained from the 1950 census. The Spearman rank coefficient is +0.7991 (for urbanization and income elasticity), which is significant beyond the 0.01 level.

3. On the basis of a covariance test, the division of observations into groups with similar characteristics (demcgraphic) is found to be significant.

Regressions are performed for each of the first three groups as a whole, first by pooling all observations in the group and, second, by measuring all first-differenced variables as deviations from their respective state means.

The low R^2's are nevertheless highly significant in view of the number of observations involved. The parameter estimates are quite significant. The urban-rural pattern noted above is clear, and the negative income elasticity in the rural states is significantly different from zero.

The authors offer a tentative explanation of the results. The pattern observed may be due to a tendency for the stock of white goods in a rural community to be relatively more heavily weighted toward major appliances such as freezers, washing machines, and so forth than in the stock of white goods in an urban community, owing to the relative absence of market-oriented alternatives like frequent trips to the supermarket, commercial laundry, and so on. Also, rural states tend to be poorer states, relatively lower in minor "luxury" appliances. Finally, rural states tend to use their appliances more to capacity at all income levels. Because the variety of white goods available to a rural community's use is less than for an urban one, equal percentage income increases do not induce as great percentage increases in electricity demand in rural homes as in urban ones.

Results are also reported for states not included in the above groups. Price elasticity, though less than unity (except for Colorado), is somewhat higher than for the groups discussed above. There is some tendency for richer and relatively more urban states to have greater income and price elasticity than do poorer and relatively more rural areas. But it is here not very low. There is a strong tendency toward negative income elasticities for predominantly rural states, but these states also have marked greater price elasticities, a fact not susceptible to explanation in terms of the composition of white goods.

Duplicate experiments were also conducted with prewar data, and, with some reservations, they yielded broadly similar patterns. In particular, the last mentioned observation of negative income and relatively large price elasticity was more in evidence (as before in the economically younger states). The authors argue that it is quite possible that in the 1930s the "electricity-using habit" had not been so strongly formed or so widely spread into different aspects of household chores that the labor of the housewife was not an unusual substitute for appliance use in all states, whereas, in the 1940s and 1950s, such substitution was unusual in economically older (and richer) states.

Conclusion: The results appear to conform with expectations and experience about consumer short-run reactions. The short-run feature of the model limits its usefulness for analyzing long-run consumption change in response to price changes.

9. Fisher and Kaysen (1962, Chapters 2 and 3)

Title: Same as No. 8.

Aim: The objective is to estimate the determinants of the change in the stock of appliances.

Approach: Fisher and Kaysen (1962) suggest that changes in the stock of appliances can be explained by:

1. permanent and transitory income
2. real price of the electrical appliance
3. real price of the gas substitute appliance
4. number of electricity connections per capita
5. population
6. marriages
7. average kWh consumption of the appliance
8. 3-year moving average of residential electricity prices
9. average price of gas per therm.

Most of these items are obvious, but a number of comments may be helpful. The distinction between permanent and transitory income was first introduced into the literature by Friedman. In general, household consumption does not respond to short-term or transitory changes in income. Households deplete savings during times of below normal income and save a large portion of windfall gains. This is the motivation behind Fisher and Kaysen's inclusion of permanent income. More recent work, however, has suggested that consumer durables in general and appliance stocks in particular may well be the forms in which transitory changes in income are applied. Faced with a decline in short-term income, the household will resist purchasing new appliances by extending the life of the existing stock. Similarly, windfall gains in income will be "invested" in household appliances. For this reason, the inclusion of permanent income in appliance stock equations may not be as appropriate as the inclusion of transitory income.

Secondly, the number of electricity customers per capita is intended to reflect the interrelationships between various forms of electricity consumption. If a household has been connected to gas or electric lines, then further appliance purchases will not have to pay the cost of connection. One would therefore expect that the total cost of the appliance would be less for such households.

The number of marriages is an interesting cyclical variable. The rise in the marriage rate in the early postwar years increased the demand for appliances. If these appliances have approximately equal working lives, one may also expect a secondary appliance boom as the initial stock is replaced. Unfortunately, this aspect was not investigated in the study.

The Fisher and Kaysen estimates use a pooled cross-section of states for the years 1946-1957. The choice of states to pool is arbitrary and is listed below.

Groups of States in the Fisher and Kaysen Study Group

Group	
a_1	Massachusetts, Connecticut, Rhode Island
a_2	New Jersey, New York

b	Pennsylvania, Ohio, Indiana, Michigan, Wisconsin, Missouri
c	Minnesota, Iowa, North Dakota, South Dakota, Nebraska, Kansas
d	Virginia, North Carolina, South Carolina, Georgia, Tennessee, Alabama, Mississippi, Arkansas
e	Louisiana, Texas, New Mexico, Arizona, Nevada
f_1	Montana, Idaho, Wyoming, Utah
f_2	Washington, Oregon

The basic equation estimated is

$$\log W_{it} - \log W_{it-1} = A_i + \eta_{i1}(\log Y^E_t - \log Y^E_{t-1}) + \eta_{i2}\log Y_t + \eta_{i3}\log E_{it}$$
$$+ \eta_{i4}\log G_{it} + \eta_{i5}(\log H_t - \log H_{t-1}) + \eta_{i6}(\log F_t - \log F_{t-1})$$
$$+ \eta_{i7}\log M_t + \eta_{i8}\log P^E_t + \eta_{i9}\log \gamma_{it} + \eta_{i10}\log V^E_t$$

where W_{it} = stock of ith appliance at time t

Y^E_t = permanent income at time t--a 17-year average with weights provided by Friedman's analysis of the consumption function

Y_t = actual income at time t

E_{it} = real price of electric appliance i at time t

G_{it} = real price of gas substitute appliance to appliance i at time t

H_t = number of electricity customers per capita

F_t = population

M_t = average number of marriages

γ_{it} = average kWh consumption of appliance i

p_t^E = 3-year moving averages of residential electricity prices

V_t^E = average price of gas per therm.

These definitions are not exact, and the reader should consult Fisher and Kaysen (pp. 87-88) for a full definition of the variables used in the study.

Finally, regressions were run for the following appliances: washing machines, refrigerators, ironing machines, and electric ranges. The estimates obtained by Fisher and Kaysen are reprinted in Tables 14 through 17. As can easily be seen, not all of the variables mentioned are actually included in the regression equation.

In each of these tables, the "group" refers to the geographical areas listed above. The "n's" are the estimated coefficients and defined as follows:

η_1 = change in long-run income

η_2 = current income

η_3 = price of appliance

η_4 = price of gas-using substitute

η_5 = change in number of wired households per capita

η_6 = change in population

η_7 = marriages

Table 14

Household Long-Run Regressions by Groups of States: Washing Machines, 1946-1949, 1951-1957

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
a_1					
	1	-0.1840	(0.4381)		
	2	+0.0721	(0.1181)		
	3	-0.0257	(0.2224)		
	6	+0.0311	(0.3155)		
	7	+0.0806	(0.0608)		
				0.5146(b)	22
a_2					
	1	+0.2791	(0.6422)		
	2	+0.0102	(0.1417)		
	3	+0.2008	(0.2852)		
	6	+0.3388	(0.6062)		
	7	+0.1042	(0.1205)		
				0.5216(a)	13
b					
	1	+0.7810(a)	(0.3059)		
	2	+0.4705(c)	(0.0941)		
	3	-0.3181(a)	(0.1307)		
	5	+0.5182	(0.2734)		
	6	+0.3722	(0.3920)		
	7	+0.1196(c)	(0.0266)		
				0.6984(c)	48
c					
	1	+0.4454	(0.3008)		
	2	+0.1183	(0.0913)		
	3	+0.1670	(0.1285)		
	5	+0.4617(b)	(0.1210)		
	6	+0.2269	(0.3601)		
	7	+0.0723(b)	(0.0285)		
				0.6379(c)	48

a. Significant at 5 percent level.
b. Significant at 1 percent level.
c. Significant at 0.1 percent level
Source: Fisher and Kaysen 1962.

Table 14 (Cont.)

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
d					
	1	+0.0634	(0.4835)		
	2	-0.0439	(0.1307)		
	3	+0.3420	(0.2145)		
	5	+0.7992(c)	(0.1355)		
	6	+0.1051	(0.3739)		
				0.6989(c)	58
e					
	1	-0.0565	(0.4377)		
	2	+0.0177	(0.1329)		
	3	+0.0396	(0.1685)		
	5	+0.2420(a)	(0.0920)		
	6	+0.1706	(0.2160)		
	7	+0.0329(a)	(0.0155)		
				0.4029(b)	39
f_1					
	1	+0.1328	(0.3521)		
	2	+0.1048	(0.1391)		
	3	+0.3466(a)	(0.1347)		
	5	+0.1535	(0.1981)		
	6	+0.4350(a)	(0.1903)		
				0.6590(c)	31
f_2					
	1	-1.0136	(1.0174)		
	2	-0.0757	(0.3160)		
	3	+0.1247	(0.2722)		
	5	+0.5666	(0.3633)		
	6	+1.1303(a)	(0.5498)		
				0.6186(c)	22

Table 15

Household Long-Run Regressions by Groups of States: Refrigerators, 1946-1949, 1951-1957

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
a_1	6	+0.7066	(0.4910)		
	7	+0.3281(c)	(0.0521)		
				0.6149(c)	25
a_2	6	+1.0767	(0.5895		
				0.1640	17
b	5	+0.8592(b)	(0.3152)		
	6	+0.8877	(0.5282)		
	7	+0.0779(a)	(0.0358)		
				0.2495(b)	51
c	1	+0.2972	(0.1811)		
	5	+1.3188(c)	(0.1103)		
	6	+1.4835(b)	(0.4401)		
	7	+0.0167	(0.0308)		
				0.7463(b)	50
d Equation I:	1	+0.3494	(0.7718)		
	2	+0.4079	(0.2182)		
	3	-0.0993	(0.1679)		
	5	+0.5642(c)	(0.1520)		
	6	+0.9572(a)	(0.3813)		
				0.6436(c)	

a. Significant at 5 percent level.
b. Significant at 1 percent level.
c. Significant at 0.1 percent level.
Source: Fisher and Kaysen 1962.

Table 15 (Cont.)

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
d Equation II:					
	1	+0.1582	(0.6809)		
	2	+0.5290(a)	(0.2125)		
	3	+0.0716	(0.1721)		
	5	+0.8019(c)	(0.1699)		
	6	+1.3703(c)	(0.3945)		
	8	-0.2331(b)	(0.0874)		
				0.6830(c)	57
e					
	1	+0.9375	(0.9173)		
	2	+0.4684	(0.2927)		
	3	-0.0305	(0.2163)		
	5	+0.2926	(0.1814)		
	6	+0.8689(a)	(0.4128)		
	7	+0.0270	(0.0469)		
				0.4345(c)	39
f_1 Equation I:					
	2	+0.2488(a)	(0.0990)		
	3	+0.1626	(0.0830)		
	5	+0.5260(a)	(0.2350)		
	6	+1.0502(b)	(0.2931)		
				0.6806(c)	32
f_1 Equation II:					
	1	+0.1556	(0.6045)		
	2	+0.3030	(0.2331)		
	3	+0.1428	(0.0978)		
	5	+0.5286(a)	(0.2387)		
	6	+1.0644(b)	(0.3026)		
				0.6812(c)	31
f_2	2	+0.5551	(0.2836)		
	3	+0.0742	(0.1594)		
	5	+1.0133(a)	(0.3926)		
	6	+1.3391	(0.7352)		
				0.7150(a)	14

Table 16

Household Long-Run Regressions by Groups of States: Ironing Machines, 1946-1949, 1951-1957

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
a_1					
	1	+0.6491	(1.5054)		
	2	+0.4312	(0.3298)		
	3	-1.0417	(0.8981)		
	6	+0.8338	(1.0748)		
	7	+0.3642(b)	(0.1285)		
				0.6237(c)	22
a_2					
	1	+1.2291	(0.5839)		
	2	+0.4040(b)	(0.1230)		
	3	+0.2248	(0.3327)		
	6	+1.0290	(0.5631)		
	7	+0.3176(b)	(0.0886)		
				0.8845(c)	13
b					
	1	+1.4940(c)	(0.3627)		
	2	+0.6873(c)	(0.0921)		
	3	-0.3277	(0.2464)		
	5	+0.2911	(0.3390)		
	6	+0.3674	(0.4968)		
	7	+0.1144(c)	(0.0303)		
				0.8179(c)	48
c					
	1	+1.4292(b)	(0.4459)		
	2	+0.3900	(0.1339)		
	3	-0.5177	(0.3618)		
	5	+1.4904(c)	(0.1496)		
	6	+0.5536	(0.6188)		
	7	+0.0935(a)	(0.0446)		
				0.7488(c)	48

a. Significant at 5 percent level.
b. Significant at 1 percent level.
c. Significant at 0.1 percent level.
Source: Fisher and Kaysen 1962

Table 16 (Cont.)

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
d					
	2	+0.4012(b)	(0.1264)		
	3	-1.5177(b)	(0.4923)		
	5	+1.6359(c)	(0.2073)		
	6	+2.1092(b)	(0.5859)		
				0.8201(c)	59
e					
	2	+0.6040(c)	(0.1121)		
	3	-0.7750	(0.6575)		
	5	+0.5428(a)	(0.2414)		
	6	+0.6860(c)	(0.0763)		
				0.7936(c)	41
f_1					
	1	+1.4060	(0.9606)		
	2	+0.8996(a)	(0.3571)		
	3	-0.2230	(0.5522)		
	5	+0.5674	(0.3799)		
	6	+1.1733(a)	(0.5389)		
				0.4628(c)	31
f_2					
	2	+0.8522(a)	(0.3412)		
	3	+0.5714	(0.8183)		
	5	+2.1883(b)	(0.5756)		
	6	+2.7585(a)	(1.1310)		
				0.7027(c)	14

Table 17

Household Long-Run Regressions by Groups of States:
Electric Ranges, 1946-1949, 1951-1957

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
a_1 Equation I:					
	1	+2.3413(a)	(0.9517)		
	2	+0.4549	(0.3257)		
	3	+0.2126	(0.3584)		
	4	-0.1317	(0.3079)		
	6	-0.0162	(0.[illegible]9)		
	7	+0.1804(a)	(0.0789)		
				0.6845(c)	21
a_1 Equation II:					
	1	+0.8512	(0.9620)		
	2	+0.0980	(0.2779)		
	3	-0.3988	(0.3169)		
	4	+0.6736(a)	(0.3111)		
	6	+0.2971	(0.5083)		
	7	+0.0541	(0.0831)		
	8	+0.2804	(0.1516)		
	10	+0.4085(b)	(0.1292)	0.8355(c)	19
a_2 Equation I:					
	1	-1.2374	(0.9187)		
	2	-0.0118	(0.3181)		
	3	+0.1370	(0.4294)		
	4	+0.1787	(0.3467)		
	6	+0.6388	(1.0257)		
				0.6374(b)	13

a. Significant at 5 percent level.
b. Significant at 1 percent level.
c. Significant at 0.1 percent level.
Source: Fisher and Kaysen 1962

Table 17 (Cont.)

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
a_2 Equation II:					
	1	-1.0568	(1.1039)		
	2	-0.4245	(0.5964)		
	3	-0.1508	(0.4185)		
	4	+0.4465	(0.3670)		
	6	+0.9338	(0.9504)		
	8	+0.0137	(0.3316)		
	10	+0.4377	(0.4150)	0.8121(c)	11
b Equation I:					
	1	+0.1803	(0.7508)		
	2	+0.1251	(0.2917)		
	3	+0.1364	(0.2973)		
	4	-0.2665	(0.2225)		
	5	+0.6662	(0.5231)		
	6	+0.7518	(0.7056)		
	7	+0.1217(b)	(0.0429)		
				0.6184(c)	47
b Equation II:					
	1	+0.3968	(0.6911)		
	2	+0.1954	(0.2889)		
	3	-0.33[illegible]	(0.2990)		
	4	+0.1070	(0.2157)		
	5	+0.0447	(0.4976)		
	6	+0.0134	(0.6496)		
	7	+0.0726	(0.0398)		
	8	+0.2974(b)	(0.1080)		
	10	+0.0536	(0.0708)	0.7205(c)	45
c Equation I:					
	1	+0.8113	(0.5730)		
	2	+0.1648	(0.1807)		
	3	+0.6034(b)	(0.2314)		
	4	-0.0246	(0.2147)		
	5	+0.6746(a)	(0.2804)		
	6	-0.0417	(0.5242)		
				0.6410(c)	48

Table 17 (Cont.)

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
c Equation II:					
	1	+0.1155	(0.5326)		
	2	-0.0185	(0.1711)		
	3	-0.1881	(0.2580)		
	4	+0.3540	(0.2113)		
	5	+0.7908(b)	(0.2407)		
	6	+0.2204	(0.6925)		
	8	+0.4026(b)	(0.1303)		
	10	+0.1073	(0.0782)	0.7495(c)	46
d Equation I:					
	1	+0.2747	(0.4649)		
	2	+0.1418	(0.1858)		
	3	+0.1437	(0.2177)		
	4	-0.1832	(0.1960)		
	5	+0.7209(c)	(0.1446)		
	6	+1.1871(c)	(0.2992)		
	7	+0.0170	(0.0140)		
				0.8583(c)	56
d Equation II:					
	1	+0.2845	(0.4656)		
	2	+0.0951	(0.1917)		
	3	+0.0800	(0.2419)		
	4	-0.0970	(0.2070)		
	5	+0.6729(c)	(0.1484)		
	6	+1.0660(c)	(0.3136)		
	7	+0.0172	(0.0140)		
	8	+0.1031	(0.0714)		
	10	-0.0337	(0.0449)	0.8636(c)	54
e Equation I:					
	1	-1.1669	(0.8743)		
	2	-0.0417	(0.3190)		
	3	+0.3153	(0.2884)		
	4	-0.0280	(0.2741)		
	5	+0.0658	(0.1577)		
	6	+0.3110	(0.3593)		
	7	+0.0074	(0.0385)		
				0.4208(c)	38

Table 17 (Cont.)

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
e Equation II:					
	1	+0.3079	(0.8449)		
	2	+0.5518	(0.3076)		
	3	-0.0250	(0.2806)		
	4	+0.1600	(0.2685)		
	5	+0.0139	(0.1350)		
	6	+0.1816	(0.3074)		
	7	+0.0290	(0.0335)		
	8	-0.1368	(0.0697)		
	10	+0.3033(c)	(0.0758)	0.6042(c)	36
f_1 Equation I:					
	1	-0.3561	(1.0928)		
	2	-0.2215	(0.4683)		
	3	+0.5256	(0.3523)		
	4	-0.3878	(0.2788)		
	5	+0.0782	(0.4875)		
	6	+0.2750	(0.5926)		
				0.4733(c)	30
f_1 Equation II:					
	1	+0.1080	(1.4863)		
	2	-0.0312	(0.6159)		
	3	+0.2496	(0.4129)		
	4	-0.2018	(0.3196)		
	5	-0.4725	(0.6652)		
	6	-0.1188	(0.6715)		
	8	+0.1800	(0.1854)		
	10	+0.0216	(0.0376)	0.5035(c)	28
f_2 Equation I:					
	1	-1.0492	(0.9485)		
	2	-0.2258	(0.3208)		
	3	+0.0706	(0.2261)		
	4	-0.3456	(0.1752)		
	5	+0.9042(a)	(0.3213)		
	6	+1.7195(a)	(0.5394)		
	7	+0.1448(a)	(0.0519)		
				0.9280(c)	11

Table 17 (Cont.)

Group	n	Regression Coefficient	Standard Error	R^2	Degrees of Freedom
f_2 Equation II:					
	1	-1.2677	(1.4042)		
	2	-0.3785	(0.4023)		
	3	-0.1668	(0.2713)		
	4	-0.1608	(0.2487)		
	5	+0.4441	(0.4331)		
	6	+1.5285(a)	(0.5439)		
	7	+0.1517(a)	(0.0568)		
	8	+0.1708	(0.1424)		
	10	+0.1179	(0.1470)	0.9432(c)	9

n_8 = price of electricity

n_9 = kWh of electricity consumed per time unit of normal use of one physical unit of appliance

n_{10} = price of gas.

The results of the regression equation can be summarized briefly:

1. Fisher and Kaysen find no substantial price effects either from the price of appliances or from the price of electricity or from gas substitutes.
2. Changes in "permanent" income were more important in wealthier communities, while changes in current income were the dominant effect in poorer and more rural states.
3. The most important determinants of the consumption of appliances are demographic. Three demographic variables--the change in the number of wired households per capita, the change in the population, and the number of marriages are all important determinants.

If the Fisher and Kaysen results are accepted, the implication is that the economic variables are unimportant either as policy tools or as predictive devices. Changes in the price of electricity or in the price of electrical appliances will have a small and unpredictable influence on demand, and consequently changes in rates are an ineffective means of regulating electricity consumption. Predictions of future electricity demand should be based primarily on the underlying demographic trends, and the interaction between the increase in the demand for electricity and its price can safely be ignored.

The results are even more surprising relative to Fisher and Kaysen's finding that the short-run demand is relatively inelastic. Intuition would suggest that changes in the utilization of a given stock of appliances would have a smaller effect on electricity demand than changes in the stock. However, Fisher and Kaysen find the opposite result.

Conclusion: In short, the Fisher and Kaysen results lack plausibility. The major faults of the study suggested by Wilson (1971) and EEH are significant.

There is weakness in the quality of the data, especially the appliance stock estimates. The weakness of these series was, of course, recognized by Fisher and Kaysen. Wilson compares their series with that in the 1960 Census of Housing. He finds that the Fisher and Kaysen series tends to overestimate stocks in high-rate areas and underestimate stocks in low-rate areas.

"For example, for Pennsylvania, New York, New Jersey, and Massachusetts, the census estimates for electric ranges were 63 percent, 69 percent, 72 percent, and 68 percent, respectively, of Fisher and Kaysen's estimates. For Washington and Oregon, in contrast, the census estimates were 107 percent and 95 percent of Fisher and Kaysen's figures."

This point should not be taken too far. In Fisher and Kaysen's study, the regression results are for groups of states, and any bias in the coefficient must result from the correlation between the error in the variable and the electricity rate within the group, rather than across the country as the above quotation suggests. However, the general point that the Fisher and Kaysen data are weak and inconsistent with the census results is important and suggests that the importance of the results should be depreciated.

The appliances chosen are a biased sample of electrical equipment in that they are predominantly appliances for which no close substitutes are available. The Fisher and Kaysen findings of insignificant price elasticities are based on four appliances--refrigerators, freezers, ironing machines, and washers. Wilson suggests that for electric water heaters and ranges, the elasticities estimated by Fisher and Kaysen are significant. Again, this criticism overstates the case. Table 17, which reproduces Fisher and Kaysen's results, demonstrates that, of the three electricity price elasticities that are significant in the study of electric ranges, all three are of the wrong sign. While Fisher and Kaysen (p. 109) state that the elasticities are of the expected sign for water heaters, they do not present the results of these regressions, and hence there is no way of gauging the significance of the coefficients.

A third criticism is more substantial. Fisher and Kaysen use statewide averages, including statewide averages of prices. It is clear that the proper geographic area for the study of electricity demand is not the state, and that probably the close empirical counterpart to the economic concept of a market is the area covered by a utility. This definition has the advantage of presenting all participants in a market with the same rate schedule. Comparisons of different markets could then be used to estimate the demand elasticities. The use of statewide data could involve aggregation problems if there were a wide variance in price within the market.

A similar problem arises with the use of average price, defined in Fisher and Kaysen as revenue from electricity sales divided by the quantity of sales in kWh. The choice of an appropriate price variable is an endemic problem in studies of electricity demand. Since utilities typically offer declining rate schedules, the correct price for the household to consider is the marginal price of electricity. Since different households face differing marginal prices, the appropriate aggregate variable is unclear. The problem is compounded by the practice of offering lower electricity rates on particular appliances, especially water and space heaters. Further complications may arise in the future as peak load marginal cost-pricing schemes are introduced. In this case, the true marginal price will be determined by the household's consumption, appliance stock, and time of the day.

At this stage, it is sufficient to say that the problem is a complex one and that Fisher and Kaysen's solution is a particularly simple and possibly inappropriate one. Some consolation can be derived from the fact that later studies using a variety of differing price variables have estimated elasticities that are reasonably close.

The major problem with Fisher and Kaysen, as Wilson recognizes, is that three variables with pronounced time trends--the percentage of new wirings, the rate of population growth, and the number of marriages--are regressed on a variable with a similar time trend. Once the trend in the stock series is accounted for, variations around the trend are almost totally random due to the noise in the data.

For this reason, the rate of growth in the stock of appliances is an inappropriate dependent variable for a regression study. Starting with Wilson, later studies have used saturation models that use the percentage of homes with a given appliance as the dependent variable. Since this percentage can be assumed independent of the rate of population growth and other demographic variables, it is a more appropriate dependent variable for an economic analysis.

10. Fisher and Kaysen (1962, Chapter 4)

Title: Same as No. 8.

Aim: This chapter considers, in some detail, the demand for electricity by industry.

Approach: The authors begin by describing intractable statistical problems. Because changes in the price of electricity will affect the composition of output, serious questions are raised about the use of index numbers to describe change in output. If, for example, a multi-product firm has different costs of variable electricity input per unit of output for each product it produces, then a rise in the price of electricity will affect the profitability (or price) of those products that are more "electricity-intensive." Barring special cases of consumer elasticity configurations, this will cause the composition of output to shift away from products with relatively large electricity input. Even if the value of output were to remain the same as before, using a fixed-weight index, implying in any equation that output is the same, the shift in composition means that total electricity input will be less than its initial value. Aggregation thus tends to obscure such substitution in demand, rather than in production.

Another problem concerns the fact that many firms generate some of their own electricity. At what price should this be valued? Rational accounting procedure for such a firm is to value its electricity input at the going price for purchased electricity. But when the latter price rises, there is substitution among electricity sources; the fall in purchased demand is less than the fall in total demand. It is the latter that is a matter of concern.

The model used for the single firm is:

$$D_{it} = A_i + B_i X_{it} P_{it}^{\pi_i} + J_{it}$$

where D_{it} = all electricity used by the i^{th} establishment

P_{it} = real price of electricity to the establishment

X_{it} = an output index

π_i = a parameter.

Aggregation is accomplished using the following convention. For all establishments producing the same goods with a given electricity-using technology, the B_i and π_i will be assumed the same, though A_i may vary with size (standardizing on the smallest plant). For any set of establishments I, there is an equation:

$$D_{It} = (A/\bar{x} + B\,P^{\pi}_{It})\,X_{it} + U_{it}$$

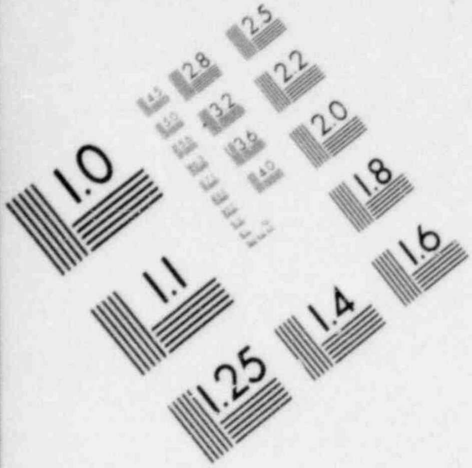
and $N_{It} = \bar{X}_{It} / \bar{x}$ = the number of smallest size plants in I (e.g., one twice the size would be counted as two)

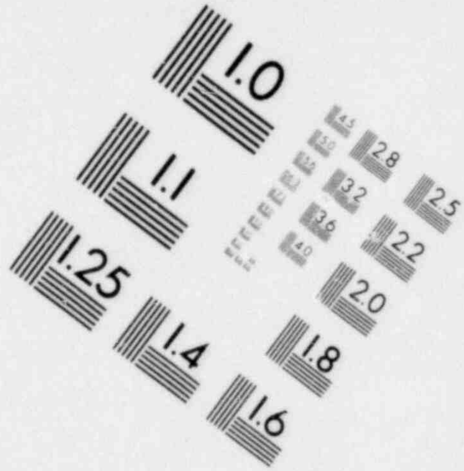
$\bar{x}$ = output capacity of the smallest plant.

i.e., $D_{It} = N_{It}A + B\,X_{It}P^{\pi}_{It} + U_{It}$

(The U's are a random disturbance with the usual properties.) Changes in technology are ignored for the moment.

For a number of reasons, estimation of the model from time-series data alone is not feasible. These reasons may include the fact that the equation is not linear and requires iterative estimation and that there is an inability to hold technology constant. Similarly, problems exist with the use of cross-section data. Current electricity price is likely to be highly correlated over states with the industry locational decisions and hence with capacity output, implying serious multicollinearity problem. Also, because technologically homogeneous subgroups of firms in an industry tend to locate in a few states at most, B is likely to be correlated with electricity price and will tend to be high in states where P_{It} is low. Further, given locations, the composition of outputs over states will depend on P_{It}. Thus, use of cross-section





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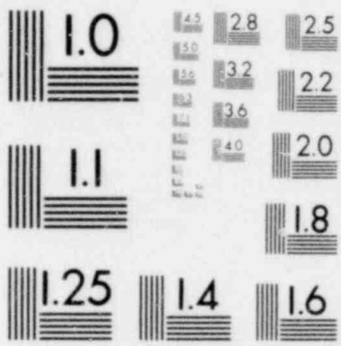

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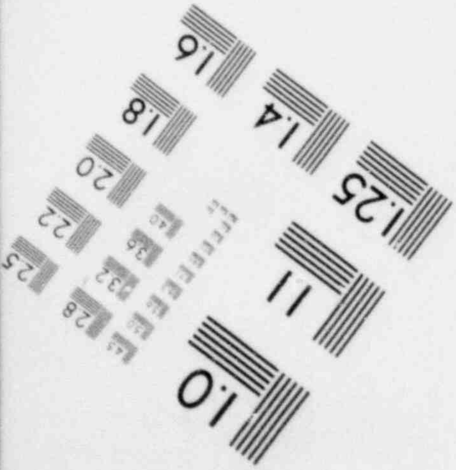

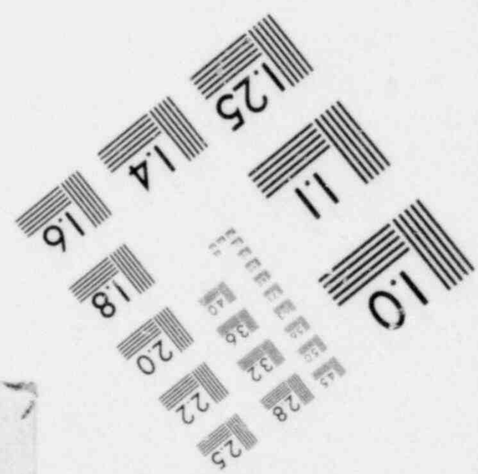

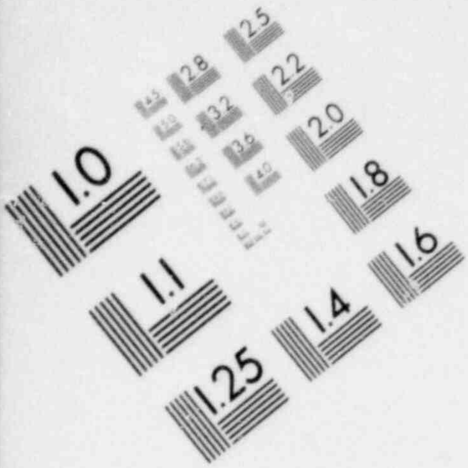

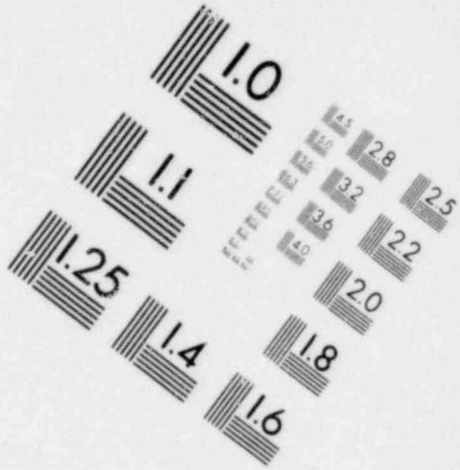

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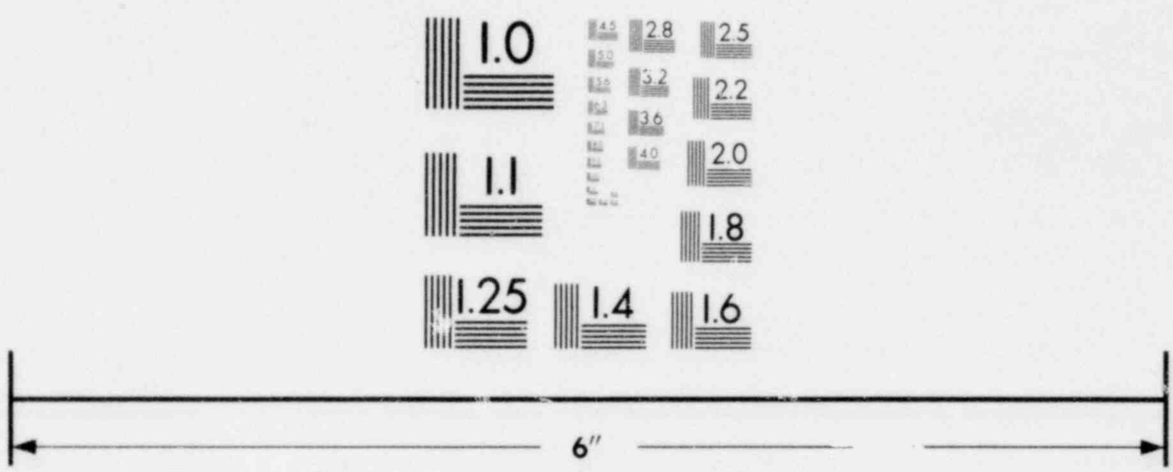

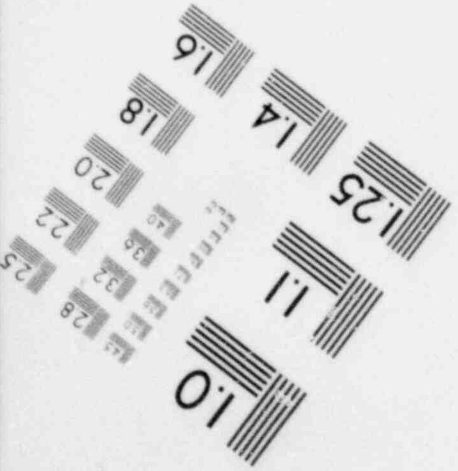

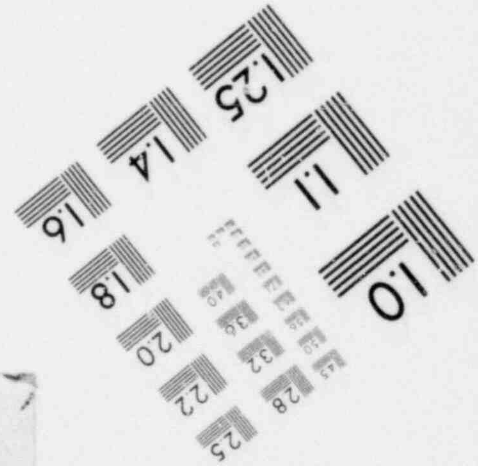

data does, however, yield some information. The effects of differentials in electricity price on the geographic distribution of output compositions are likely to be greater than the effects over time, as the opportunities for geographic adjustment are greater than those for adjustment to a universal change in the real price of electricity. It follows that estimation of the equation for a full-capacity year from state cross-section data will yield an upper bound for π provided that technology has been reasonably constant for some time. Finally, B may also be estimated, using some assumptions. Let

$$B_I = C\,(P_{It} / \bar{P}_t)^u$$

where B_I = the value of B in the I_{th} state

$\bar{P}_t$ = a weighted average over I of the P_{It}, the weights being the quantity of electricity consumed by the industry in each state

C and u = parameters.

Then

$$D_{It} = A\,X_{It/\bar{x}} + C\,P_{It}^{u+\pi}\,X_{It} / \bar{P}_t^{-u} + U_{It}$$

Thus, C and B would always coincide if P_{It} were always at its weighted average value. The estimate of C that is obtained by fitting the above equation to cross-section data will in fact be an estimate of this common value and hence the overall B for the industry. U here represents the effects addition to π of electricity price on geographic adjustments in output composition. B_I actually represents the gross effect of electricity price on geographic adjustments in output composition. B_I really represents the gross effect of electricity price differentials, including locational effects and the like.

Limited two-digit industry cross-section data from the Annual Survey of Manufacturers were used in an application of the above. Multiplying the first term of the last-mentioned equation by P^o_{It}, i.e., by unity, then least-squares regression of log D_{It} on log X_{It} and log P_{It} will give estimates of weighted averages of $u + \pi$ and zero, and of C and $A/\bar{x}$. Formally, using a logarithmic regression, the authors estimate

$$D_{It} = K X^{B}_{It} P^{\alpha}_{It} + v_{It}$$

as an approximation to the desired equation.

B may be different from unity, since value added by manufacturer is used as the output index, and this means that locational factors, uncorrelated with the price of electricity, may cause parts of the industry under study to locate in a few states. These may weigh heavily in the value-added index. If these industry parts are those with relatively low electricity coefficients, the states with high value added will be those with relatively low electricity inputs so that D_{It} will go up less than proportionately with value added over states, even though it would have unit elasticity, over time, given balanced growth. B greater than unity is also possible, but unlikely, since, if the more important parts of value added are the electricity intensive parts of the industry, their location is likely to be influenced by the electricity price.

If B does differ from unity, α is the maximum overall price effect. Assuming B is unity, though, manipulation will yield P^{α}_{It} as a weighted average of o and u + π, the weighted being the quantities of electricity used for constant and for variable purposes, respectively, at the average price of electricity. Approximately, then α can be regarded as an average of u + π with those same weights (p. 132). This yields approximations to the relative importance of constant and variable use. Similarly, using the same technique, K can be seen to be the sum of $A/\bar{x}$ and C, K is essentially an average long-run input-output coefficient, and x indicates the way in which that coefficient is affected by electricity price.

The analysis is performed for 1956. The independent variables are thus 1956 prices. Some additional analyses are done for some extractive industries for 1954 from 1954 Census of Mineral Industries. Table 18 reports these results.

There is a significantly negative price effect in six out of the 10 industries and a nonsignificantly negative effect in two others. Values of B are all positive and are significant in all but two industries. Furthermore, B is nonsignificantly different from unity in seven industries, and within about 10 percent of unity in five. Where B is significantly different from unity, it is below it. Six industries show an

Table 18

Fisher and Kaysen Industrial Demand Equation

The Results: Dependent Variable = D_{It} = Millions of kWh Consumed

Manufacturing	α (Electricity Price) Coefficient [= cents per kWh]	β (Output Coefficient) [$ million of value added]	K (Efficiency Parameter)	R^2	Degrees of Freedom	β Significantly Different From Unity
Food and kindred products	-0.7841 (0.4065)	+0.6591 (0.1324)	12.88	0.8323	11	Yes
Textile mill products	-1.6167 (0.1117)	+1.0071 (0.0877)	2.84	0.9880	6	No
Pulp, paper, and products	-0.9747 (0.2077)	+0.7[illegible]03 (0.4205)	26.43	0.8822	3	No
Chemicals and products	-2.5976 (0.5234)	+0.6150 (0.2167)	22.55	0.6387	14	No
Stone, clay, and glass products	-1.7386 (1.2231)	+1.0273 (0.3074)	2.44	0.8429	3	No
Primary metal industries	-1.2829 (0.2117)	+0.4937 (0.1143)	9.17	0.7428	16	Yes
Fabricated metal products	+0.5533 (0.4832)	+1.1094 (0.1143)	0.29	0.9593	4	No
		+1.1009 (0.1175)	0.39	0.9460	5	No
Machinery except electrical	-1.3349 (0.4286)	+0.9043 (0.0870)	1.30	0.9742	7	No
Electrical machinery	-1.8209 (0.4489)	+0.3797 (0.2191)	76.50	0.8985	4	Yes
Transportation equipment	+0.6877 (0.6445)	+1.0526 (0.1174)	0.61	0.9521	5	No
		+0.9859 (0.1005)	1.04	0.9412	6	No

Table 18 (Cont.)

Industry (Extractive)	α (Price Coefficient)	β (Output Coefficient)	K (Efficiency Parameter)	R^2	Degrees of Freedom	β Significantly Different From Unity
Iron ores	-0.500 (0.9488)	+0.8503 (0.1791)	7.67	0.8620	4	No
Lead and zinc ores	-0.8849 (0.2544)	+0.7493 (0.0954)	11.43	0.8926	9	Yes
Bituminous coal	-0.3462 (0.3579)	+0.9695 (0.0552)	3.24	0.9599	13	No
Crude petroleum and natural gas	-1.8567 (1.0718)	+0.6524 (0.1286)	6.20	0.7890	12	Yes
Sand and gravel	-0.9096 (0.1933)	+0.8010 (0.0993)	5.33	0.7927	18	No
Crushed and broken stone	-1.0710 (0.4876)	+0.9620 (0.1697)	4.82	0.7280	12	No

elastic price effect and are probably overestimates (incorporating geographical variation). π (the elasticity of demand for electricity for variable uses) is underestimated though, as obtained by multiplying each α by the reciprocal of the percentage of electricity used for variable purposes.

The authors conclude there is probably a fairly high price elasticity of demand, given 1956 technology, for electricity in the long run in several industries. However, the 10 industries observed are probably those with the greatest price electricity.

For the extractive industries observed, price elasticities are closest to zero and less significant than for manufacturing. This is due both to the greater homogeneity of the extractive industries and to the fact that 1954 was not a full-capacity year. Thus, α is quite possibly biased downward, which is interpreted as indicating that long-run electricity demand from industry is price-sensitive, given constant technology.

Technological Change: The assumption of constant technology is controverted in fact, and, therefore, the previous analysis must be taken as showing tendencies (as giving some indications of what would happen in the long run if technology did remain unchanged).

The data on technological change are very limited, and an adequate analysis of the mechanism of technological change is lacking. The authors judge the best available overall measure to be the comparison of two overall electricity input coefficients (K) for the same industry at different points of time under the same price conditions. Data exist on total electricity inputs for two-digit industries from the Census of Manufactures for 1939, 1947, and 1954 and from the Survey of Manufactures for various other years. Electricity generated by private industry is not available for 1939. Therefore, 1947 and 1956 are compared.

The authors ask whether there is a difference between the importance of electricity in total costs and the direction and magnitude of change in K. There are two conceptual problems. It is desired to take account of electricity price effects not affecting technological change, by using the previous section's results, and attribute the residual to technological change. However, some changes occur through changes in the composition of industry output not induced by such price changes. Thus, the residual is a "catch-all." Exogenous demand shifts are, however, considered to be random and small.

Secondly, absolute rather than percentage change in K may be relevant, and, if so, the comparison will understate the relative change in those industries where electricity was already important in 1947.

The electricity input coefficients used are the total electricity inputs divided by the Federal Reserve Index of manufacturing production for the various industries. Cost coefficients are the ratio of total electricity cost (the total of purchased and the cost of self-generated electricity) to value of shipments in 1947.

Three out of the 22 industries experienced a downward shift in electricity input coefficients (K). This includes the effects of a falling real electricity price. The Kendall τ coefficient of rank correlation is -0.1421, which is not significant.

Using the maximum electricity price effect, estimated in the last section, the maximum percentage change is K, which can be attributed to the change in electricity price assuming no technological change is computed. The 1947 coefficients are adjusted by this percentage. Kendall's τ is now -0.1333, which is not significant, although now half of the 10 industries experience a decline in K.

The authors conclude that, in general, technological change was either neutral or acted to increase the importance of electricity for industry as a whole.

<u>Conclusion</u>: Aspects of the methodologies may prove useful for residential demand elasticity estimation, especially the work designed to measure the impact of technical change. The same criticisms introduced in Nos. 8 and 9 about the quality of the data tend to apply here also.

11. <u>Gujarati (1969)</u>

<u>Title</u>: Gujarati, D. 1969. Demand for electricity and natural gas. <u>Public Utilities Fortnightly</u>.

<u>Aim</u>: In his review of the Fisher and Kaysen work, Gujarati (1969) endeavors to further interpret the Fisher and Kaysen work, without performing additional empirical work.

<u>Approach</u>: Gujarati (1969) compares some of the major findings of Fisher and Kaysen and some results from studies of natural gas demand.

He argues that distinction between residential-commercial and industrial demand is important because of different price elasticities in the two sectors. The greater elasticity of industrial demand is important for rate policy and, in fact actually helps explain existing rate structure between residential, commercial, and industrial use.

Gujarati points out that, while total residential and commercial demand may be inelastic, not all of its components are price inelastic. He cites a NERA study of residential space heating with a short- and long-run elasticity of about -5.

Conclusion: While the discussion does clarify the results reported by Fisher and Kaysen, the criticisms of the original study (Articles 8, 9, and 10) still apply. Gujarati's major conclusion, that elasticity studies should distinguish between residential, commercial, and industrial demand, is valid, in spite of these limitations.

12. Wilson (1970)

Title: Wilson, J. 1970. Residential and Industrial Demand for Electricity: An Empirical Analysis. University Microfilms.

Aim: In this portion of the study, Wilson seeks to determine appliance demand.

Approach: Wilson's data for the percentage of homes with a given appliance (Wilson 1970) come from the 1960 Census of Housing and cover 83 SMSA's. The appliances considered are electric ranges (S_m), electric water heaters (S_w), electric clothes driers (S_d), electric space heaters (S_h), home food freezers (S_f), and a r conditioners (S_a). The two equations estimated are:

$$S_x = K + b_1 P + b_2 G + b_3 Y + b_4 C$$

$$\log S_x = K + b_1 \log P + b_2 \log G + b_3 \log Y + b_4 \log C$$

where S_x = percentage of homes with at least one appliance of type

P = the price of electricity, as measured by the Federal Power Commission listing of "typical electric bills for major urban areas"

G = the average price of natural gas (cents per therm)

Y = median family income (dollars per year)

C = a measure of climate condition (degree-days).

The results of the regressions are reproduced in Table 19. The differences between these results and those of Fisher and Kaysen are striking. All of the price elasticities with the exception of air conditioning are large, statistically significant, and of the correct sign. In addition, the own-price and cross-price elasticities are higher for appliances for which close gas substitutes are available and decrease as the possibilities for substitution decline.

Conclusion: Wilson's income elasticity estimates are disappointing. This study implies that income is not an important variable. This implication is counterintuitive and arises presumably because income is

Table 19

Estimated Equations for Stocks of Selected Household Appliances

Electric Ranges

$$S_r = 90.49 - 8.10P^{(a)} + 2.07G^{(a)} - 0.0003Y^{(e)} \qquad R^2 = 0.585$$

$$\log_{10}S_r = 6.17 - 1.98\log_{10}P^{(a)} + 0.91\log_{10}G^{(a)} + 0.11\log_{10}Y^{(e)} \qquad R^2 = 0.673$$

Variable	Partial R^2
P	0.530
G	0.370
Y	0.000
$\log_{10}P$	0.433
$\log_{10}G$	0.335
$\log_{10}Y$	0.001

Electric Water Heaters

$$S_w = 91.1 - 8.45P^{(a)} + 2.83G^{(a)} - 0.0042Y^{(d)} + 0.001C^{(e)} \qquad R^2 = 0.673$$

$$\log_{10}S_w = 10.31 - 3.22\log_{10}P^{(a)} + 2.10\log_{10}G^{(a)} - 1.44\log_{10}Y^{(c)} + 0.38\log_{10}C^{(c)} \qquad R^2 = 0.660$$

Variable	Partial R^2
P	0.566
G	0.534
Y	0.039
C	0.017
$\log_{10}P$	0.482
$\log_{10}G$	0.540
$\log_{10}Y$	0.054
$\log_{10}C$	0.080

Electric Clothes Dryers

$$S_d = 15.9 - 3.14P^{(a)} + 0.37G^{(b)} + 0.0030Y^{(b)} + 0.0012C^{(a)} \qquad R^2 = 0.613$$

$$\log_{10}S_d = 0.57 - 1.77\log_{10}P^{(a)} + 0.41\log_{10}G^{(b)} + 1.42\log_{10}Y^{(b)} + 0.32\log_{10}C^{(a)} \qquad R^2 = 0.585$$

Variable	Partial R^2
P	0.526
G	0.109
Y	0.113
C	0.137
$\log_{10}P$	0.422
$\log_{10}G$	0.102
$\log_{10}Y$	0.126
$\log_{10}C$	0.136

Electric Space Heating

$$S_h = 23.9 - 1.96P^{(a)} + 0.46G^{(a)} - 0.0010Y^{(e)} - 0.0003C^{(e)} \qquad R^2 = 0.337$$

$$\log_{10}S_h = 15.37 - 4.88\log_{10}P^{(a)} + 1.20\log_{10}G^{(a)} + 0.85\log_{10}Y^{(e)} - 1.38\log_{10}C^{(a)} \qquad R^2 = 0.680$$

Variable	Partial R^2
P	0.266
G	0.136
Y	0.011
C	0.009
$\log_{10}P$	0.546
$\log_{10}G$	0.177
$\log_{10}Y$	0.011
$\log_{10}C$	0.388

Home Food Freezers

$$S_f = 31.92 - 1.58P^{(a)} - 0.00002Y^{(e)} \qquad R^2 = 0.292$$

$$\log_{10}S_f = 6.74 - 0.94\log_{10}P^{(a)} - 0.13\log_{10}Y^{(e)} \qquad R^2 = 0.286$$

Variable	Partial R^2
P	0.291
Y	0.000
$\log_{10}P$	0.283
$\log_{10}Y$	0.003

Air Conditioners

$$S_a = 41.31 + 0.13P^{(e)} - 0.0022Y^{(e)} - 0.0029C^{(a)} \qquad R^2 = 0.358$$

$$\log_{10}S_a = 9.79 + 0.031\log_{10}P^{(e)} - 1.28\log_{10}Y^{(d)} - 0.554\log_{10}C^{(a)} \qquad R^2 = 0.303$$

Variable	Partial R^2
P	0.001
Y	0.020
C	0.228
$\log_{10}P$	0.000
$\log_{10}Y$	0.041
$\log_{10}C$	0.151

a. Statistically significant at the 0.001 confidence limit.
b. Statistically significant at the 0.01 confidence limit.
c. Statistically significant at the 0.05 confidence limit
d. Statistically significant at the 0.10 confidence limit.
e. Statistically insignificant at the 0.10 confidence limit.

correlated with an omitted variable whose influence on demand is of the opposite sign to its correlation with income. One such variable, which is shown to be important in later studies, is the percentage of the population living in urban areas. Urban dwellers tend to have higher measured incomes and smaller homes than rural or smalltown dwellers. In addition, much electricity use by apartment dwellers is paid for by landlords under the commercial category. The failure to include variables, such as the percentage of one-family dwellings, the percentage of population living in the urban area, or some other measure of housing density, is probably responsible for the problem with income elasticity.

Another weakness of Wilson's study is failure to test for differences across regions. One of the primary findings of the Fisher and Kaysen study was that regions do differ with respect to the elasticities and with respect to the constant term. A closer examination of the residuals from the regression equation would have been useful in suggesting the need for dummy variables or alternate procedures to cope with the non-homogeneity of the sample. This problem is discussed in greater detail below.

In the regression equations reported, the dependent variable is the proportion of homes with at least one unit of a given appliance. A proportion has limits of zero and one, and yet Wilson's equations are either linear in the basic variables or linear in logs. It is obvious therefore that Wilson's equations are only a linear approximation to the true curve, which would normally be expected to follow an S shape, reaching an asymptote at the ultimate saturation level. A model of this type is reviewed next, but insufficient information is available to describe the error in the approximation that Wilson uses.

13. Wilson (1971)

Title: Wilson, J. W. 1971. Residential demand for electricity. The Quarterly Review of Economics and Business.

Aim: In this study, Wilson reports on the relationship between average electricity consumption per household and socioeconomic radius.

Approach: Wilson (1971) uses a cross section of 77 SMSA's to estimate the following equation:

$$Q = k + b_1 p + b_2 G + b_3 Y + b_4 R + b_5 C$$

where Q = average electricity consumption per household

P = FPC's typical electric bill for 500 kWh per month

G = average price of natural gas

Y = median family income

R = average size of housing unit (R = rooms per unit)

C = climate condition (degree-days)

The equation is estimated in both linear and log-linear form. The log-linear equation is reported here:

$$\log Q = 10.25 - 1.33 \log p^{*} + 0.31 \log G^{**} - 0.46 \log Y^{*}$$
$$+ 0.49 \log R^{****} 0.04 \log C^{****}$$

where * = statistically significant at the 0.001 confidence limit

** = statistically significant at the 0.01 confidence limit

**** = statistically insignificant at the 0.10 confidence limit.

<u>Conclusion</u>: The interesting aspects of this equation are: (1) the income elasticity is significantly negative and (2) the "environmental" variables representing climate and the average size of the housing unit are not significant. Later studies include a variable representing the extent of urbanization that enters the equation with a significantly negative coefficient. Since urbanization is correlated with income, Wilson's results underestimate the true income elasticity (see Anderson).

The second problem with Wilson's results is that his study appears to suggest that climate is not an important variable in the determination of the consumption of electricity. This result is counterintuitive, since one expects warmer climates to be associated with larger electricity demands through larger stocks of cooling appliances such as refrigerators and air conditioners.

A final comment on the Wilson paper concerns the statistical insignificance of the housing-size variable. As his proxy variable, Wilson chooses the number of rooms per housing unit. Anderson, in contrast, measures household size by the average number of persons per household, and suggests that income per household and Wilson's proxy variable are responsible for biased estimates of the income elasticity. It is not true, however, that collinearity biases the estimates of the coefficients (see, for example, Huang, p. 149), although it does increase the variance of the estimates. This appears to be the explanation of the statistical insignificance of the housing-size variable.

14. Landon and Wilson (1970)

Title: Landon, J. H. and J. W. Wilson. 1970. An Economic Analysis of Combination Utilities. Working Paper 19, Case Western Reserve University, Research Program in Industrial Economics, Cleveland, Ohio.

Aim: Landon and Wilson study the effect of utilities providing both electricity and natural gas on economic growth.

Approach: Landon and Wilson (1970) have both a theoretical and empirical discussion of the effects of combination utilities as opposed to separate ownership. Interutility competition between gas and electric companies is studied, and a relationship between electric power rates and industrial growth is found.

Using cross-section data on all urban places with a population of 100,000 or more for which adequate data were available and where there was at least a minimum of interfuel competition (72 cities), the following regression equation was run

$$\log_{10}\left(W_g/W_e\right) = \underset{(0.974)}{2.525 - 2.834} \log_{10}(G/E) + \underset{(0.499)}{1.783} \log_{10}(P) \quad R^2=0.73$$

where W_g/W_e = ratio of gas water heaters to electric water heaters

G = price per therm for residential users with gas heat

E = typical bill for 500 kWh per month

P = average incremental rate for consumption between 250 and 500 kWh per month.

Both variables are significant at the 99 percent confidence limit. The correlation between G/E and P was only 0.08. The test was repeated for electric ranges yielding:

$$\log_{10}\left(S_g/S_e\right) = 4.309 - \underset{(0.83)}{2.38} \log_{10} (G/E) + \underset{(0.65)}{1.235} \log_{10} (P') \qquad R^2=0.55$$

Wilson and Landon conclude from these regressions that there is a substantial degree of potential price competition between electricity and gas in residential markets.

A regression relating power rates and industrial growth was also run.

$$\frac{V.A.63}{V.A.47} = K + a\ P_{54} + b\ P_{63}/P_{37}$$

where P_{63}/P_{37} = ratio of the typical monthly bill for 400,000 kWh in 1963

$\frac{V.A.63}{V.A.47}$ = measure of industrial growth from 1947 to 1963.

Conclusion: The major finding that combination utilities do not restrict competition in residential markets has significant implications for such utilities, but does not provide any insights into a residential pure elasticity demand study.

15. Anderson (1972)

Title: Anderson, K. P. 1972. Residential Demand for Electricity Econometric Estimates for California and the U.S. The Rand Corporation, R-905-NSF, Santa Monica.

Aim: The study attempts to explain the quantity of electricity purchased by residential customers, using a model incorporating the rigidities of appliance ownership.

Approach: In Anderson's (1972) study, based on the year 1969, a model with the following dependent variable is used:

$$\left(\frac{D - \delta D_{-1}}{H - \delta H_{-1}}\right)$$

where D = quantity of electricity purchased by residential customers in 1969 and D_{-1} is the same statistic for the previous year

H = average number of residential customers in each state in 1969, and H_{-1} is the same statistic for the previous year

δ = fraction of the total number of residential customers who remain "locked in" to an appliance in 1968-1969.

The rationale for Anderson's approach is to try to incorporate the rigidities of appliance ownership into the study of electricity demand. If $\delta = 1$, all customers are locked into electric appliance and the only demand influenced by economic faction is the demand arising from new customers. If, on the other hand, $\delta = 0$, all customers are in the market for appliances. Anderson's procedure is to search for the correct value of δ. The results of this procedure are not entirely satisfactory, since the value of δ suggested by the regression equation is zero. If the search procedure is valid, and Anderson suggests some reasons why it is not, then the model would suggest that electricity consumers are always in long-run equilibrium.

In any event, the fraction δ is not an arbitrary number but is itself endogenous to the economic system. It would therefore appear preferable to estimate δ from the household's scrapping decision. In this regard, it is important to note that δ fills two roles in the Anderson model: first, as the fraction of locked-in electricity consumers and second, as the fraction of all residents who are locked into particular appliances. Once δ is recognized as an economically determined variable, there is no reason why the δ for electricity consumers should be the same as the δ for all energy consumers. For example, an increase in the wage rate would tend to lower the δ of those appliances with higher maintenance costs.

Anderson's results are presented in Table 20, with a list of variable definitions in Table 21. As one would expect from the preceding discussion, the price elasticities decline with the value of δ. More disconcerting is the fact that the cross-price elasticities increase with δ. According to the theoretical discussion, the elasticities should decline as a larger percentage of the demand becomes locked in. This does not occur, which tends to suggest again that the empirical results are inconsistent with the theoretical model.

<u>Conclusion</u>: While it should be recognized that the issue of rigidity in appliance stocks is important, Anderson's approach is clearly inadequate both in its empirical and theoretical forms. What is required is

Table 20

Residential Electricity Demand I, U.S. State by State Data, 1969

Equation No.		Constant	DCE	PG	RYPH	SOH	NMP	WTEMP	STEMP	df	Sum of Squared Residuals	Corrected R^2
	D	- 9.79	-0.91	+0.13	+1.13	-0.85	+0.63	+0.0055	+0.0111	42	0.998	0.717
T2A			N	(0.086)	(0.001)	(0.096)	N	(0.063)	(0.079)			N
	H		[0.10]	[0.07]	[0.32]	[0.50]	[0.14]]	[0.0029]	[0.0062]			
	$D - 0.50D_{-1}$	-10.31	-0.91	+0.14	+1.18	-0.94	+0.65	+0.0055	+0.0132	42	1.013	0.716
T2B			N	(0.072)	N	(0.067)	N	(0.065)	(0.040)			N
	$H - 0.50H_{-1}$		[0.10]	[0.08]	[0.32]	[0.50]	[0.14]	[0.0029]	[0.0062]			
	$D - 0.75D_{-1}$	-11.01	-0.90	+0.15	+1.26	-1.10	+0.68	+0.0053	+0.0165	42	1.074	0.706
T2C			N	(0.058)	N	(0.039)	N	(0.083)	(0.014)			N
	$H - 0.75_{-1}$		[0.10]	[0.08]	[0.33]	[0.52]	[0.14]	[0.0030]	[0.0064]			
	$D - 0.90D_{-1}$	-11.87	-0.88	+0.17	+1.35	-1.47	0.75	+0.0040	+0.0238	42	1.442	0.640
T2D			N	(0.063	(0.001)	(0.018)	N	(0.255)	(0.003)			N
	$H - 0.90H_{-1}$		[0.12]	[0.09]	[0.39]	[0.60]	[0.16]	[0.0034]	[0.0074]			
	$D - 0.95D_{-1}$	-12.52	-0.84	+0.20	+1.43	-1.98	+0.87	+0.0009	+0.0331	42	3.300	0.419
T2E			N	(0.151)	(0.019)	(0.034)	N	(0.860)	(0.005)			N
	$H - 0.95_{-1}$		[0.18]	[0.14]	[0.59]	[0.90]	[0.25]	[0.0052]	[0.0112]			

a. All variables are transformed into logarithms except NMP, WTEMP, and STEMP.

Note: Numbers in parentheses are significance levels. N = significance at better than the 0.001 level. Numbers in brackets are standard errors. Both the significance levels and the standard errors are conditional upon the value of δ specified. Significance levels in last column refer to the F-test.

Source: Anderson 1972.

Table 21

Definitions of Variable Symbols

Variable	Definition	Units
D	Total quantity of electricity consumed annually by residential customers	10^6kWh/year
H	Average number of residential customers	10^2 customers
DE	Average quantity of electricity consumed annually per flexible residential customer, i.e., $(D - \delta D_{-1})/(H - \delta H_{-1})$	10^4 kWh/custom-year
CE	Average real cost to residential customers of 500 kwh/month	Real $/500 kWh[(a)]
DCE	Average real cost to residential customers of 1,000 kwh/month - CE (defined above)	Real $/500 kWh[(a)]
PG	Average real cost of gas to residential customers	Real $/$10^4$ therms[(a)]
RYPH	Average real personal income per household	Real $/household[(a)]
SOH	Average size of household	Persons/household
SOH	Average size of household	Persons/household
NMP	Fraction of population living in non-metropolitan areas	--
WTEMP	Average January temperature	°F
STEMP	Average July temperature	°F
FAEC	Fraction of residential customers classified as all electric	%
Y	Average real disposable income per capita	Real $/capita(a)
T	Time	Years

a. By "real $" is meant actual money cost divided by a cost-of-living index.
Source: Anderson 1972.

an analysis of the factors determining the scrapping decision. Important arguments in such a model would be the age structure of the current capital stock, the depreciation rate, maintenance costs, and the prices of new capital equipment. While the theoretical models are available, these have not yet been applied to the residential electricity market.

Anderson's study is a distinct improvement over Wilson's study in the choice of variables used in the regression equation. The results reflect these improvements in the sense that the income elasticity is of a plausible magnitude. The paper fails to make a case for a new dependent variable; consequently, the average consumption per household appears to be the best dependent variable for aggregate equations.

16. Anderson (1973)

Title: Anderson, K. P. 1973. Residential Energy Use: An Econometric Analysis, The Rand Corporation, R-1297-NSF, Santa Monica.

Aim: This study attempts to explain the relationship between appliance saturation and energy use.

Approach: Anderson's latest work (1973) on residential energy use includes an important section on the demand for the stock of appliances and energy-using equipment. While this paper is concerned with electricity demand only incidentally, the techniques employed are of great relevance to the study of the demand of electricity.

Anderson is also concerned with predicting saturation levels of various appliances. The major innovation is that the saturation level of appliances using differing types of energy are estimated simultaneously. This not only allows the more efficient estimating technique of seemingly unrelated regression to be used but also allows for cross elasticities to be contained in a manner suggested by the Slutsky conditions.

The basic type equation estimated is illustrated by the following equation for space heating:

$$\log\left(\frac{S_iH}{S_jH}\right) = a_{ij}^0 + a_i \log p_i + a_j \log P_j + a_{ij}^1 \log YPH + a_{ij}^2 \log HS + a_{ij}^3 SHU + a_{ij}^4 NUHU + a_{ij}^5 WTEMP$$

where S_iH = fraction of total space heating installations using energy source i (eight categories of energy are used--gas, oil, coal, electricity, bottled gas, wood, other, and none--so that there are seven equations to be estimated for a given S_jH)

P_i = price of energy source i

Pj = price of energy source j

YPH = average income per household

HS = average household size

SHU = fraction of single housing units in total housing

NUHU = fraction of nonurban housing units in total housing

WTEMP = mean December temperature.

Anderson estimates equations similar to the preceding one for residential space heating, water heating, residential cooking units, washing and drying units, air conditioning, food freezing, dishwashing, and television. The results of some of these regressions, and a list of variables used in Anderson's study, are given in Tables 22 through 32.

In general, the results confirm those of the EEH study, finding significant price, cross-price, and income elasticities. Anderson's results are computed overall elasticities as estimated directly from the appliance equations by using the formula.

$$\frac{\partial p_i}{\partial p_j} \; \frac{P_j}{q_i} = \sum_{k=1}^{n} \left[\frac{e_{ik}}{e_{ik}} \frac{S_{ik}}{s_{ik}} \; \frac{\partial s_{ik}}{\partial p_j} \; \frac{P_j}{s_{ik}} \right]$$

where e_{ik} = average amount of energy type i used for household function k and

s_{ik} = fraction of households using energy type i for function k.

Basically, the overall elasticity of demand for energy type i with respect to price j is the weighted sum of the change in energy demand arising from the effect of P_j on the appliance shares s_{ik}. The elasticity

$$\frac{\partial s_{ik}}{\partial p_j} \cdot \frac{P_j}{s_{ik}}$$

can be taken from Anderson's tables. The estimated new price elasticities for electricity are -0.84 for own price and 0.81 for cross price with gas (Table 31). It would appear that the own-price elasticity is implausibly low, but this result reflects in part the absence of any consideration of the effect of electricity prices on the utilization of the stock of

Table 22

Identification of Variables in Anderson's Study

Variable[a]	Definition	Units of Measurement
S_iH	Heating, type i[b]	
S_iWH	Water heating, type i	
S_iC	Cooking, type i	
S_iCW	Clothes washing, type i	
S_iCD	Clothes drying, type i	fraction of total installations
S_iAC	Air conditioning, type i	
SFF	Food freezers	
SDW	Dishwashers	
S_iTV	Air conditioning, type i	
EPC	Annual electricity consumption per customer	kWh/customer-year
EPH	Annual electricity consumption per household	kWh/household-year
GPC	Annual utility gas consumption per customer	therms/customer-year
GPH	Annual utility gas consumption per household	therms/household-year
PGAS	Price of gas[c]	$/40 therms
POIL	Price of oil	mills/gallon
PCOAL	Price of coal	$/short-ton
PELEC	Price of electricity	$/1,000 kWh
PBGAS	Price of bottled gas	mills/gallon
PKER	Price of kerosene	mills/gallon
PGR	Price of gas range	$/unit
PER	Price of electric range	$/unit
PWCW	Price of wringer clothes washer	$/unit
PACW	Price of automatic clothes washer	$/unit
PRAC	Price of room air conditioner	$/unit
PEFF	Price of electric food freezer	$/unit
PTV	Price of television	$/unit
YPH	Annual income per household	$/household-year
HS	Household size	persons/household
SHU	Single detached housing units	fraction of total housing
NUHU	Nonurban housing units	fraction of total housing
WTEMP	Mean December temperature	°F
STEMP	Mean July temperature	°F
CL	Cost-of-living	index number

a. Where necessary, variables pertaining to 1960 are identified by a trailing "6"--income per household in 1960 is YPH6. Variables that represent averages of 1960 and 1970 variables are identified by a leading A--average income per household during the period 1960-70 is AYPH.

b. Heating types include gas, oil, coal, electricity, bottled gas, wood, other, and none. Water heating types are gas, oil, electricity, bottled gas, other, and none. Cooking types consist of gas, electricity, bottled gas, other, and none. Washer types are wringer, automatic, and none. Dryer types include gas, electric, and none. Air conditioning types are room, central, and none. Television "types" consist of one, more than one, and none. The following symbols are used to designate unit types: G = utility gas, O = oil, C = coal (heating and water heating), E = electricity, BG = bottled gas, W = wood, OTH = other fuels, N = none, W = wringer, A = automatic, R = room, C = central (air conditioning), M = multiple installations (air conditioning and television), S = single installation (television).

c. All prices and income per household are divided by (CL/100) or (CLG/100) to normalize for cross-state variations in the price level.

Source: Anderson 1973.

Table 23

Residential Heating Installations, Constrained Estimates, 50 States, 1970

Dependent Variable	Constan	PGAS	POIL	PCOAL	PELEC	PBGAS	YPH	HS	SHU	NOHU	WTEMP	Unconstrained R^2	Degrees of Freedom
	Explanatory Variables[a]												
SOH/SGH	-10.33	4.01	-1.31				1.80	-3.33	-8.92	6.56	-0.0207	0.89	42
	(-0.39)	(4.47)	(-0.89				(0.68)	(-0.90)	(-4.03)	(3.31)	(-1.37)		
SGH/SOH	-0.90	-6.95	2.13				-0.38	4.01	5.55	-4.40	0.0261		
	(-0.05)	(-13.15)	(1.77)				(-0.19)	(1.42)	(3.51)	(-3.03)	(2.32)		
SCH/SGH	-15.57	4.01		-3.22			0.04	10.11	-4.23	7.21	-0.0136	0.65	42
	(-0.52)	(3.63		(-4.59)			(0.01)	(2.35)	(-1.61)	(3.2-)	(-0.78)		
SGH/SCH	14.40	-4.70		3.30			0.02	-10.13	3.50	-6.59	0.0149		
	(0.49)	(-11.46)		(4.51)			(0.01)	(-2.37)	(1.46)	(-3.13)	(0.85)		
SEH/SGH	9.78	4.01			-2.65		0.98	-1.92	-1.04	3.49	0.0560	0.77	42
	(0.06)	(7.14)			(-7.29)		(0.59)	(-0.85)	(-0.75)	(2.96)	(6.29)		
SGH/SEH	2.08	-3.59			2.21		-1.08	2.11	1.43	-3.72	-0.0574		
	(0.13)	(-9.88)			(3.42)		(-0.65)	(0.92)	(1.09)	(-3.25)	(-6.42)		
SBGH/SGH	1.27	4.01				-1.71	-0.33	-3.48	4.53	2.86	0.0238	0.53	42
	(0.06)	(5.40)				(-2.32)	(-0.16)	(-1.23)	(2.61)	(1.92)	(2.07)		
SGH/SBGH	-3.61	-2.73				2.23	-0.06	3.70	-2.65	-4.35	-0.0303		
	(-0.18)	(-6.87)				(2.71)	(-0.03)	(1.41)	(-1.67)	(-3.15)	(-2.75)		
SCH/SOH	-10.70		2.13	-3.39			-1.65	14.12	4.52	0.44	0.0057	0.51	42
	(-0.31)		(1.02	(-4.99)			(-0.48)	(2.87)	(1.75)	(0.18)	(0.28)		
SOH/SCH	15.10		-2.95	3.30			1.70	-14.67	-4.51	-0.01	-0.0024		
	(0.46)		(-2.20)	(4.18)			(0.50)	(-3.09)	(-1.75)	(-0.01)	(-0.12)		
SEH/SOH	1.98		2.13		-1.71		-1.03	1.61	7.79	-3.70	0.0745	0.66	42
	(0.07)		(1.16)		(-3.97)		(-0.34)	(0.37)	(3.55)	(-1.75)	(4.35)		
SOH/SEH	-6.10		-1.84		2.21		0.91	-1.63	-7.91	3.43	-0.0752		
	(-0.20)		(-1.22)		(1.88)		(0.30)	(-0.38)	(-3.48)	(1.62)	(-4.44)		
SBGH/SOH	31.19		2.13			-4.18	-3.16	-0.72	11.24	-2.14	0.0557	0.76	42
	(0.94)		(1.02)			(-3.74)	(-0.97)	(-0.15)	(4.29)	(-0.91)	(2.95)		
SOH/SBGH	-9.37		-2.59			2.23	2.34	-0.54	-12.90	3.85	-0.0433		
	(-0.25)		(-1.54)			(1.43)	(0.66)	(-0.11)	(-4.32)	(1.48)	(-2.08)		
SEH/SCH	9.04			3.30	-1.05		0.53	-12.79	3.51	-4.26	0.0697	0.63	42
	(0.28)			(4.21)	(-1.95)		(0.16)	(-2.77)	(1.30)	(-1.86)	(3.70)		
SCH/SEH	-14.27			-3.19	2.21		-0.86	12.22	-3.24	3.82	-0.0701		
	(-0.42)			(-4.82)	(1.63)		(-0.25)	(2.52)	(-1.22)	(1.60)	(-3.63)		
SBGH/SCH	34.91			3.30		-3.51	-1.17	-14.49	7.25	-3.03	0.0468	0.60	42
	(0.96)			(3.82)		(-3.62)	(-0.32)	(-2.85)	(2.50)	(-1.17)	(2.21)		
SCH/SBGH	-21.35			-3.07		2.23	0.49	13.79	-8.21	3.82	-0.0415		
	(-0.54)			(-4.74)		(1.37)	(0.13)	(2.59)	(-2.57)	(1.35)	(-1.83)		
SEH/SBGH	-2.71				-3.20	2.23	1.65	2.06	-5.20	0.39	0.0290	0.75	42
	(-0.16)				(-8.34)	(3.17)	(1.00)	(0.90)	(-3.77)	(0.32)	(3.01)		
SBGH/SEH	0.67				2.21	-1.53	-1.14	-1.27	5.66	-0.65	-0.0334		
	(0.03)				(2.98)	(-2.12)	(-0.61)	(-0.49)	(3.69)	(-0.47)	(-3.15)		

a. F..ures in parentheses are t-ratios.
Source: Anderson 1973.

Table 24

Residential Water Heating Installations, Constrained Estimates, 50 States, 1960-1970

Dependent Variable	Constant	APGAS	APOIL	APELEC	APBGAS	AYPH	AHS	ASHU	ANUHU	WTEMP	Unconstrained R^2	Degrees of Freedom
	Explanatory Variables[a]											
SOWH/SGWH	27.48	3.98	-4.29			-0.19	-5.72	-13.39	7.07	-0.0156	0.91	42
	(1.16)	(4.81)	(-3.02)			(-0.08)	(-1.58)	(-5.79)	(3.08)	(-0.94)		
SGWH/SOWH	-34.87	-6.18	4.80			1.29	5.88	10.17	-4.77	0.0235		
	(-1.86)	(-12.75)	(3.44)			(0.69)	(2.07)	(5.91)	(-2.74)	(1.81)		
SEWH/SGWH	7.70	3.98		-1.86		-0.22	-1.91	0.69	3.95	0.0186	0.89	42
	(0.75)	(10.79)		(-6.02)		(-0.21)	(-1.22)	(0.67)	(4.01)	(2.63)		
SGWH/SEWH	-8.19	-4.29		1.83		0.39	1.91	-1.12	-3.59	-0.0173		
	(-0.81)	(-14.22)		(4.73)		(0.37)	(1.24)	(-1.16)	(-3.82)	(-2.52)		
SBGWH/SGWH	11.55	3.98			-2.15	-0.98	-3.03	1.08	3.35	0.0179	0.53	42
	(0.71)	(6.24)			(-3.62)	(-0.59)	(-1.27)	(0.68)	(2.19)	(1.60)		
SGWH/SBGWH	-15.51	-3.45			2.83	0.81	3.44	0.42	-4.61	-0.0248		
	(-0.96)	(-10.-0)			(4.52)	(0.50)	(1.42)	(0.28)	(-3.10)	(-2.21)		
SEWH/SOWH	-23.53		4.80	-1.66		-0.08	4.03	13.96	-3.37	0.0328	0.84	42
	(-1.11)		(3.07)	(-4.67)		(-0.04)	(1.26)	(7.74)	(-1.83)	(2.30)		
SOWH/SEWH	21.43		-4.58	1.83		0.05	-3.96	-13.98	3.25	-0.0333		
	(0.99)		(-3.34)	(2.35)		(0.03)	(-1.24)	(-7.75)	(1.77)	(-2.35)		
SBGWH/SOWH	4.23		4.80		-5.13	-1.28	1.51	10.86	-1.00	0.0524	0.87	42
	(0.1[illegible])		(2.72)		(-7.03)	(-0.56)	(0.43)	(4.92)	(-0.43)	(3.24)		
SOWH/SBGWH	15.06		-5.16		2.83	0.95	-2.81	-13.39	3.41	-0.0354		
	(0.55)		(-3.33)		(2.79)	(2.79)	(0.35)	(-0.69)	(1.37)	(-1.86)		
SBGWH/SEWH	8.44			1.83	-2.73	-0.84	-1.43	-0.27	-0.03	0.0033	0.67	42
	(0.52)			(3.03)	(-4.96)	(-0.54)	(-0.61)	(-0.19	(-0.02)	(0.30)		
SEWH/SBGWH	-7.43			-2.09	2.83	0.86	1.58	0.30	-0.01	-0.0043		
	(-0.49)			(-5.68)	(5.07)	(0.59)	(0.71)	(0.21)	(-0.01)	(-0.42)		

Table 24 (Cont.)

Dependent Variable	Explanatory Variables[(a)] Constant	PGAS	POIL	PELEC	PEGAS	YPH	HS	SHU	NUHU	WTEMP	Unconstrained R^2	Degrees of Freedom
SOWH/SGWH	13.44 (0.50)	3.99 (4.30)	-2.47 (-1.74)			0.34 (0.12)	-4.94 (-1.27)	-15.23 (-6.66)	6.[illegible] (3.32)	-0.0184 (-1.19)	0.91	42
SGWH/SOWH	-19.87 (-0.94)	-6.45 (-11.05)	2.65 (2.06)			0.84 (0.40)	[illegible] (1.69)	12.45 (7.33)	-4.74 (-3.05)	0.0247 (2.04		
SEWH/SGWH	8.67 (0.63)	3.99 (8.17)		-2.80 (-6.34)		0.26 (0.18)	-0.32 (-0.16)	0.40 (0.33)	4.35 (4.21)	0.0143 (1.84)	0.83	42
SGWH/SEWH	-8.44 (-0.61)	-4.32 (-11.07)		2.60 (4.68)		-0.06 (-0.04)	0.42 (0.21)	-0.80 (-0.70)	-4.00 (-3.98)	-0.0134 (-1.75)		
SBGWH/SGWH	12.05 (0.67)	3.99 (6.23)			-2.07 (-3.04)	-1.02 (-0.57)	-3.10 (-1.29)	0.98 (0.66)	3.25 (2.55	0.0138 (1.40)	0.53	42
SGWH/SBGWH	-17.45 (-0.98)	-3.35 (-8.14)			2.76 (3.66)	1.01 (0.58)	3.42 (1.44)	0.33 (0.23)	-4.33 (-3.45)	-0.0194 (-1.95)		
SEWH/SOWH	-8.22 (-0.33)		2.65 (1.78)	-2.30 (-4.59)		-0.19 (-0.08)	4.51 (1.29)	15.70 (8.67)	-2.65 (-1.55)	0.0324 (2.35)	.081	42
SOWH/SEWH	7.26 (-0.29)		-2.74 (-2.03)	2.60 (2.70)		0.12 (0.05)	-4.[illegible] (-1.33)	-15.64 (-8.42)	2.60 (1.49)	-0.0319 (-2.29)		
SBGWH/SOWH	19.58 (0.68)		2.65 (1.47)		-4.30 (-4.45)	-2.30 (-0.82)	0.88 (0.22)	14.25 (6.29)	-1.86 (-0.92)	0.0442 (2.71)	0.83	42
SOWH/SBGWH	-11.76 (-0.04)		-3.20 (-1.97)		2.76 (2.00)	1.65 (0.53)	-2.01 (-0.46)	-15.55 (-5.94)	3.30 (1.45)	-0.0337 (1.85)		
SBGWH/SEWH	9.06 (0.50)			2.60 (3.76)	-2.55 (3.76)	-1.44 (-0.83)	-2.93 (-1.22)	0.13 (0.09)	-0.67 (-0.52)	0.0021 (0.21)	0.67	42
SEWH/SBGW	-8.42 (-0.49)			-3.16 (-6.43)	2.76 (3.96)	1.66 (1.02)	3.28 (1.46)	-0.04 (-0.03)	0.66 (0.55)	-0.0036 (-0.38)		

a. Figures in parentheses are t-ratios.
Source: Anderson 1973.

Table 25

Residential Heating Installations, Constrained Estimates, 50 States, 1960-1970

Dependent Variables[b]	Constant	APGAS	APOIL	APCOAL	APELEC	APEGAS	AYPH	AHS	ASHU	ANUHU	WTEMP	Unconstrained R^2	Degrees of Freedom
	Explanatory Variables[a]												
SOH/SCH	9.82 (0.40)	3.54 (4.17)	-2.72 (-1.60)				0.39 (0.16)	-3.46 (-0.92)	-8.22 (-3.45)	7.46 (3.13)	-0.0140 (-0.81)	0.87	42
SGH/SOH	-19.09 (-0.98)	-5.75 (-11.17)	3.61 (2.50)				0.68 (0.36)	3.84 (1.30)	4.86 (2.72)	-5.31 (-2.93)	0.0207 (1.54)		
SCH/SGH	5.72 (0.22)	3.54 (3.58)		-2.97 (-4.40)			-2.24 (-0.82)	10.32 (2.59)	-3.77 (-1.46)	4.99 (2.00)	-0.0301 (-1.64)	0.65	42
SGH/SCH	-6.69 (-0.26)	-3.97 (-9.93)		2.99 (4.34)			2.46 (0.92)	-10.34 (-2.61)	3.18 (1.36)	-4.51 (-1.92)	0.0319 (1.75)		
SEH/SGH	2.39 (0.18)	3.54 (7.38)			-1.41 (-4.13)		0.17 (0.12)	-3.79 (-1.85)	-0.16 (-0.12)	2.72 (2.12)	0.0522 (5.69)	0.75	42
SGH/SEH	-0.78 (-0.06)	-3.16 (-9.27)			1.29 (2.54)		-0.03 (-0.25)	3.85 (1.90)	0.32 (0.26)	-3.13 (-2.58)	-0.0540 (-6.01)		
SBGH/SGH	8.21 (0.43)	3.54 (4.77)				-2.08 (-3.00)	-0.88 (-0.45)	-3.11 (-1.11)	4.21 (2.28)	4.48 (2.52)	0.0260 (1.99)	0.62	42
SGH/SBGH	-9.85 (-0.54)	-2.68 (-6.79)				2.55 (3.61)	0.51 (0.28)	3.39 (1.25)	-2.49 (-1.45)	-5.91 (-3.54)	-0.0320 (-2.60)		
SCH/SOH	-8.13 (-0.27)		3.61 (1.55)	-2.97 (-4.59)			-2.69 (-0.87)	14.28 (3.01)	4.14 (1.53)	-2.83 (-1.01)	-0.0189 (-0.86)	0.50	42
SOH/SCH	10.09 (0.34)		-3.95 (-2.54)	2.99 (3.92)			2.70 (0.88)	-14.49 (-3.13)	-4.02 (-1.51)	2.96 (1.08)	0.0199 (0.93)		
SEH/SOH	-14.26 (-0.50)		3.61 (1.73)		-1.03 (-2.73)		-0.32 (-0.11)	0.04 (0.01)	8.20 (3.40)	-5.19 (-2.11)	0.0639 (3.34)	0.65	42
SOH/SEH	12.01 (0.42)		-3.50 (-1.98)		1.29 (1.25)		0.29 (0.10)	-0.08 (-0.02)	-8.15 (-3.40)	5.09 (2.08)	-0.0635 (-3.30)		
SBGH/SOH	17.19 (0.64)		3.61 (1.78)			-5.12 (-6.59)	-1.80 (-0.68)	-0.60 (-0.15)	8.62 (3.43)	-0.35 (-0.14)	0.0580 (3.12)	0.82	42
SOH/SBGH	7.43 (0.24)		-4.63 (-2.47)			2.55. (2.20)	1.47 (0.48)	-1.21 (-0.25)	-11.23 (-3.72)	3.30 (1.16)	-0.0370 (-1.70)		
SEH/SCH	-8.67 (-0.32)			2.99 (4.10)	-0.60 (-1.17)		2.32 (0.81)	-14.40 (-3.39)	4.21 (1.72)	-2.46 (-0.99)	0.0833 (4.28)	0.66	42
SCH/SEH	4.11 (0.14)			-2.93 (-4.66)	1.29 (1.15)		-2.41 (-0.80)	14.15 (3.15)	-3.94 (-1.53)	2.26 (0.87)	-0.0828 (-4.09)		
SBGH/SCH	11.09 (0.36)			2.99 (3.63)		-3.21 (-4.69)	1.19 (0.37)	-13.98 (-2.93)	6.63 (2.35)	0.59 (0.21)	0.0637 (2.87)	0.57	42
SCH/SBGH	-5.99 (-0.19)			-2.68 (-4.30)		2.55 (2.10)	-1.37 (-0.42)	13.57 (2.81)	-7.21 (-2.36)	-0.20 (-0.07)	-0.0616 (-2.67)		
SEH/SBGH	-7.59 (-0.45)				-1.68 (-4.91)	2.55 (4.10)	1.14 (0.69)	-0.35 (-0.14)	-3.60 (-2.30)	-2.16 (-1.42)	0.0227 (1.96)	.069	42
SBGH/SEH	6.85 (0.38)				1.29 (1.92)	-2.11 (-3.40)	-1.04 (-0.60)	0.69 (0.27)	3.97 (2.40)	1.82 (1.14)	-0.0261 (-2.19)		

a. Figures in parentheses are t-ratios.
b. ρ = 0.75.
Source: Anderson 1973.

Table 26

Residential Washing and Drying Units Constrained Estimates, 50 States, 1970

Explanatory Variables[(a)]

Dependant Variables	Constant	PELEC	PWCW	PACW	YPH	HS	SHU	NUHU	Unconstrained R^2	Degrees of Freedom
SACW/SWCW	-18.47 (-1.52)	-0.93 (-2.08)	3.30 (3.41)	-1.25 (-2.04)	1.96 (1.69)	0.20 (0.13)	-1.26 (-1.38)	-2.02 (-2.97)	0.54	42
SWCW/SACW	18.33 (1.53)	0.93 (2.06)	-3.29 (-3.03)	1.24 (0.97)	-1.95 (-1.58)	-0.19 (-0.12)	1.26 (1.24)	2.02 (-2.79)		
SNCW/SWCW	-14.83 (-1.05)	-0.69 (-1.33)	3.30 (3.04)		0.67 (0.51)	0.27 (0.15)	-2.57 (-2.48)	-2.83 (-3.64)	0.52	
SNCW/SACW	3.65 (0.60)	0.24 (0.97)		1.24 (2.06)	-1.29 (-1.99)	0.07 (0.08)	-1.30 (-2.37)	-0.81 (-2.05)	0.21	43

Dependant Variables	Constant	PGAS	PELEC	PECD	YPH	HS	SHU	NUHU	WTEMP	Unconstrained R^2	Degrees of Freedom
SECD/SGCD	19.01 (1.17)	2.17 (3.68)	-1.73 (-4.78)	-0.04 (-0.04)	-1.02 (-0.59)	-0.46 (-0.19)	0.09 (0.06)	3.39 (2.71)	0.0205 (2.16)	0.64	41
SGCH/SECD	-18.81 (-1.08)	-2.19 (-3.45)	1.58 (2.23)	0.20 (0.09)	1.03 (0.57)	0.59 (0.23)	-0.20 (-0.12)	-3.37 (-2.43)	-0.0209 (-1.98)		
SNCD/SGCD	14.26 (0.86)	2.17 (3.63)			-1.80 (-1.02)	-0.81 (-0.33)	-1.23 (-0.84)	3.18 (2.54)	0.0459 (4.82)	0.56	43
SNCD/SECD	-4.51 (-0.54)		1.56 (4.59)	0.20 (0.21)	-0.78 (-0.92)	-0.22 (-0.17)	-1.42 (-1.81)	-0.20 (-0.35)	0.0250 (5.14)	0.64	42

Dependant Variables	Constant	PGAS	PELEC	PBGAS	PGR	PER	YPH	HS	SHU	NUHU	Unconstrained R^2	Degrees of Freedom
SEC/SGC	2.83 (0.19)	3.06 (5.53)	-1.34 (-3.25		2.78 (2.36)	-1.98 (-1.56)	-0.54 (-0.34)	0.89 (0.43)	1.76 (1.33)	1.83 (1.89)	0.68	41
SGC/SEC	-0.51 (-0.03)	-3.07 (-6.44)	1.06 (1.47)		-3.17 (-2.17)	2.07 (0.94)	0.66 (0.41)	-0.83 (-0.38)	-1.61 (-1.15)	-1.73 (-1.75)		
SBGC/SGC	6.52 (0.49)	3.06 (6.34)		-1.35 (-3.17)	0.48 (0.58)		-1.07 (-0.85)	-0.75 (-0.43)	0.55 (0.51)	4.07 (5.13)	0.73	42
SGC/SBGC	-6.76 (-0.47)	-3.07 (-6.37)		1.40 (2.45)	-0.58 (-0.69)		1.13 (0.83)	0.74 (0.42)	-0.47 (-0.43)	-4.08 (-5.10)		
SBGC/SEC	6.00 (0.43)		1.06 (1.81)	-1.40 (-3.21)	-2.49 (-2.17)	2.07 (1.20)	-0.48 (-0.37)	-1.55 (-0.89)	-1.22 (-1.03)	2.35 (3.03)	0.64	41
SEC/SBGC	-3.81 (-0.28)		-1.42 (-3.24)	1.40 (2.81)	2.37 (2.34)	-2.05 (-1.56)	0.58 (0.48)	1.68 (1.04)	1.22 (1.19)	-2.23 (-3.05)		

a. Figures in parentheses are t-ratios.
Source: Anderson 1973.

Table 27

Air Conditioning, Food Freezing, Dishwashing, and Television, Constrained Estimates, 50 States, 1970

Dependent Variable	Explanatory Variables[a]								Adjusted R^2	Degrees of Freedom
	Constant	PELEC	YPH	HS	SHU	NUHU	STEMP			
SRAC/SNAC	-37.91 (-3.07)	-0.14 (-0.26)	3.54 (2.74)	-6.18 (-3.59)	1.74 (1.68)	-0.21 (-0.25)	0.1317 (7.56)		0.70	43
SMAC/SNAC	-50.64 (-2.81)	0.76 (-0.96)	4.69 (2.49)	-6.28 (-2.50)	-1.35 (-0.89)	0.85 (0.68)	0.2262 (8.90)		0.70	43
SCAC/SNAC	-50.93 (-2.70)	-1.09 (-1.32)	5.21 (2.64)	-6.83 (-2.60)	3.57 (2.25)	-0.24 (-0.18)	0.1740 (6.54)		0.65	43
	Constant	PELEC	PEFF	YPH	HS	SHU	NUHU	WTEMP		
SFF/SNFF	-8.02 (-1.03)	-0.80 (-2.81)	1.19 (1.35)	0.33 (0.46)	1.79 (1.80)	2.86 (5.29)	0.35 (0.60)	-0.0208 (-3.34)	0.66	42
SFF/SNFF	-0.04 (-0.01)	-0.62 (-1.98)	-1.14 (-1.87)	0.70 (0.89)	1.19 (1.09)	2.61 (4.38)	1.71 (3.70)	--	0.58	43
	Constant	PELEC	YPH	HS	SHU	NUHU				
SDW/SNDW	-6.98 (-1.13)	-0.91 (-3.64)	1.42 (2.24)	-0.82 (-0.95)	0.05 (0.10)	-0.70 (-1.90)			0.45	44
	Constant	PELEC	FTV	YPH	HS	NUHU				
SMTV/SSTV	-10.24 (-2.23)	-0.07 (-0.41)	-0.38 (-1.30)	1.29 (3.02)	0.09 (0.14)	-1.20 (-4.60)			0.[illegible]	44
SNTV/SSTV	4.78 (0.58)	-0.52 (-1.63)	-0.11 (-0.20)	-0.64 (-0.84)	2.62 (2.38)	0.22 (0.47)			0.10	44

a. Figures in parentheses are t-ratios.
Source: Anderson 1973.

Table 28

Additional Variable Definitions
and Units of Measurement

Variable	Definition	Units of Measurement
QE	Total annual residential electricity consumption	kWh/year
CE	Average number of residential electricity customers	customers
QG	Total annual residential utility gas consumption	therms/year
CG	Average number of utility gas customers	customers
NH	Number of households	households
EPC	QE/CE	kWh/customer-year
EPH	QE/NH	kWh/household-year
GPC	QG/CG	therms/customer-year
GPH	QG/NH	therms/household
DEPH[a]	$(QE_{70}-\bar{\rho}_e \cdot QG_{60})/NH_{70}$	kWh/household-year
DGPH[a]	$(QG_{70}-\bar{\rho}_g \cdot QG_{60})/NH_{70}$	therms/household-year
REPH[a]	$(QE_{70}-\bar{\rho}_e \cdot QE_{60})/(NH_{70}-\bar{\rho}_e \cdot NH_{60})$	kWh/household year
RGPH[a]	$(QG_{70}-\bar{\rho}_g \cdot QG_{60})/(NH_{70}-\bar{\rho}_g \cdot NH_{60})$	therms/household-year
REG	QE/QG	kWh/therm
RPEPG	PELEC/PGAS	therm/kWh
GEPH	12.5 · GPH + EPH	equivalent kWh/household-year[b]
PEG	1.53 · PGAS + PELEC	\$/1,000 kWh-mo. = \$/80 therms-mo.

a. For definitions of $\bar{\rho}_e$ and $\bar{\rho}_g$, see Anderson 1973, p. 15. The subscripts 70 and 60 refer to the two census years 1970 and 1960.

b. Based upon typical gas and electric appliance operating efficiencies.

Source: Anderson 1973.

Table 29

Residential Electricity Consumption, 50 States, 1960, 1970, and 1960-1970

Dependent Variables	Explanatory Variables[a] Constant	PELEC	PGAS	POIL	PCOAL	PGAS	YPH	HS	SHU	NUHU	WTEMP	STEMP	Adjusted R^2	Degrees of Freedom
EPC (1960)	2.16 (0.57)	-1.07 (-6.70)	0.33 (2.27)	0.73 (2.52)	-0.05 (-0.43)	-0.09 (-0.62)	1.06 (3.05)	0.04 (0.08)	0.69 (1.71)	0.42 (1.03)	0.0014 (0.39)	0.0001 (0.02)	0.70	38
EPH (1960)	-0.78 (-0.21)	-0.99 (-6.20)	0.36 (2.40)	0.87 (2.98)	0.05 (0.50)	0.15 (0.98)	1.01 (2.90)	0.07 (0.13)	1.03 (2.54)	-0.03 (-0.07)	-0.0040	0.0057 (0.70)	0.70	38
EPC (1970)	10.48 (2.24)	-1.28 (-6.80)	0.27 (1.62)	0.32 (1.14)	0.06 (0.59)	-0.27 (-1.21)	0.67 (1.52)	-0.56 (-0.94)	0.23 (0.60)	0.97 (2.93)	0.0054 (1.60)	0.0106 (1.39)	0.63	38
EPH (1970)	6.83 (1.47)	-1.12 (-6.00)	0.30 (1.84)	0.27 (0.97)	0.12 (1.13)	0.00 (0.01)	0.80 (1.84)	-0.94 (-1.60)	0.76 (2.03)	0.88 (2.68)	0.0030 (0.38)	0.0113 (1.49)	0.66	38
DEPH ($\bar{\rho}_e$ = 0.5)	7.25 (1.66)	-0.99 (-6.17)	0.35 (2.08)	0.01 (0.05)	0.26 (2.44)	0.05 (0.32)	0.76 (1.87)	-1.89 (-3.26)	0.58 (1.46)	1.18 (3.09)	0.0047 (1.31)	0.0202 (2.55)	0.70	38
REPH ($\bar{\rho}_e$ = 0.5)	-3.90 (-1.05)	-0.95 (-6.91)	0.28 (1.98)	-0.05 (-0.19)	0.25 (2.79)	0.10 (0.63)	0.51 (1.48)	-1.88 (-3.79)	0.61 (1.81)	1.19 (3.67)	0.0019 (0.62)	0.0221 (3.26)	0.76	38
DEPH ($\bar{\rho}_e$ = 0.75)	8.60 (1.67)	-1.03 (-5.39)	0.38 (1.94)	-0.15 (-0.41)	0.32 (2.52)	0.03 (0.12)	0.73 (0.152)	-0.29 (-3.33)	0.43 (0.92)	1.40 (3.09)	0.0067 (1.58)	0.0239 (2.54)	0.65	38
REPH ($\bar{\rho}_e$ = 0.75)	0.42 (0.10)	-0.91 (-6.20)	0.24 (1.58)	-0.25 (-0.89)	-0.29 (3.05)	0.10 (0.60)	0.18 (0.48)	-2.30 (-4.34)	0.49 (1.33)	1.45 (4.17)	0.0004 (0.12)	0.0278 (3.82)	0.75	38

a. Figures in parentheses are t-ratios.
Source: Anderson 1973.

Table 30

Estimated Pattern of Electricity Consumption According to Household Function, 1970

Function	Typical Annual Consumption (kWh/yr)	Average U.S. Saturation	Contribution to Average Household Consumption (kWh/yr)	Share of Average Household Consumption
Refrigerator	1,200	1.000	1,200	0.170
Heating	14,500	0.077	1,117	0.158
Water heating	4,500	0.250	1,125	0.159
Television	400	1.242	497	0.070
Cooking	1,175	0.406	477	0.068
Room air conditioning	1,350	0.178	240	0.034
Multi-room air conditioning	2,700	0.072	194	0.027
Central air conditioning	4,000	0.107	428	0.061
Food freezing	1,400	0.282	395	0.056
Clothes drying	990	0.294	291	0.041
Dishwashing	360	0.189	68	0.010
Wringer clothes washing	75	0.112	8	0.001
Automatic clothes washing	100	0.559	56	0.008
Other[a]	--	--	962[b]	0.136
Total	--	--	7,058[c]	1.000

a. Includes lighting, pumping, small appliances, etc.
b. Residual.
c. Actual, not estimated.
Source: Anderson 1973.

Table 31

Estimated Mean Price Elasticities of Consumption, 1970

Energy Types	Energy Prices				
	PGAS	PELEC	POIL	PBGAS	PCOAL
Indirect Estimates(a)					
Utility gas	-1.73	0.28	0.43	0.13	0.07
Electricity	0.81	-0.84	0.10	0.05	0.02
Fuel oil	2.10	0.21	-1.58	0.13	0.08
Bottled gas	2.04	0.26	0.43	-2.04	0.01
Coal	2.21	0.17	0.55	0.13	-3.29
Direct Estimates					
Utility gas	-2.75	-0.67(b)	-0.25(b)	0.47(b)	-0.41(b)
Electricity	0.30(b)	-1.12	0.27(b)	0.00(b)	0.12(b)
Utility gas(c)	-2.68	0.20(b)	-0.26(b)	0.57(b)	-0.48(b)
Electricity(c)	0.11(b)	-1.19	0.20(b)	0.15(b)	0.11(b)

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a. The indirect estimates are based upon the following values for the price coefficients.

Function	Energy Type				
	Utility Gas	Electricity	Bottled Gas	Oil	Coal
Heating	-4.01	-2.21	2.23	-2.13	-3.99
Water heating	-3.99	-2.60	2.76	-2.65	--
Cooking	-3.06	-1.06	1.40	--	--
Clothes drying	-2.17	-1.58	--	--	--

The coefficients for food freezing, multiple room air conditioning, central air conditioning and dishwashing apply only to electricity. They are -0.80, -0.76, -1.09, and -0.90.

b. Not significant at 0.05 level.

c. Constrained estimates.

Source: Anderson 1973.

Table 32

Mean Elasticity Estimates for Electricity from 1970 Static Models

Elasticity Type	Approach or Source of Estimate		Elasticity(a)
Total ($\bar{\varepsilon}_{q,p}$)	unconstrained electricity eq.		-1.12 (-6.00)
	constrained electricity eq.		-1.19 (-5.74)
Saturation ($\bar{\varepsilon}^{e}_{q,p}$)	indirect, from stock eqs.		-0.84(b)
Usage level ($\bar{\varepsilon}^{s}_{q,p}$)	with systematic error term	linear	-0.53 (-3.92)
		log-linear	-0.37 (-3.11)
	no systematic error term	linear	-0.32 (-2.51)
		log-linear	-0.19 (-1.78)
	$(\bar{\varepsilon}_{q,p} - \bar{\varepsilon}^{e}_{q,p})$		-0.28/-0.35(b)

a. The t-ratio in parentheses refers to the estimated price coefficient, not to the elasticity estimate shown, in cases where the two differ.

b. T-ratio not available.

Source: Anderson 1973.

appliances. Anderson's direct estimates of the elasticities are 0.30 for the cross-price and -1.12 for the own-price elasticity. He suggests that the greater elasticity of the directly estimated equation is due to the influence of prices in the utilization of the stock of appliances.

Conclusion: The concept of short-run and long-run elasticities that is implicit in Anderson's work is far more satisfactory than the concept based on slow adjustment through time. The economic concept of the long run is that period of time required for stocks to adjust to their new equilibrium levels, while the short run is concerned with changes in the utilization of the stock of equipment. As far as appliance demand is concerned, adjustment of stocks to a lower equilibrium level should be a slow process since, in the absence of efficient markets in secondhand appliances, the household generally waits for the appliance to depreciate. On the other hand, adjustment toward a higher stock is generally very sensitive to economic variables--the automobile industry is a classic example. This phenomenon is due to the fact that the demand for new consumer durables is a replacement demand in many instances, and the elasticity of substitution between the old and new pieces of equipment is very high.

It is not impossible, then, that the long-run demand adjusts more rapidly than the short-run in some instances. Indeed, much of what has been traditionally described as the "short-run" elasticity of demand is probably due to rapid stock adjustment rather than changes in levels of utilization.

This is not to deny the validity and usefulness of temporally based definitions of short- and long-run demand. In many cases, the source of the increase in consumption is irrelevant although the timing of the increase is important, and in these cases the economic concept is less useful than the temporal. The aim of the present discussion is rather to emphasize the importance of Anderson's work as a conceptually satisfying framework for estimating the economic concept of the short- and long-run elasticities.

17. Environmental Analysts, Inc. (1974)

Title: Environmental Analysts, Inc. 1974. Electricity Demand and Load Forecasting with Application to the Wisconsin Utilities Service Area.

Aim: The saturation model development section endeavors to extend Wilson's saturation model by dropping the needlessly restrictive assumption that appliance adoption is a linear or log-linear relationship, and to check Anderson's results using an equally satisfactory approach.

Approach: The EAI (1974) study is significant in that it replaces the linear regression equation of Wilson with a dynamic adoption model. This model has the desirable property that the saturation level approaches an asymptote through time, the asymptote given by the upper limit to the saturation level. The basic differential equation is:

$$\frac{dY}{dt} \frac{1}{k-Y} = a \frac{Y}{k}$$

where Y = the saturation level

k = the maximum saturation level.

Shifting the terms in the equations gives

$$\frac{dY}{dt} = aY\,(1 - \frac{Y}{k})$$

which states that the rate of change in the actual saturation level is in proportion to the actual saturation level, the factor of proportionality being determined by the difference between the actual and maximum saturation levels. This equation demonstrates the property that $\frac{dy}{dt} = 0$ when Y = K. Integrating this equation, taking logs, and adding an error term, the following regression equation is derived:

$$\log\,(\frac{Y}{k-Y}) = \log b \div at + \mu$$

where $b = (\frac{k-Yo}{Yo})$ is the ratio of the percentage of potential adopters to the percentage that have already adopted at the beginning of the period.

Since this equation is not an economic model, economic considerations can be introduced by three methods:

1. making "k" a function of economic variables
2. making "a" a function of economic variables
3. introducing economic variables independently into the equation.

Consider the second approach first. Let χ be a matrix of exogenous variables and β a vector of appropriate dimension representing the coefficients relating χ to a third variable. Then if

$$a = \chi\beta$$

the equation can be written as

$$\log \left(\frac{Y}{K-Y}\right) = - \log b + (t\chi)\ \beta + \mu$$

since t is a scalar. The third approach produces the regression equation

$$\log \left(\frac{Y}{K-Y}\right) = - \log b + (t\chi)\ \beta + \mu$$

EAI estimated the last two equations for 50 states over the years 1963-1972. The estimation procedure therefore involves pooling cross sections over time, in contrast to Wilson who considered only one cross section. The model is applied to the following appliances--electric ranges, freezers, electric water heaters, and electric driers.

Before estimating the equation, however, an estimate must first be found for k, the maximum saturation level. On the supposition that this maximum must lie between the latest saturation level and unity, k is searched for by means of the equation

$$k = s + d\ (1-s)$$

where s = the current saturation level.

Possible values for d range from 0 to 1 with the associated values of k ranging from s to 1. An example will perhaps clarify this issue. The saturation level for appliance X in 1972 is 70 percent, which implies that seven out of every 10 households own at least one unit of appliance X. Thus, the value of s is 0.7. The following table gives the relationship between k and d for this value of s.

$k = s + d\,(1-s);\ \ s = 0.7$

d	k
0	0.7
0.25	0.78
0.5	0.85
0.75	0.93
1.00	1.00

Note that there will be a different k_i for each state, although d will be the same across states. The final step before estimation is to decide the value of the constant term. As stated above, the constant term can be expressed as

$$- \log b = - \log \left(\frac{k-Y_o}{Y_o}\right)$$

for each state i. EAI considered three variants in its treatment of the constant term.

Variant A. This equation exactly determines the constant term. The associated dependent variable in regression models is then

$$D_o = \log \left(\frac{Y}{k-y}\right) + \log b_i$$

Variant B. This is the same as A except that a constant term is allowed in the equation.

Variant C. In this variant, a two-stage procedure is adopted. The constant term, log b_i, is regressed on the independent variables for the initial year, and the predicted values of the constant terms are used. That is

$$\log b_j = \alpha_0 + X\alpha + \mu$$

is estimated using the cross-section data for 1963. The estimated vector b_j is then used in a second regression of the type discussed in Variant B.

The data used in the EAI study are also more extensive than those used in the Wilson, and Fisher and Kaysen works. Notable additions to the list of independent variables are

1. percentages of state population living in rural areas
2. percent of single-family dwellings
3. price of the appliance.

The results of the EAI study are reproduced in Tables 33 to 40. One notable feature of the results are the strength and size of the income variable. It can be easily seen that the negative and insignificant income elasticity in the Wilson study is due to the strong negative effect of the urbanization variable. The second obvious characteristic of the EAI study is the superiority of Model I, which assumed that economic variables only affected the coefficients on the time variable, over Model II, which did not consider time as an independent variable.

It is noticeable that Model I is equivalent to Model II when a particular set of dummy variables, t = 1,2,3,....8, are used to multiply

Table 33

Water Heater Saturation Study, 1963-1972, State Pooled Time-Series/Cross-Section Regressions--Model II[a]

	Constant	Marginal Residential Price of Electricity	Average Residential Price of Gas	Per Capita Personal Income	Percent Urban	Percent Single-Dwelling Units	Average Temperature	R^2
Model IIa								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$								
i = 1, 2, 3, 4								
$k_1 = S + 0.01(1 - S)$	--	-0.2890	-0.1988	8.98×10^{-4}	-2.87×10^{-2}	-2.01×10^{-4}	2.27×10^{-2}	0.2222
	--	(-6.31)	(-0.25)	(10.83)	(-7.24)	(-0.29)	(6.38)	
$k_2 = S + 0.05(1 - S)$	--	-0.2044	0.9953	5.01×10^{-4}	-1.88×10^{-2}	5.82×10^{-5}	1.77×10^{-2}	0.2208
	--	(-6.96)	(1.96)	(9.42)	(-7.41)	(0.13)	(7.74)	
$k_3 = S + 0.1(1 - S)$	--	-0.1773	1.272	3.70×10^{-4}	-1.50×10^{-2}	1.91×10^{-4}	1.55×10^{-2}	0.2624
	--	(-8.28)	(3.44)	(9.56)	(-8.12)	(0.58)	(9.31)	
$k_4 = S + 0.2(1 - S)$	--	-0.1377	1.035	2.63×10^{-4}	-1.15×10^{-2}	1.78×10^{-4}	1.31×10^{-2}	0.2532
	--	(-8.05)	(3.50)	(8.48)	(-7.75)	(0.68)	(9.83)	
Model IIb								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$								
i = 1, 2, 3, 4								
$k_1 = S + 0.01(1 - S)$	-1.868	-0.2090	-0.2716	1.20×10^{-3}	-3.39×10^{-2}	5.65×10^{-4}	4.08×10^{-2}	0.2445
	(-3.81)	(-4.20)	(-0.35)	(10.52)	(-8.19)	(0.79)	(6.92)	
$k_2 = S + 0.05(1 - S)$	-1.153	-0.1551	0.9503	6.89×10^{-4}	-2.21×10^{-2}	5.31×10^{-4}	2.89×10^{-2}	0.2414
	(-3.67)	(-4.85)	(1.89)	(7.39)	(-8.29)	(1.15)	(7.61)	
$k_3 = S + 0.1(1 - S)$	-0.6510	-0.1495	1.246	4.76×10^{-4}	-1.69×10^{-2}	4.58×10^{-4}	2.18×10^{-2}	0.2742
	(-2.83)	(-6.38)	(3.39)	(8.87)	(-8.65)	(1.35)	(7.35)	
$k_4 = S + 0.2(1 - S)$	-0.5333	-0.1149	1.014	3.49×10^{-4}	-1.30×10^{-2}	3.96×10^{-4}	1.82×10^{-2}	0.2657
	(-2.90)	(-6.14)	(3.45)	(8.14)	(-8.33)	(1.46)	(8.22)	
Model IIc								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log \hat{b}_j^i$								
i = 1, 2, 3, 4								
j = 1, 2,..., No. of States								
$k_1 = S + 0.01(1 - S)$	-1.683	-0.1924	-0.5540	1.17×10^{-3}	-3.23×10^{-2}	2.87×10^{-4}	3.69×10^{-2}	0.1726
	(-2.88)	(-3.23)	(-0.59)	(8.59)	(-6.51)	(0.33)	(5.23)	
$k_2 = S + 0.05(1 - S)$	-1.038	-0.1389	0.8117	6.81×10^{-4}	-2.15×10^{-2}	1.87×10^{-4}	2.61×10^{-2}	0.1330
	(-2.41)	(-3.17)	(1.18)	(6.79)	(-5.89)	(0.30)	(5.03)	
$k_3 = S + 0.1(1 - S)$	-0.5306	-0.1384	1.230	4.71×10^{-4}	-1.65×10^{-2}	9.10×10^{-5}	1.91×10^{-2}	0.1031
	(-1.34)	(-3.43)	(1.95)	(5.10)	(-4.91)	(0.16)	(4.09)	
$k_4 = S + 0.2(1 - S)$	-0.4011	-0.1100	1.137	3.46×10^{-4}	-1.27×10^{-2}	1.72×10^{-5}	1.55×10^{-2}	0.0732
	(-1.07)	(-2.88)	(1.90)	(3.95)	(-3.99)	(0.03)	(3.43)	

a. Numbers in parentheses are t-values.
Source: EAI 1974.

Table 34

Water Heater Saturation Study, 1963-1972, State Pooled Time-Series/Cross-Section Regressions--Model I[a]

	Constant	Marginal Residential Price of Electricity	Average Residential Price of Gas	Per Capita Personal Income	Percent Urban	Percent Single-Dwelling Units	Average Temperature	R^2
Model Ia								
Dependent variable:								
$\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$								
$i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	-- --	-0.0197 (-2.81)	0.3361 (3.04)	7.06×10^{-5} (5.77)	-3.66×10^{-3} (-6.96)	3.28×10^{-4} (2.11)	3.89×10^{-3} (8.06)	0.5318
$k_2 = S + 0.05(1 - S)$	-- --	-0.0166 (-3.63)	0.4955 (6.47)	2.81×10^{-5} (3.52)	-2.35×10^{-3} (-6.84)	2.77×10^{-4} (2.73)	3.04×10^{-3} (9.64)	0.5130
$k_3 = S + 0.1(1 - S)$	-- --	-0.0144 (-4.37)	0.4681 (8.51)	1.51×10^{-5} (2.64)	-1.81×10^{-3} (-7.31)	2.50×10^{-4} (3.43)	2.62×10^{-3} (11.55)	0.5512
$k_4 = S + 0.2(1 - S)$	-- --	-0.0105 (-3.91)	0.3708 (8.26)	5.78×10^{-6} (1.23)	-1.32×10^{-3} (-6.54)	2.07×10^{-4} (3.47)	2.20×10^{-3} (11.93)	0.5269
Model Ib								
Dependent variable:								
$\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$								
$i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	-0.4571 (-6.15)	-0.0018 (-0.24)	0.4423 (3.88)	4.73×10^{-5} (3.82)	-3.10×10^{-3} (-6.01)	5.25×10^{-4} (3.43)	4.25×10^{-3} (9.06)	0.5651
$k_2 = S + 0.05(1 - S)$	-0.2317 (-4.70)	-0.0075 (-1.54)	0.5392 (7.13)	1.63×10^{-5} (1.99)	-2.07×10^{-3} (-6.04)	3.77×10^{-4} (3.70)	3.22×10^{-3} (10.35)	0.5338
$k_3 = S + 0.1(1 - S)$	-0.1232 (-3.44)	-0.0096 (-2.70)	0.4914 (8.96)	8.87×10^{-6} (1.49)	-1.65×10^{-3} (-6.67)	3.03×10^{-4} (4.11)	2.71×10^{-3} (12.01)	0.5617
$k_4 = S + 0.2(1 - S)$	-0.0908 (-3.10)	-0.0069 (-2.39)	0.3879 (8.65)	1.15×10^{-6} (0.24)	-1.21×10^{-3} (-5.94)	2.46×10^{-4} (4.07)	2.28×10^{-3} (12.32)	0.5359
Model Ic								
Dependent variable:								
$\log\left(\frac{Y}{k_i - Y}\right) + \log \hat{b}_j^i$								
$i = 1, 2, 3, 4$								
$j = 1, 2, \ldots,$ No. of States								
$k_1 = S + 0.01(1 - S)$	-0.4708 (-4.81)	0.0028 (0.29)	0.4414 (2.94)	4.33×10^{-5} (2.66)	-2.75×10^{-3} (-4.05)	5.33×10^{-4} (2.64)	3.80×10^{-3} (6.15)	0.4228
$k_2 = S + 0.05(1 - S)$	-0.2386 (-3.12)	-0.0049 (-0.64)	0.5698 (4.86)	1.51×10^{-5} (1.19)	-1.87×10^{-3} (-3.53)	3.58×10^{-4} (2.27)	2.86×10^{-3} (5.94)	0.3162
$k_3 = S + 0.1(1 - S)$	-0.1249 (-1.70)	-0.0086 (-1.18)	0.5480 (4.87)	9.00×10^{-6} (0.74)	-1.51×10^{-3} (-2.95)	2.81×10^{-4} (1.85)	2.37×10^{-3} (5.12)	0.2263
$k_4 = S + 0.2(1 - S)$	-0.0871 (-1.22)	-0.0078 (-1.10)	0.4733 (4.32)	2.60×10^{-6} (0.22)	-1.09×10^{-3} (-2.20)	2.[illegible]5 $\times 10^{-4}$ (1.52)	1.94×10^{-3} (4.29)	0.1601

a. Numbers in parentheses are t-values.
Source: EAI 1974.

Table 35

Range Saturation Study, 1963-1972, State Pooled Time-Series/Cross-Section Regressions--Model II[a]

	Constant	Marginal Residential Price of Electricity	Average Residential Price of Gas	Per Capita Personal Income	Percent Urban	Percent Single-Dwelling Units	Average Temperature	R^2
Model IIa								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$, i = 1, 2, 3, 4								
$k_1 = S + 0.01(1 - S)$	--	-0.3775	-0.2223	1.29×10^{-3}	-2.91×10^{-2}	-1.65×10^{-3}	1.34×10^{-2}	0.3318
	--	(-8.21)	(-0.28)	(15.45)	(-7.33)	(-2.35)	(3.74)	
$k_2 = S + 0.05(1 - S)$	--	-0.2418	0.6421	8.42×10^{-4}	-2.08×10^{-2}	-1.04×10^{-3}	9.65×10^{-3}	0.3300
	--	(-8.18)	(1.26)	(15.75)	(-8.15)	(-2.30)	(4.20)	
$k_3 = S + 0.1(1 - S)$	--	-0.1850	0.8643	6.54×10^{-4}	-1.70×10^{-2}	-7.84×10^{-4}	7.81×10^{-3}	0.3147
	--	(-7.84)	(2.12)	(15.32)	(-8.35)	(-2.17)	(4.26)	
$k_4 = S + 0.2(1 - S)$	--	-0.1337	0.9150	4.86×10^{-4}	-1.33×10^{-2}	-5.72×10^{-4}	5.95×10^{-3}	0.2936
	--	(-7.29)	(2.89)	(14.63)	(-8.37)	(-2.04)	(4.17)	
Model IIb								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$, i = 1, 2, 3, 4								
$k_1 = S + 0.01(1 - S)$	-0.6671	-0.3409	-0.2404	1.39×10^{-3}	-3.10×10^{-2}	-1.30×10^{-3}	1.98×10^{-2}	0.3342
	(-1.34)	(-6.89)	(-0.31)	(12.01)	(-7.36)	(-1.88)	(3.31)	
$k_2 = S + 0.05(1 - S)$	-0.1611	-0.2349	0.6358	8.69×10^{-4}	-2.13×10^{-2}	-9.73×10^{-4}	1.12×10^{-2}	0.3304
	(-0.50)	(-7.21)	(1.24)	(11.62)	(-7.85)	(-2.07)	(2.90)	
$k_3 = S + 0.1(1 - S)$	-0.0095	-0.1846	0.8640	6.56×10^{-4}	-1.71×10^{-2}	-7.80×10^{-4}	7.90×10^{-3}	0.3167
	(-0.04)	(-7.09)	(2.12)	(10.99)	(-7.87)	(-2.07)	(2.56)	
$k_4 = S + 0.2(1 - S)$	0.0703	-0.1367	0.9178	4.74×10^{-4}	-1.31×10^{-2}	-6.01×10^{-4}	5.27×10^{-3}	0.2937
	(0.35)	(-6.75)	(2.89)	(10.22)	(-7.77)	(-2.05)	(2.20)	
Model IIc								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log \hat{b}_j^i$, i = 1, 2, 3, 4; j = 1, 2,..., No. of States								
$k_1 = S + 0.01(1 - S)$	-0.2643	-0.3787	0.0402	1.31×10^{-3}	-2.89×10^{-2}	-1.56×10^{-3}	1.62×10^{-2}	0.2695
	(-0.46)	(-6.51)	(0.04)	(9.79)	(-5.97)	(-1.86)	(2.35)	
$k_2 = S + 0.05(1 - S)$	0.3529	-0.2743	1.117	7.62×10^{-4}	-1.86×10^{-2}	-1.22×10^{-3}	6.25×10^{-3}	0.2224
	(0.85)	(-6.49)	(1.68)	(7.84)	(-5.28)	(-2.00)	(1.25)	
$k_3 = S + 0.1(1 - S)$	0.6001	-0.2327	1.507	5.32×10^{-4}	-1.39×10^{-2}	-1.08×10^{-3}	1.79×10^{-3}	0.1780
	(1.60)	(-6.11)	(2.52)	(6.09)	(-4.40)	(-1.97)	(0.40)	
$k_4 = S + 0.2(1 - S)$	0.8026	-0.1946	1.765	3.27×10^{-4}	-9.32×10^{-3}	-9.68×10^{-4}	-2.33×10^{-3}	0.1231
	(2.29)	(-5.46)	(3.16)	(4.00)	(-3.14)	(-1.88)	(-0.55)	

a. Numbers in parentheses are t-values.
Source: EAI 1974.

Table 36

Range Saturation Study, 1963-1972, State Pooled Time-Series/Cross-Section Regressions--Model I[a]

	Constant	Marginal Residential Price of Electricity	Average Residential Price of Gas	Per Capita Personal Income	Percent Urban	Percent Single-Dwelling Units	Average Temperature	R^2
Model Ia								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$, $i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	--	-0.0291	0.2904	1.35×10^{-4}	-3.66×10^{-3}	-2.73×10^{-4}	2.38×10^{-3}	0.6004
	--	(-4.63)	(2.77)	(12.36)	(-7.78)	(-1.96)	(5.52)	
$k_2 = S + 0.05(1 - S)$	--	-0.0139	0.4200	7.44×10^{-5}	-2.41×10^{-3}	-1.07×10^{-4}	1.62×10^{-3}	0.6683
	--	(-3.38)	(6.13)	(10.42)	(-7.85)	(-1.18)	(5.74)	
$k_3 = S + 0.1(1 - S)$	--	-0.0088	0.4225	5.31×10^{-5}	$-[illegible].92 \times 10^{-3}$	-5.60×10^{-5}	1.27×10^{-3}	0.6381
	--	(-2.59)	(7.47)	(9.00)	(-7.57)	(-0.75)	(5.45)	
$k_4 = S + 0.2(1 - S)$	--	-0.0045	0.3810	3.58×10^{-5}	-1.46×10^{-3}	-2.66×10^{-5}	9.38×10^{-4}	0.5985
	--	(-1.65)	(8.36)	(7.53)	(-7.15)	(-0.44)	(5.00)	
Model Ib								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$, $i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	-0.3936	-0.0136	0.3546	1.15×10^{-4}	-3.18×10^{-3}	-1.03×10^{-4}	2.69×10^{-3}	0.7015
	(-5.90)	(-2.06)	(3.57)	(10.36)	(-6.87)	(-0.75)	(6.40)	
$k_2 = S + 0.05(1 - S)$	-0.1815	-0.0067	0.4542	6.52×10^{-5}	-2.19×10^{-3}	$-2.9[illegible] \times 10^{-5}$	1.76×10^{-3}	0.6797
	(-4.09)	(-1.54)	(6.69)	(8.83)	(-7.12)	(-0.3[illegible])	(6.30)	
$k_3 = S + 0.1(1 - S)$	-0.1153	-0.0042	0.4442	4.72×10^{-5}	-1.78×10^{-3}	-6.29×10^{-6}	1.36×10^{-3}	0.6451
	(-3.12)	(-1.16)	(7.87)	(7.69)	(-6.96)	(-0.08)	(5.85)	
$k_4 = S + 0.2(1 - S)$	-0.0702	-0.0018	0.2943	3.23×10^{-5}	-1.38×10^{-3}	3.72×10^{-6}	9.33×10^{-4}	0.6029
	(-2.35)	(-0.59)	(8.62)	(6.49)	(-6.65)	(0.06)	(5.28)	
Model Ic								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log \hat{b}_j^i$, $i = 1, 2, 3, 4$; $j = 1, 2, \ldots,$ No. of States								
$k_1 = S + 0.01(1 - S)$	-0.3897	-0.0178	0.4757	1.10×10^{-4}	-2.95×10^{-3}	-5.32×10^{-5}	2.65×10^{-3}	0.5790
	(-4.49)	(-2.07)	(3.57)	(7.59)	(-4.89)	(-0.30)	(4.84)	
$k_2 = S + 0.05(1 - S)$	-0.1727	-0.0127	0.6057	6.01×10^{-5}	-1.92×10^{-3}	2.62×10^{-5}	1.67×10^{-3}	0.4702
	(-2.51)	(-1.86)	(5.76)	(5.25)	(-4.02)	(0.18)	(3.84)	
$k_3 = S + 0.1(1 - S)$	-0.1034	-0.0114	0.6311	4.18×10^{-5}	-1.46×10^{-3}	5.48×10^{-5}	1.21×10^{-3}	0.3722
	(-1.58)	(-1.76)	(6.30)	(3.83)	(-3.22)	(0.41)	(2.94)	
$k_4 = S + 0.2(1 - S)$	-0.0553	-0.0104	0.6241	2.63×10^{-5}	-1.00×10^{-3}	7.29×10^{-5}	7.82×10^{-4}	0.2591
	(-0.86)	(-1.62)	(6.30)	(2.44)	(-2.23)	(0.55)	(1.92)	

a. Numbers in parentheses are t-values.

Source: EAI 1974.

Table 37

Freezer Saturation Study, 1963-1972, State Pooled Time-Series/Cross-Section Regressions--Model II[a]

	Constant	Marginal Residential Price of Electricity	Average Residential Price of Gas	Per Capita Personal Income	Percent Urban	Percent Single-Dwelling Units	Average Temperature	R^2
Model IIa								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$, i = 1, 2, 3 4								
$k_1 = S + 0.\ 1(1 - S)$	-- --	-0.4280 (-9.22)	-1.714 (-2.14)	1.474×10^{-3} (17.55)	-3.004×10^{-2} (-7.49)	-2.127×10^{-4} (-0.30)	1.106×10^{-2} (3.07)	0.3883
$k_2 = S + 0$)5(1 - S)	-- --	-0.2667 (-8.98)	-0.7959 (-1.55)	9.714×10^{-4} (18.08)	-2.147×10^{-2} (-8.36)	7.410×10^{-5} (0.16)	8.160×10^{-3} (3.53)	0.3821
$k_3 = S + 0\ 1(1 - S)$	-- --	-0.2003 (-8.25)	-0.4102 (-0.98)	7.679×10^{-4} (17.49)	-1.792×10^{-2} (-6.54)	1.135×10^{-4} (0.31)	6.565×10^{-3} (3.48)	0.3552
$k_4 = S + 0\ 2(1 - S)$	-- --	-0.1463 (-7.40)	-0.1071 (-0.31)	5.947×10^{-4} (16.63)	-1.445×10^{-2} (-8.46)	9.429×10^{-5} (0.31)	4.828×10^{-3} (3.14)	0.3223
Model IIb								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$, i = 1, 2, , 4								
$k_1 = S + .01(1 - S)$	-0.4569 (-0.91)	-0.4034 (-7.98)	-1.732 (-2.16)	1.548×10^{-3} (13.20)	-0.0313 (-7.36)	-2.546×10^{-5} (-0.03)	0.0155 (2.56)	0.3893
$k_2 = S + .05(1 - S)$	0.0362 0.11)	-0.2682 (-8.18)	-0.7945 (-1.55)	9.660×10^{-4} (12.86)	-0.0214 (-7.83)	5.928×10^{-5} (0.13)	7.810×10^{-3} (2.01)	0.3832
$k_3 = S + 0.1(1 - S)$	0.1754 (0.67)	-0.2078 (-7.76)	-0.4034 (-0.96)	7.394×10^{-4} (12.05)	-0.0174 (-7.83)	4.162×10^{-5} (0.11)	4.867×10^{-3} (1.54)	0.3553
$k_4 = S + 0.2(1 - S)$	0.2142 (1.0)	-0.1554 (-7.14)	-0.0958 (-0.29)	5.598×10^{-4} (11.21)	-0.0138 (-7.64)	6.487×10^{-6} (0.02)	2.754×10^{-3} (1.07)	0.3237
Model IIc								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log \hat{b}_j^i$, i = 1, 2, 3, 4; j = 1, 2,..., No. of States								
$k_1 = S + 0.01(1 - S)$	-9.458×10^{-3} (-0.02)	-0.4389 (-8.25)	-1.243 (-1.49)	1.446×10^{-3} (11.86)	-0.0279 (-6.31)	-3.307×10^{-4} (-0.43)	[illegible] (…60)	0.3625
$k_2 = S + 0.05(1 - S)$	0.4778 (1.39)	-0.3026 (-8.63)	-0.2420 (-0.44)	8.727×10^{-4} (10.86)	-0.0184 (-6.29)	-2.433×10^{-4} (-0.48)	[illegible] $\times 10^{-3}$ (0.62)	0.3449
$k_3 = S + 0.1(1 - S)$	0.6228 (2.13)	-0.2456 (-8.26)	0.1949 (0.42)	6.505×10^{-4} (9.54)	-0.0147 (-5.93)	-2.682×10^{-4} (-0.62)	-3.015×10^{-4} (-0.09)	0.3066
$k_4 = S + 0.2(1 - S)$	0.6772 (2.64)	-0.1974 (-7.56)	0.5495 (1.34)	4.741×10^{-4} (7.92)	-0.0113 (-5.21)	-3.185×10^{-4} (-0.64)	-2.403×10^{-3} (-0.78)	0.2554

a. Numbers in parentheses are t-values.
Source: EAI 1974.

Table 38

Freezer Saturation Study, 1963-1972, State Pooled Time-Series/Cross-Section Regressions--Model I[a]

	Constant	Marginal Residential Price of Electricity	Average Residential Price of Gas	Per Capita Personal Income	Percent Urban	Percent Single-Dwelling Units	Average Temperature	R^2
Model Ia								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$, $i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	-- --	-0.0331 (-5.24)	-0.1025 (-0.97)	1.573×10^{-4} (14.27)	-3.746×10^{-3} (-7.90)	4.329×10^{-4} (3.09)	1.659×10^{-3} (3.82)	0.7080
$k_2 = S + 0.05(1 - S)$	-- --	-0.0146 (-3.41)	-0.0494 (-0.69)	9.039×10^{-5} (12.14)	-2.495×10^{-3} (-7.78)	4.203×10^{-4} (4.44)	1.119×10^{-3} (3.81)	0.6721
$k_3 = S + 0.1(1 - S)$	-- --	-8.258×10^{-3} (-2.25)	0.1030 (1.68)	6.753×10^{-5} (10.56)	-2.062×10^{-3} (-7.48)	3.625×10^{-4} (4.45)	8.606×10^{-4} (3.41)	0.6201
$k_4 = S + 0.2(1 - S)$	-- --	-3.717×10^{-3} (-1.19)	0.1375 (2.62)	4.965×10^{-5} (9.08)	-1.645×10^{-3} (-6.99)	2.837×10^{-4} (4.08)	5.966×10^{-4} (2.77)	0.5612
Model Ib								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$, $i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	-0.3065 (-4.49)	-0.0211 (-3.12)	-0.0447 (-0.43)	1.417×10^{-4} (12.48)	-3.370×10^{-3} (-7.13)	5.650×10^{-4} (4.02)	1.900×10^{-3} (4.42)	0.7195
$k_2 = S + 0.05(1 - S)$	-0.0993 (-2.12)	-0.107 (-2.30)	0.0681 (0.95)	8.534×10^{-5} (10.05)	-2.373×10^{-3} (-7.31)	4.631×10^{-4} (4.80)	1.197×10^{-3} (4.06)	0.6751
$k_3 = S + 0.1(1 - S)$	-0.0470 (-1.16)	-6.414×10^{-3} (-1.60)	0.1119 (1.81)	6.514×10^{-5} (9.69)	-2.004×10^{-3} (-7.16)	3.828×10^{-4} (4.60)	8.975×10^{-4} (3.53)	0.6212
$k_4 = S + 0.2(1 - S)$	-0.0180 (-0.52)	-3.011×10^{-3} (-0.98)	0.1409 (2.67)	4.873×10^{-5} (8.48)	-1.623×10^{-3} (-6.78)	2.914×10^{-4} (4.10)	6.107×10^{-4} (2.81)	0.5615
Model Ic								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log \hat{b}_j^i$, $i = 1, 2, 3, 4$, $j = 1, 2, \ldots,$ No. of States								
$k_1 = S + 0.01(1 - S)$	-0.3112 (-4.22)	-0.0229 (-3.13)	0.0884 (0.78)	1.336×10^{-4} (10.88)	-2.928×10^{-3} (-5.73)	5.210×10^{-4} (3.82)	1.658×10^{-3} (3.57)	0.6833
$k_2 = S + 0.05(1 - S)$	-0.0981 (-1.86)	-0.0140 (-2.66)	0.2131 (2.53)	7.918×10^{-5} (8.99)	-1.998×10^{-3} (-5.45)	4.825×10^{-4} (4.43)	9.631×10^{-4} (2.89)	0.6149
$k_3 = S + 0.1(1 - S)$	-0.0413 (-0.86)	-0.0102 (-2.27)	0.2647 (3.60)	6.036×10^{-5} (7.55)	-1.676×10^{-3} (-5.04)	4.033×10^{-4} (4.08)	6.746×10^{-4} (2.23)	0.5333
$k_4 = S + 0.2(1 - S)$	-6.884×10^{-3} (-0.15)	-8.576×10^{-3} (-1.92)	0.3016 (4.38)	4.549×10^{-5} (6.07)	-1.348×10^{-3} (-4.32)	3.188×10^{-4} (3.36)	4.039×10^{-4} (1.42)	0.4286

a. Numbers in parentheses are t-values.
Source: EAI 1974.

Table 39

Dryer Saturation Study, 1963-1972, State Pooled Time-Series/Cross-Section Regressions--Model II[a]

	Constant	Marginal Residential Price of Electricity	Average Residential Price of Gas	Per Capita Personal Income	Percent Urban	Percent Single-Dwelling Units	Average Temperature	R^2
Model IIa								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$; $i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	--	-0.4791	-0.9378	1.62×10^{-3}	-4.00×10^{-2}	-1.45×10^{-3}	2.15×10^{-2}	0.3779
	--	(-9.20)	(-1.05)	(15.86)	(-8.48)	(-1.84)	(5.29)	
$k_2 = S + 0.05(1 - S)$	--	-0.3478	-0.0481	1.14×10^{-3}	-[illegible].04 x 10^{-2}	-8.63×10^{-4}	1.93×10^{-2}	0.3971
	--	(-9.89)	(-0.08)	(16.44)	(-9.54)	(-1.63)	(7.03)	
$k_3 = S + 0.1(1 - S)$	--	-0.2837	0.1459	9.20×10^{-4}	-2.60×10^{-2}	-6.20×10^{-4}	1.77×10^{-2}	0.3862
	--	(-9.73)	(0.29)	(16.04)	(-9.82)	(-1.41)	(7.78)	
$k_4 = S + 0.2(1 - S)$	--	-0.2245	0.2880	7.21×10^{-4}	-2.16×10^{-2}	-4.41×10^{-4}	1.59×10^{-2}	0.3655
	--	(-9.31)	(0.70)	(15.20)	(-9.89)	(-1.21)	(8.46)	
Model IIb								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$; $i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	-0.8322	-0.4436	-0.9799	1.76×10^{-3}	-4.22×10^{-2}	-1.11×10^{-3}	2.96×10^{-2}	0.3808
	(-1.49)	(-7.75)	(-1.10)	(12.99)	(-8.55)	(-1.35)	(4.36)	
$k_2 = S + 0.05(1 - S)$	-0.5527	-0.3242	-0.0760	1.22×10^{-3}	-3.19×10^{-2}	-6.37×10^{-4}	2.46×10^{-2}	0.3996
	(-1.47)	(-8.39)	(-0.13)	(13.42)	(-9.56)	(-1.15)	(5.38)	
$k_3 = S + 0.1(1 - S)$	-0.3500	-0.2688	0.1282	9.75×10^{-4}	-2.69×10^{-2}	-4.77×10^{-4}	2.11×10^{-2}	0.3877
	(-1.12)	(-8.38)	(0.26)	(12.88)	(-9.71)	(-1.04)	(5.54)	
$k_4 = S + 0.2(1 - S)$	-0.2506	-0.2138	0.2753	7.61×10^{-4}	-2.23×10^{-2}	-3.38×10^{-4}	1.84×10^{-2}	0.3667
	(-0.97)	(-8.06)	(0.67)	(12.14)	(-9.73)	(-0.89)	(5.83)	
Model IIc								
Dependent variable: $\log\left(\frac{Y}{k_i - Y}\right) + \log \hat{b}_j^i$; $i = 1, 2, 3, 4$; $j = 1, 2, \ldots,$ No. of States								
$k_1 = S + 0.01(1 - S)$	-0.4380	-0.4480	-0.7750	1.90×10^{-3}	-4.90×10^{-2}	-1.64×10^{-3}	2.35×10^{-2}	0.4026
	(-0.77)	(-7.67)	(-0.85)	(13.76)	(-9.73)	(-1.97)	(3.39)	
$k_2 = S + 0.05(1 - S)$	-0.1443	-0.3337	0.2159	1.35×10^{-3}	-3.83×10^{-2}	-1.17×10^{-3}	1.85×10^{-2}	0.4232
	(-0.37)	(-8.28)	(0.34)	(14.22)	(-11.00)	(-2.03)	(3.88)	
$k_3 = S + 0.1(1 - S)$	0.0610	-0.2824	0.4943	1.10×10^{-3}	-3.29×10^{-2}	-1.00×10^{-3}	1.51×10^{-2}	0.4084
	(0.18)	(-8.23)	(0.93)	(13.51)	(-11.10)	(-2.04)	(3.72)	
$k_4 = S + 0.2(1 - S)$	0.1451	-0.2322	0.7311	8.66×10^{-4}	-2.77×10^{-2}	-8.42×10^{-4}	1.28×10^{-2}	0.3727
	(0.50)	(-7.75)	(1.57)	(12.26)	(-10.72)	(-1.97)	(3.60)	

a. Numbers in parentheses are t-values.
Source: EAI 1974.

Table 40

Dryer Saturation Study, 1963-1972, State Pooled Time-Series/Cross-Section Regressions--Model I[a]

	Constant	Marginal Residential Price of Electricity	Average Residential Price of Gas	Per Capita Personal Income	Percent Urban	Percent Single-Dwelling Units	Average Temperature	R^2
Model Ia								
Dependent variable:								
$\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$								
$i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	--	-0.0345	0.0582	1.54×10^{-4}	-4.72×10^{-3}	-1.00×10^{-4}	4.24×10^{-3}	0.7619
	--	(-5.46)	(0.56)	(12.76)	(-9.37)	(-0.72)	(9.68)	
$k_2 = S + 0.05(1 - S)$	--	-0.0188	0.2626	8.14×10^{-5}	-3.15×10^{-3}	8.29×10^{-5}	3.62×10^{-3}	0.8037
	--	(-4.79)	(4.02)	(10.85)	(-10.04)	(0.96)	(13.29)	
$k_3 = S + 0.1(1 - S)$	--	-0.0125	0.2766	5.62×10^{-5}	-2.56×10^{-3}	1.37×10^{-4}	3.25×10^{-3}	0.7837
	--	(-3.72)	(4.97)	(8.77)	(-9.58)	(1.85)	(13.96)	
$k_4 = S + 0.2(1 - S)$	--	-0.0072	0.2741	3.55×10^{-5}	-2.04×10^{-3}	1.52×10^{-4}	2.87×10^{-3}	0.7607
	--	(-2.49)	(5.68)	(6.40)	(-8.83)	(2.38)	(14.27)	
Model Ib								
Dependent variable:								
$\log\left(\frac{Y}{k_i - Y}\right) + \log\left(\frac{k_i - Y_0}{Y_0}\right)$								
$i = 1, 2, 3, 4$								
$k_1 = S + 0.01(1 - S)$	-0.5289	-0.0144	0.1604	1.22×10^{-4}	-3.89×10^{-3}	1.37×10^{-4}	4.73×10^{-3}	0.7900
	(-8.03)	(-2.23)	(1.61)	(10.19)	(-8.03)	(1.02)	(11.37)	
$k_2 = S + 0.05(1 - S)$	-0.3204	-0.0066	0.3245	6.22×10^{-5}	-2.65×10^{-3}	2.27×10^{-4}	3.92×10^{-3}	0.8256
	(-7.79)	(-1.65)	(5.23)	(8.31)	(-8.75)	(2.70)	(15.08)	
$k_3 = S + 0.1(1 - S)$	-0.2319	-0.0037	0.3214	4.23×10^{-5}	-2.20×10^{-3}	2.41×10^{-4}	3.46×10^{-3}	0.8057
	(-6.50)	(-1.05)	(5.96)	(6.50)	(-8.38)	(3.31)	(15.35)	
$k_4 = S + 0.2(1 - S)$	-0.1679	-0.0008	0.3065	2.54×10^{-5}	-1.78×10^{-3}	2.28×10^{-4}	3.03×10^{-3}	0.7742
	(-5.36)	(-0.27)	(6.48)	(4.46)	(-7.73)	(3.57)	(15.30)	
Model Ic								
Dependent variable:								
$\log\left(\frac{Y}{k_i - Y}\right) + \log \hat{b}_j^i$								
$i = 1, 2, 3, 4$								
$j = 1, 2, \ldots$, No. of States								
$k_1 = S + 0.01(1 - S)$	-0.4183	-0.0191	0.1319	1.65×10^{-4}	-5.36×10^{-3}	1.34×10^{-5}	4.28×10^{-3}	0.7466
	(-5.57)	(-2.59)	(1.16)	(12.02)	(-9.70)	(0.09)	(9.02)	
$k_2 = S + 0.05(1 - S)$	-0.2121	-0.0124	0.3191	1.03×10^{-4}	-4.04×10^{-3}	1.12×10^{-4}	3.49×10^{-3}	0.7425
	(-3.99)	(-2.38)	(3.97)	(10.60)	(-10.33)	(1.03)	(10.38)	
$k_3 = S + 0.1(1 - S)$	-0.1267	-0.0103	0.3363	8.10×10^{-5}	-3.52×10^{-3}	1.34×10^{-4}	3.06×10^{-3}	0.6946
	(-2.60)	(-2.15)	(4.57)	(9.12)	(-9.83)	(1.35)	(9.93)	
$k_4 = S + 0.2(1 - S)$	-0.0692	-0.0084	0.3473	6.10×10^{-5}	-2.98×10^{-3}	1.31×10^{-4}	2.66×10^{-3}	0.6175
	(-1.50)	(-1.86)	(4.98)	(7.25)	(-8.78)	(1.39)	(9.12)	

a. Numbers in parentheses are t-values.
Source: EAI 1974.

the independent variables. This would suggest that differences in the regression coefficients over time account for Model II's poor performance. Estimates of each cross section separately, or a pooled cross section using Zellner's "seemingly unrelated regression model," would be helpful in evaluating these influences.

Conclusion: The EAI work is an improvement over the Wilson and the Fisher and Kaysen works for the reasons referred to, but several limitations are involved in the procedure. First, the EAI approach requires an estimate of the final saturation of each appliance. Since the saturation level may change over time, the estimated adoption model parameters may also differ over time. Changing saturation levels over time, which may vary at different rates between states, limits the model's results to the time period being studied and the applicability of the results to individual states.

In addition, the extension of the EAI work, which has the benefit of the wider data base from the pooled cross section, toward estimating the indirect elasticities in the manner suggested by Anderson would be an important check on the validity of Anderson's results and a useful summary of the appliance demand issue.

18. Environmental Analysts, Inc. (1974)

Title: Same as No. 17.

Aim: The purpose of the EAI study is to check earlier studies estimating elasticities of electricity consumption from state data and to determine the effect of income distribution on electricity consumption.

Approach: The major contribution of the EAI (1974) study to the estimation of price and income elasticities of the re⌣idential sector is the pooled cross-section technique discussed in the following. However, in searching for the appropriate estimating model and for the viability of aggregation over time, the study presents results of regression analysis for a cross section of states estimated for each year from 1965 to 1972.

The major features of the elasticities estimated from the individual cross sections can be summarized in the area and range of the estimates.

Elasticities Estimated from Individual Cross Sections, 1965-1972

Elasticity	Lowest (year)	Average	Highest
Own price	-0.813 (1967)	-0.892 (0.106)	-0.957 (1971)
Cross price	0.0573 (1963)	0.088 (0.080)	0.1208 (1972)
Income	0.498 (1967)	0.652 (0.344)	0.923 (1972)

Two features of these results are worthy of comment. First, there appears to be evidence of rising elasticities over time. This evidence may indicate that the constant price elasticity model may not be appropriate and that models incorporating elasticities that rise with prices may be more successf⌣l.

The results also indicate that aggregation over time is generally appropriate. In the preceding table, above the average standard error is given in brackets below the average elasticity. In all cases, the extreme values lie within one standard error of the average value, and in most cases they lie within one half of one standard error. This would suggest that aggregation over time is justified although it is not a formal test for such aggregation.

Another interesting feature of the EAI cross-section results is an attempt to take account of the distribution of income in measuring the elasticities. To understand the importance of this approach, the individual demand function is incorporated into a time-aggregate demand function for a state. This function is then compared with that normally employed in elasticity studies. The individual demand function can be written:

$$q = a\ p^b y^n$$

where q = quantity demanded

p = the marginal price

y = income

b, n = the price and income elasticities.

This equation gives the average demand function for a particular income class. For example, with data on the number of people with certain incomes--below \$5,000, \$5,000-\$10,000, \$10,000-\$20,000, etc., statewide aggregates are formed by integrating over these income classes. Then average state consumption is

$$\overline{q} = a\ p^b \int y^n\ f(y)\ dy$$

where y = median income of the income class

$f(y)$ = number of people in that income class.

This equation should be compared with the following equation, which is the one normally used in electricity demand studies.

$$\bar{q} = a\ p^b\ \bar{y}^n$$

where $\bar{y}$ = the average income in the state.

Only in the case in which n is equal to 1 will the approaches be equivalent. If n is less than 1, a state with a high proportion of low-income residents will have an estimated elasticity that is higher than the actual estimate. Since the distribution of income is asymmetric, this approach would suggest that conventionally measured income elasticities would overestimate the true income elasticity of demand.

This presumption is weighed by the data. The estimating procedure for the income distribution model can be seen by taking logarithms of the demand equation. Letting $E(y^n) = y\ f(y)dy$, the logarithmic form is

$$\log q = \log a + b \log p + \log E(y^n)$$

The noticeable feature of this equation is that there is no coefficient on the last term. This suggests that the "best" estimate of "n" is that which makes the coefficient on $\log E\ (y^n)$ equal to one. The estimating procedure therefore involves searching over the range of values of n to find the value that sets the regression coefficient equal to unity. The value of n found through this procedure was 0.66, which was indeed lower than the "conventional" estimate of 0.77, suggesting that income distribution does affect demand.

This method is important because it permits the analysis of distribution considerations that cannot be handled within the traditional framework. The EAI study was only an experiment using cross-sectional data for 1 year, but the promising nature of this approach deserves further consideration.

When the cross-section data are pooled and an error components model is used to estimate the equation, the estimated elasticities, both short- and long-run, are

$$Q/Pop = \underset{(-.78)}{-0.00213} - \underset{(-1.92)}{0.0229}\, p^e + \underset{(.31)}{0.00168}\, p^g + \underset{(2.36)}{0.0197}\, y$$

$$\underset{(-4.47)}{-0.0537}\, R + \underset{(4.27)}{0.0483}\, T + \underset{(92.0)}{0.9693}\, (Q/Pop)_{t-1}$$

Long-Run Elasticities

Electricity Price	Gas Price	Income
-0.746	0.055	0.642

Conclusions: Even though this study is more comprehensive than most studies, the results are not useful for formulating regional pricing policies because Michigan does not typify the national average, having a colder climate, different saturation levels of appliances, and different intensities of fuel usage. The findings of this study, however, indicate that the methods employed may prove useful in service-area elasticity studies. For a similar approach, see Halvorsen (1973) and Mount et al. (1972).

19. Halvorsen (1973)

Title: Halvorsen, R. 1973. Long-Run Residential Demand for Electricity, Discussion Paper No. 73-6. Short-Run Determinants of Residential Electricity Demand, Discussion Paper No. 73-10. Institute for Economic Research, University of Washington.

Aim: This study explores the potential for price rationing by examining the short-run determinants of residential demand for electricity (this accounts for one-third of the kilowatt hours sold annually and is subject to greater seasonal variations than the other major components of demand).

Approach: The equations are estimated with annual data for 47 states for the period 1947-1969. Average sales per customer are calculated from data in the Statistical Year Book of the Edison Electric Institute. TEB data are published annually by the Federal Power Commission in Typical Electric Bills. Data on average income per capita are from the Survey of Current Business. Price and income variables are reflected by the consumer price index.

The general form of the demand equation is written

$$Q = Q\ (P,\ \underline{W},\ u)$$

where Q = the quantity of electricity purchased

P = electricity price

$\underline{W}$ = a vector of all other relevant variables

u = disturbance term.

The price of electricity is determined by the marginal price schedule and the quantity purchased. The marginal price schedule is in turn determined by the utility's costs.

Therefore

$$P = P\ (Q,\ \underline{Z},\ v)$$

where $\underline{Z}$ = a vector of cost variables

v = a disturbance term.

The existence of Federal Power Commission data on typical electric bills makes it possible to replace the vector of cost variables by a direct proxy for the rate structure, and so avoid the problems posed by regulatory lags that occur between changes in costs and changes in the price structure. So

$$P = P\ (Q,\ B,\ v)$$

where B = the TEB variable.

The reduced-form equation for quantity purchased is

$$Q = Q\ (B,\ \underline{W},\ w)$$

The estimated coefficients of this measure the total effects of the explanatory variables for quantity purchased. The total effect of a variable will be equal to its direct effect on quantity purchased plus the sum of indirect effects that arise owing to the dependence of price on quantity.

For the short run, the only relevant variable in W is average income per capita (Y). Substitute price elasticities are negligible in the short run, and data on heating degree-days and average July temperature change are only in the form of long-run averages. The omission of the latter (temperature variable) is unlikely to cause misspecification not being correlated with the included variables. The general form of the equation to be estimated is then simply

$$Q = Q\ (B,\ Y,\ w)$$

The response of residential electricity demand to changes in price and income can be expected to be spread over a number of periods. The most general dynamic specification of the demand equation is

$$Q_t = Q_t\ (P_{t-j},\ Y_{t-k},\ u_t)$$

$$j = 0, 1 \ldots, m$$

$$k = 0, 1, \ldots, n$$

On the basis of good performance, a log-lineal form is used

$$\log Q_t = a + \sum_{j=0}^{m} b_j \log P_{t-j} + \sum_{k=0}^{n} C_k \log Y_{t-k} + \log U_t$$

A common set of restrictions is that the coefficients of logged values of the variables decline geometrically:

$$b_j = b(1-D_1)\ D_i^j \qquad 0 \leq D_1 < 1 \quad j = o, 1, \ldots, \infty$$
$$c_k = c(1-D_2)\ {}_2^k \qquad 0 \leq D_2 < 1 \quad k = o, 1, \ldots, \infty$$

If $D_1 = D_2 = D$, the substitution and application of the Koyck transformation yields

$$\log Q_t = a(a-D) + D \log Q_{t-1} + b(1-D) \log P_t + C(1-D) \log Y_t + \log U_t + \log U_{t-1} \qquad (1)$$

The short-run price elasticity is equal to -b(1-D), and the short-run income elasticity is equal to c(1-D). Long-run price and income elasticities are equal to -b and c, respectively.

The assumption of geometrically declining coefficients can be derived by allowing the coefficients of the current values of price and income to take any value, imposing the geometrically declining lag structure only after the current period.

$$b_j = b_j \qquad j = o,$$
$$b_j = b(1-D)D^j \qquad j = 1, \ldots, \infty$$
$$c_k = c_k \qquad k = o$$
$$c_k = c(1-D)D^k \qquad k = 1, \ldots, \infty$$

Again, substitution and application of the Koyck transformation yields the demand equation

$$\log Q_t = a(1-D) + D \log Q_{t-1} + \left[b-X\ (bo + b)\right] \log P_{t-1}$$

$$+ Co \log Y_t + \left[C-D\ (Co + C)\right] \log Y_{t-1}$$

$$+ \log U_t - T \log U_{t-1}$$

and using the identities (to eliminate collinearity)

$$\log P_t = (\log P_t - \log P_{t-1}) + \log P_{t-1} = \Delta\log P_t + \log P_{t-1}$$

$$\log Y_t = (\log Y_t - \log Y_{t-1}) + \log Y_{t-1} = \Delta\log Y_t + \log Y_{t-1}$$

we get

$$\log Q_t = a(1-D) + D \log Q_{t-1} + bo \log \Delta P_t + (bo + b)\ (1-D) \log P_{t-1} \quad (2)$$

$$+ Co \log \Delta Y_t + (Co + c)\ (1-D) \log Y_{t-1}$$

$$+ \log U_t + Y \log U_{t-1}$$

The short-run price and income elasticities are -bo and Co. If $D_1 \neq D_2$, the following alternative equation can be derived

$$\log Q_t = a(1-D_1)(1-D_2) + (D_1+D_2)\ \Delta\log Q_{t-1} \quad (3)$$

$$+ (D_1+D_2 - D_1D_2) \log Q_{t-2}$$

$$+ b(1-D_1)\ \Delta\log P_t + b(1-D_1)(1-D_2) \log P_{t-1}$$

$$+ c(1-D_2)\ \Delta\log Y_t + c(1-D_1)(1-D_2) \log Y_{t-1}$$

$$+ c(1-D_1)(1-D_2) \log Y_{t-1}(D_1+D_2) \log U_{t-1}$$

$$+ D_1 D_2 \log U_{t-2}$$

This is

$$\log \Delta Q_t = A_o + A_1 \log \Delta P_t + A_2 \log \Delta Y_t + V_t$$

The reduced-form equation for quantity purchased is obtained for each model by substituting for price in the demand equation using the relation,

$$\log P_t = C_o + C_1 \log Q_t + C_2 \log B_t + \log U_t$$

where B = the TEB variable.

For example, equation 1 becomes

$$\log Q_t = \frac{A_o + A_2 C_o}{1-A_2 C_1} + \frac{A_1}{1-A_2 C_1} \log Q_{t-1} + \frac{A_2 C_2}{1-A_2 C_1} \log B_t + \frac{A_3}{1-A_2 C_1} Y_t + W_t$$

So, the coefficient of B_t is the short-run price elasticity estimate and part of Y_t the short-run income elasticity estimate.

A three-step procedure is used to correct for inconsistency, inefficiency, and general correlation of the variables. The logged dependent variable is replaced by an instrument that is correlated with it but not with the disturbance term. Secondly, a generalized least-squares procedure is used to obtain more efficient estimates, by calculating the first-order general correlation coefficient of the residuals from the equation incorporating the instrumental variable. To correct for bias, k/u is added to the correlation coefficient where k is the number of parameters in the equation and u is the number of observations. Finally, the estimate of the autocorrelation coefficient is used to transform the data using a transformation suggested by Kadiyala (Econometrica 1968). The estimate obtained will be more, but not fully, efficient.

The short-run price and income elasticities are $-b(1-D_1)$ and $c(1-D_2)$.

Thus, equations 1, 2, and 3 provide three variants of an equation expressing quantity purchased as a function of all past values of electricity price and income.

The influence of past levels of consumption can be incorporated as well. The equation

$$\log Q_t = A_o + A_1 \log Q_{t-1} + A_2 \log P_t + A_3 \log Y_t + V_t$$

is the general form of the demand equation (1), with price and income elasticities of $-A_2$ and A_3. The long-run price and income elasticities are $-A_2/(1-A_1)$ and $A_3/1-A_1$, respectively. Similarly, we have general forms of (2) and (3).

$$\log Q_t = A_o + A_1 \log Q_{t-1} + A_2 \log P_{t-1} + A_4 \Delta \log Y_t + A_5 \log Y_{t-1} + V_t$$

Short-run price and income elasticities are $-A_2$ and A_4 and long-run ones $-A_3/1-A_1$ and $A_5/1-A_1$.

$$\log Q_t = A_o + A_1 \log \Delta \log Q_{t-1} + A_2 \log Q_{t-2} + A_3 \log \Delta P_t + A_4 \log P_{t-1} + A_5 \log \Delta Y_t + A_6 \log Y_{t-1} + V_t$$

Price and income elasticities are $-A_3$ and A_6 in the short run and $-A_3A_5/A_6$ and A_3A_5/A_4 in the long run.

Reduced form equations are estimated for models containing each of the three dynamic demand equations. In addition, the demand equation estimated by Fisher and Kaysen (1962) is included and compared in an appendix.

Using 1961-1969 data on the 48 contiguous states, Halvorsen's (1973) basic regression is

$$Q = \underset{(1.015)}{-0.5936} - \underset{(33.475)}{1.1482}\, p_a^e + \underset{(8.193)}{0.5129}\, y + \underset{(2.755)}{0.0405}\, p^g - \underset{(1.297)}{0.0240}\, D$$

$$+ \underset{(4.588)}{0.5386}\, J - \underset{(10.537)}{0.2139}\, R - \underset{(1.961)}{0.2408}\, H - \underset{(3.484)}{0.0108}\, T \quad \bar{R}^2 = 0.9151$$

where Q = average annual residential electricity sales per customer

p_a^e = average real price of residential electricity

y = average real income per capita

p^g = average real price per therm for all types of residential gas

D = heating degree-days

J = average July temperature

R = percentage of population living in rural areas

H = average size of households

T = time.

These estimates have a number of surprising features. First, there is a remarkable difference between the own-price and cross-price elasticities. Halvorsen's study suggests that a 10 percent increase in the price of electricity will reduce consumption by approximately 11.5 percent. Where is this reduced electricity consumption going to come from?

One would think that the primary source would be substitution from electric appliances to gas and oil substitutes, but the extremely low cross-price elasticity would appear to place doubt on this explanation. To be consistent with these statistics, states with high electricity prices must have low utilization rates and more efficient appliances--i.e., a greater quantity of insulation around homes and water heaters. This may well be the case, but if it is so, the appliance-based approach of the previous sections is unlikely to capture the true price elasticities.

Halvorsen includes two climate variables. The July temperature variable appears to capture the air-conditioning demand fairly successfully, but the variable for the heating degree-days borders on statistical insignificance. As Halvorsen suggests, there may well be nonlinearity present here. For moderately cold climates, electric heating with its low installation costs dominates gas and oil, but in colder climates the cheaper bulk fuel rates of the latter fuels predominate. This would suggest that further divisions of the climatic effects would bring this variable into significance. A similar problem arises with the housing size variable. We would expect larger houses to be associated with greater electricity demands. The negative coefficient may be due to substitution between electric and competing fuel appliances as housing size expands.

Conclusion: Halvorsen's study (1973) has the largest number of environmental variables. In addition to the urbanization variable, he includes separate summer and winter temperatures, a housing size variable, and a time trend. Unfortunately it is not possible to directly compare this study with the other two, since the adjustment mechanisms are not the same. The significance of Halvorsen's environmental variables suggests that their omission may have biased the results of the other two studies.

20. Mount, Chapman, and Tyrell (1973)

Title: Mount, T.D., L. D. Chapman, and T. J. Tyrell. 1973. Electricity Demand in the United States: An Econometric Analysis. Oak Ridge National Laboratory.

Aim: In the Mount et al. (1973) study, the estimating procedures used to prepare the two articles discussed earlier are described, the basic objective being to develop a more comprehensive model explaining electrical energy demand.

Approach: Mount et al. (1973) estimate a pooled cross-section model of residential electricity demand. Their data are for 47 contiguous states (North and South Carolina are combined) for the years 1947-1970. They report results for both constant and variable elasticity models, so only the constant elasticity results are reported here. Their basic regression is

$$Q_t = \underset{(136.5)}{0.8859}\, Q_{t-1} + \underset{(17.0)}{0.1075}\, Pop + \underset{(4.2)}{0.0343}\, y - \underset{(12.5)}{0.1385}\, p^e$$

$$+ \underset{(6.7)}{0.0238}\, p^g - \underset{(2.4)}{0.0408}\, p^a + DV_i$$

where Q_{t-1} = lagged consumption

Pop = population in state i at time t

p^a = an appliance price index

DV_i = nine regional dummy variables.

This model is built on the dynamic adjustment mechanisms. The long-run price, cross-price, and income elasticities are

Long-Run Elasticities

Price	Income	Cross-Price
-1.2138	0.3006	0.2086

In addition, the long-run response to population growth is approximately 0.94, which is not statistically different from the plausible value of 1.00, and the long-run elasticity of electricity demand with respect to the appliance price index is -0.3576.

Conclusion: Mount et al. employ regional dummy variables to measure the differences in consumption patterns across regions. Dummy variables are not a good proxy for regional differences because the correlation between the dummy variables and the lagged dependent variable lowers the value of the coefficient on the lagged dependent variables and because the dummy variables also capture other effects. For example, urbanization differences, a variable excluded from the study and shown to be important in the review of Wilson (1971), are accounted for by the dummy variables.

21. Moore (1970)

Title: Moore, T. G. 1970. The effectiveness of regulation of electric utility prices. Southern Economic Journal.

Aim: Moore's study (1970) is designed to measure the effectiveness of regulation in controlling residential electricity prices.

Of interest in Moore (1970) is the estimation of demand equation using a cross section of 41‾ companies, both public and private.

Sales of electricity per resid al customer in 1963 were regressed on long-run expected price of ele icity, long-run expected cost of gas in the area, and a dummy variable for the area of the country. Income was excluded because of difficulty in getting the data and because in a sample of 37 companies the income coefficient was approximately zero. The two main variables were

$P_i\ \overline{Q}_i$ = typical electric bill for a consumer buys 250 kWh per month (taken from Typical Ele ric Bills)

P_g = price of gas for compani servicing t e main cities in each electric company's territory. When more than one gas company was operating within a given electric company's territory, a weighted average (weights being the population of the major cities serviced by gas companies) was used; data were gathered from The American Gas Association Rate Service Manual.

The above variables were not used in the regression equations. They were used to calculate the long-run expected price, which was found using the following equation

$$P_t^e = \beta P_{t-}A_1 + (1-\beta)\, P_{t-1}^e$$

where $P_{t-1}^e = \beta P_{t-2}^A + (1-\beta)\, p_{t-2}^e$

In Moore's model, the firms form an estimate of the price in period t from information available in period t-1. The expectation mechanism is Bayesian in that expectations are revised each period as a new piece of sample data, the current price, becomes available. Moore's estimate of β is 0.9, which suggests that firms adapt rapidly to current information.

Linear demand functions were estimated using the expected price concept, which was itself estimated from the typical electric bills data. Two sets of dummy variables were employed. One set divides the country into nine regions--New England, Middle Atlantic, East North Central, West North Central, South Atlantic, East South Atlantic, East South Central, West South Central, Mountain, and Pacific. A second set divides the above regions in two sets, the first covering New England to West North Central in the above classif.cation, while the second covers the South Atlantic to Pacific regions.

Several forms of a demand equation were estimated, and the results are given in Table 41. The equations are given below:

$$Q = \alpha_1 + \text{---} + \alpha_q = \beta_1 \Sigma P_i\overline{Q}_i + \beta_g P_g + e$$

$$Q = \alpha_1 + \alpha_2 + \beta_1 \Sigma P_i\overline{Q}_i + \beta_b P_g + e$$

$$Q = \alpha_1 + \text{---} + \alpha_q + \beta_1 \Sigma P_i\overline{Q}_i + \beta_2 P_g . \Sigma P_i\overline{Q}_i + e$$

Table 41

Estimates of Linear Demand Coefficients

Specification	Number of Areas	Electricity Coefficients	Elasticities at Mean	Gas Coefficients	Electricity/ Gas	R^2	F
1	9	-0.693 (0.071)	-1.020	1.314 (0.213)		0.581	55.0
2	2	-1.010 (0.061)	-1.487	1.057 (0.179)		0.515	142.9
3	9	-0.873 (0.080)	-1.028		(146.030)	0.567	51.81
4	2	-0.406 (0.161)	-1.458	4.626 (0.897)	-0.485 (0.120)	0.535	115.1

Numbers in parentheses are standard errors.
Source: Moore 1970.

$$Q = \alpha_1 + \alpha_2 + \beta_1 \Sigma P_i\overline{Q}_i + \beta_g P_g + \beta_2 P_g \cdot \Sigma P_i \overline{Q}_i + e$$

where α = a dummy variable.

Conclusions: The main limitation of Moore's results are due to the fact that the equation is estimated using a sample of 417 companies. It is not obvious that the typical electric bill is the relevant price variable for these companies, and Moore has not considered the possibility of declining rate schedules as a source of simultaneous equation bias. In addition, Moore points out that the elasticity measure does not take account of the influence of price on new customer sales and therefore possibly underestimates the true elasticity of demand. Owing to the fact that the estimation of the demand equation was not the major focus of Moore's paper, the details of the estimation procedures and data characteristics are not given. The study should therefore be considered as of minor importance apart from the interesting attempt at the construction of an expected price series. The decision to purchase an electric appliance is influenced by the prices that are expected to prevail over the lifetime of the machine. Most models have implicitly assumed static expectations--that is, that consumers expect the current price to prevail in the future. While Moore's expectations mechanism is particularly simple, the basic idea is worthy of further consideration.

22. Powell (1973)

Title: Powell, K. B. 1973. Price elasticity can be misleading. Electrical World.

Aim: In this article, Powell (1973) qualitatively assesses the price elasticity concept as a meaningful tool for utility planning.

Approach: Powell comments on the usefulness of estimated price elasticity of electricity demand to utility companies. According to Powell, estimated price elasticities for electricity usage do not take into account the fact that peak-load price elasticity may be less than general price elasticity. Powell believes that peak demand may be very inelastic with respect to price. To support this contention, he cites an estimate of Wilson that shows near-zero price elasticity of air-conditioning demand. According to Powell, air conditioning is a prime component of most companies' summer peak demand.

Powell suggests that because of price inelasticity of peak demand, raising prices of electricity will merely reduce nonpeak demand with no change in peak demand, and hence cause reduction in revenue (if nonpeak demand is sufficiently elastic) and a rise in average costs. This may lead to an explosive cycle as utilities might then ask for further rate increases. However, the natural solution would be to lower prices in such a situation, though Powell does not suggest this. Instead, he suggests sales promotion and advertising of off-peak load electricity use.

Conclusion: Powell successfully illuminates a potential shortcoming of misguided applications of price elasticity, but the lack of specific empirical work limits its usefulness to anything other than an interesting article explaining the limitations of the price elasticity concept.

23. Tansil (1973)

Title: Tansil, J. 1973. Residential Consumption of Electricity, 1950-1970. ORNL-NSF-EP-51. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Aim: Forecasts of electricity demand are computed using a noneconomic methodology.

Approach: Tansil's work is a sophisticated noneconomic approach to the problem of estimating electricity demand. The following definitional relationship is employed:

Electricity consumption = number of appliances per wired household (saturation) x No. of wired households x average electricity use per appliance.

Tansil has therefore broken down the problem of estimating consumption per appliance into three separate problems. Table 42 presents the projections of saturation and average electricity use per appliance.

Interested readers should consult the original article for the details behind these projections. Once the projections for each appliance are calculated, the total electricity demand can be calculated by summing the component parts. It is also possible to calculate how sensitive the aggregate estimates are to assumptions about the saturation levels or energy intensiveness of a particular appliance. Tansil's estimates are given in Table 43 and are compared to some other estimates. While his approach leads to estimates of future demand growth that are below those reached by other noneconometric approaches, they are within the bounds of the econometric estimates that he cites.

Table 42

Projections of Appliance Saturations and Average Annual Electricity Use

Use	Saturations (%) 1970	1980	1990	Average Annual Electricity Use in Households Having the Appliance (kWh/household) 1970	1980	1990
Refrigerators	99.8	100	100	1,300	1,600	1,800
Air conditioning						
Room	26.5	36	41	1,946	2,000	2,000
Central	11.3	18	26	3,560	3,600	3,600
Lighting	100.0	100	100	750	850	900
Space heating	7.6	16	27	14,588	15,000	15,000
Water heating	25.2	33	41	4,500	4,800	4,800
Clothes drying	29.1	40	51	993	1,000	1,000
Cooking	40.3	47	54	1,175	1,200	1,200
Television	94.7	100	100	417	440	470
Food freezers	28.0	34	39	1,384	1,500	1,600

Source: Tansil 1973.

Table 43

Present and Future Residential Electricity Demand[a]

Use	Demand (billion kWh) 1970	1980	1990
Refrigerators	83	122	158
Air conditioning			
Room	33	55	72
Central	26	49	82
Lighting	48	65	79
Space heating	71	183	356
Water heating	72	121	173
Clothes drying	19	30	45
Cooking	30	43	57
Television	25	33	41
Food freezers	28	39	55
Other (clothes washers, irons, etc.)[b]	13	20	27
New uses (electric car, etc.)[c]	--	10	30
Total residential use			
Tansil 1973	448	770	1,175
Federal Power Commission estimate	448	755	1,409
Electrical World estimate	448	930	1,700
Econometric model high estimate	448	978	1,727
Econometric model low estimate[d]	448	711	751

a. Data in the upper part of the table are computed from data in Table 42 using the relationship:
(national average annual electricity use per appliance) = (saturation) X (wired households) X (electricity use per appliance)
with the number of wired households as 64.0 X 10^6 in 1970, 76.1 X 10^6 in 1980, and 87.8 X 10^6 in 1990.

b. It is assumed that clothes washers, dishwashers, and minor appliances such as irons, radios, electric toothbrushes, can openers, electric blankets, etc., will show an approximate linear increase in electricity use.

c. Hypothetical new uses of electricity such as electric cars, electric incinerators, etc., are projected to have a growing consumption.

d. See Chapman et al. 1972.

Source: Tansil 1973.

Tansil examines the sensitivity of his predictions to some different assumptions about saturation levels and energy conservation methods. The results of these experiments are reproduced in Table 44.

Introducing these assumptions does result in demand projections that are similar to those reached by extrapolative techniques. The reasons for continued growth are, however, quite different.

Conclusion: This work is interesting, but does not add anything substantive to the results discussed already, especially since the forecasts are within the range of forecasts presented previously.

24. Asbury (1974)

Title: Asbury, J. G. 1974. Regional Studies--Lake Michigan Energy Forecasts, The Econometric Approach to Electricity Supply and Demand: Review and Analysis. Argonne National Laboratory, Argonne, Illinois. ANL/ES-33.

Aim: Asbury (1974) reviews the assumptions, methodologies, and results of previous empirical studies of electricity use to determine their usefulness for predicting future electricity use, and to support his conclusions with his own empirical work.

Methodology: Using data for cross sections of 48 states for 1959, 1965, and 1970 obtained from conventional sources, Asbury estimates the following equations.

$$\log Q = \alpha_0 + \alpha_1 \cdot \log P + \alpha_2 \cdot \log F + \alpha_3 \cdot \log Y + \alpha_4 \cdot \log D + \alpha_5 \cdot \log H + \alpha_6 \cdot \log T$$

Table 44

Effect of Increased Appliance Saturations on Future Residential Electricity Use[a]

	Case I, Past and Current Trends[b]	Case II, Greater Appliance Saturations in New Dwellings[c]	Case III, Greater Appliance Saturations in New Dwellings Plus Much Greater Conversion Rate From Fossil Fuels to Electricity[d]
Applicance Saturation in 1990			
Air conditioning			
Room	41	55	55
Central	26	30	30
Space heating	27	34	58
Water heating	41	49	66
Cooking	54	63	71
Clothes drying	51	54	63
Residential Electricity Use in 1990 (10^9 kWh)[a]			
Future A	1,175	1,350	1,750
Future B	1,000	1,150	1,500

a. Each case is based on a different set of saturations for air conditioning, space heating, water heating, cooking, and clothes drying. For these five appliances, future residential electricity consumption is computed from the saturations, electricity use per appliance per household from Table 42. Electricity consumption for other appliances is taken from Table 43 and assumes a 15% reduction in electricity use resulting from implementation of energy conservation measures.

b. Based on past and current trends. Saturations are from footnotes c, e, f, g, h in Table 42.

c. Air-conditioning saturations are assumed to increase substantially: Northeast, 80%; South, 95%; North Central, 85%; and West, 70%. It is assumed that all new dwellings constructed from 1981 to 1990 would use electricity for space heating, water heating, and cooking, and 70% would use electricity for clothes drying. Assumptions regarding conversions as a fraction of new installations are the same as Table 43.

d. Assumptions are the same as in case II for air-conditioning saturations and installation of space heating, water heating, cooking, and clothes drying in new dwellings. From 1971 to 1990, it is assumed that half of all households using alternative fuels for heating purposes in the home convert to electricity, i.e., the number of electrically heated households in 1970 would be $[4.88 + (0.4\text{[illegible]}) \times (76.1 - 64.0) + (1.00) \times (87.8 - 76.1) + 0.5(64.0 - 4.88)] \times 10^6 = 51 \times 10^6$.

Source: Tansil 1973.

and

$$\log P = B_0 + B_1 \cdot \log Q + B_2 \cdot \log D + \sum_{i=3}^{5} B_i \cdot Z_i$$

where Q = electricity consumption (kWh)

P = average price in dollars

F = average gas price in dollars

Y = per capita personal income

H = heating degree-days

T = average July temperature

D = population density

Z_3 = percentage of hydroelectric capacity as a percentage of total capacity

Z_4 = percent of capacity under private ownership

Z_5 = residential sales as a percent of total sales.

These equations are estimated in two variants. In the first, residential electricity use is estimated by ordinary least squares for 1960, 1965, and 1970. The results of the regressions are reported in Table 45. Elasticity estimates fall in a range of -0.87 to -1.11 for all of the regressions. Asbury further observes that the price elasticities are increasing over time in all equations. The rising price elasticities reported in Table 45 are misleading because there is not a statistically significant difference between the price elasticity estimates for the 3 years; in particular, none of the parameter estimates is statistically different than one.

Table 45

Computed Elasticities

Year	Elasticities α_1	α_2	α_3	α_4	α_5	α_6	R^2
1959	-0.98						0.72
1965	-1.04						0.78
1970	-1.05						0.81
(Error)[a]	(0.08)						
1959	-0.98	0.15					0.76
1965	-1.03	0.14					0.80
1970	-1.14	0.15					0.82
(Error)	(0.08)	(0.09)					
1959	-1.02	0.08	0.32				0.77
1965	-1.07	0.12	0.09				0.80
1970	-1.11	0.21	-0.19				0.83
(Error)	(0.08)	(0.10)	(0.13)				
1959	-0.88	0.31	0.48	0.16			0.88
1965	-0.95	0.30	0.34	0.14			0.89
1970	-1.07	0.26	0.09	0.06			0.85
(Error)	(0.07)	(0.08)	(0.09)	(0.03)			
1959	-0.90	0.30	0.44	0.15	0.05		0.89
1965	-0.93	0.30	0.40	0.15	-0.04		0.89
1970	-0.99	0.31	0.19	0.11	-0.11		0.87
(Error)	(0.07)	(0.08)	(0.12)	(0.03)	(0.04)		
1959	-0.87	0.28	0.40	0.15	0.02	-0.05	0.89
1965	-0.92	0.30	0.38	0.15	-0.05	-0.02	0.89
1970	-1.03	0.35	0.20	0.11	-0.07	0.06	0.88
(Error)	(0.07)	(0.08)	(0.12)	(0.03)	(0.04)	(0.04)	
1959[b]	-0.93	0.19	0.43	0.15	0.03		0.88
1965[b]	-0.97	0.14	0.40	0.13	-0.02		0.88
1970[b]	-1.03	0.17	0.18	0.10	-0.10		0.86
(Error)	(0.07)	(0.05)	(0.13)	(0.03)	(0.04)		

a. Error refers to standard errors for year 1965.
b. Competing-fuel price equals natural-gas price.
Source: Asbury 1974.

In the second phase of his study, Asbury adds an equation to measure the simultaneous relationship between average price and quantity of electricity consumed, which arises because, under a declining block rate structure, average price decreases at higher levels of usage. The simultaneous relationship between average price and consumption, estimated by two-stage least squares (2SLS), is intended to test the effect of the simultaneous equation bias in the price elasticity estimate. The greater the difference between the two-stage least squares and OLS price elasticity estimates, the greater the bias.

The only results reported by Asbury are reported in Table 46. The 2SLS result (-0.89) is less than the OLS price elasticity (-1.03), and the results are statistically different at a 5 percent confidence interval. This supports Asbury's argument that OLS estimates of price effects are biased because of the interrelationship between average price and electricity consumption.

Conclusion: Although Asbury does succeed in clarifying the supply-demand aspects of price elasticity estimation, the contribution of the empirical work to the understanding of electricity price elasticities is limited. Asbury's main conclusion that residential price elasticities are changing over time is incorrect since there is no statistical difference between the estimated elasticity coefficients. Second, Asbury's results show that the 2SLS price elasticity is significantly different from the OLS elasticity, but it is impossible to determine if the 2SLS elasticity estimate is any closer to the true price elasticity than the OLS estimate. We only know that the two are statistically different (see Lacy and Street).

Table 46

Estimated Demand and Supply Elasticities, 1970

Method of Estimation	Demand Elasticities: Price (α)	Cross Price (β)	Income (γ)	Distance (δ)	Heating Degree Days (ε)
Ordinary least squares	-1.03	0.31	0.19	0.11	-0.11
Two-stage least squares	-0.89	0.34	0.18	0.12	-0.13

	Supply Elasticities: Quantity (ρ)	Distance (ρ_1)	% Hydro (ρ_2)	% Private (ρ_3)	% Residential (ρ_4)
Two-stage least squares	-0.66	0.024	-0.03	0.10	0.18

25. Griffin (1974)

Title: Griffin, J. M. 1974. The effects of higher prices on electrical energy consumption. Bell Journal of Economics and Management Science 5: 515-539.

Aim: Griffin (1974) determines the short- and long-run effects of higher electricity prices using simultaneous equation models with lagged variables.

Approach: Griffin (1974) specifies a model containing 12 stochastic and 13 definitional equations. Of these 25 equations, two bear directly on price elasticity estimation, one explaining residential electricity sales and the other average electricity price. The two equations are

$$DR/N = \alpha_0 + \alpha_1 (K_1/N) + \sum_{i=2}^{m} \alpha_i (YD/N)_{-i+2} + \sum_{j=m+1}^{n} \alpha_j (PR/P)_{-j+m+1}$$

and

$$PR = B_0 + B_1 \cdot FUEL + B_2 \cdot ULC + B_3 \cdot AUCC + B_4 \cdot \frac{DR}{N}$$

where DR = residential electricity use (kWh)

N = population

FUEL = average fuel cost in dollars

ULC = average labor cost in dollars

AUCC = average capital cost in dollars

K_1 = stock of air conditioners

PR = average residential price of electricity in dollars

P = GNP price deflator

YD = real per capita disposable income.

These equations conform to the specification proposed by Asbury (19 in that electricity use and average electricity price are simultaneously determined and are estimated by two-state least squares. A significant difference, however, is the addition of lagged explanatory variables to capture dynamic adjustments in electricity consumption in response to price and income changes.

Lagged explanatory variables, represented by

$$\sum_{i=2}^{m} \alpha i \; (YD/N)_{-i+2}$$

and

$$\sum_{j=m+1}^{n} \alpha_j \cdot (PR/P)_{-j+m+1}$$

measure the effect of past income and price on current electricity consumption. The purpose of lagged variables is to measure how past incomes and prices affect consumer expectations about current and future income and price variables. In the case of income, the lag specification is intended to approximate permanent income, an income concept originally developed by Friedman to remove the effect of temporary income gains or losses on electricity consumption.

Using national data for the years 1951 to 1971 and the Almon lag estimation procedure, Griffin obtains

$$DR/N = \underset{(1.7)}{0.648} + \underset{(6.6)}{0.009}\,(K_1/N) + \underset{(0.9)}{0.028} \cdot (YD/N) + \underset{(2.3)}{0.068}\,(YD/N)_{-1}$$

$$+ \underset{(2.7)}{0.093}(YD/N)_{-2} + \underset{(2.8)}{0.104}(YD/N)_{-3} + \underset{(2.7)}{0.100}(YD/N)_{-4} + \underset{(2.7)}{0.086}(YD/N)_{-5}$$

$$+ \underset{(2.7)}{0.048}(YD/N)_{-6} \underset{(1.7)}{-0.038} (PR/P) \underset{(2.0)}{-0.061} (PR/P)_{-1} \underset{(3.2)}{-0.068} (PR/P)_{-2}$$

$$- \underset{(11.2)}{-0.061} (PR/P)_{-3} \underset{(1.9)}{-0.037} (PR/P)_{-4}$$

and

$$PR/P = \underset{(26.0)}{2.084} + 1.0 \cdot FUEL + \underset{(2.1)}{0.0028} (AUCC - 4.7 \cdot T) \underset{(47.1)}{-0.514} \log (DR/N)$$

In the first equation, the results indicate that current energy consumption is affected more by income and price 3 and 4 years ago than current income and price. Income is small in value and statistically insignificant in the current year (0.028), increases in value until the maximum coefficient is reached in year 3 (0.104), and declines in value thereafter. Price coefficients follow a similar pattern, rising from an initial value of -0.038 to -0.068 for year t-2 and again declining.

The policy implication of Griffin's results suggests that a one-unit increase in a.erage electricity price in year t reduces electricity consumption year t by 0.038 units. In year t + 1, electricity consumption is reduced by 0.61 units, 0.068 in year t + 2, and 0.061 in year t + 3. The effect of an electricity price increase thus appears to have been fully worked out by the end of the third year after the price increase.

From these results, Griffin computes a short- and long-run price elasticity of -0.06 and -0.52. The corresponding income elasticities are 0.06 and 0.88.

Conclusions: Griffin's study provides preliminary evidence that current residential price elasticity studies fail to adequately account for the dynamics of electricity consumption, and this creates some doubt about the value of these studies for evaluating the impacts of alternative pricing policies. Whether Griffin's findings can be expected to hold for specific utility service areas is unknown.

26. Liew (1972)

Title: Liew, C. 1972. Market Share and Price Structure in the Case of Energy Industries. Oklahoma Gas and Electric Company.

Aim: Price elasticities of gas and electricity and the elasticity of substitution between gas and electricity are estimated for individual years, and the change in these elasticities over time observed.

Approach: Time series data representing electricity and natural gas sales in the Oklahoma Gas and Electric service area from 1950 to 1970 are used to estimate the following equation.

$$\left[TD - (1 - \delta_1) \cdot TD_{-1}\right] = \alpha_1 \cdot Y^{\sigma 1} + \alpha_3 Y^{\sigma} (P_1/P_2)^{0.5}$$

and

$$\left[TG - (1 - \delta_2)\, TG_{-1}\right] = \alpha_2 \cdot Y^{\sigma\, 2} + \alpha_3 \cdot Y^{\sigma} (P_2/P_1)^{0.5}$$

where TD = consumption of electricity in year t (kWh)

TD_{-1} = consumption of electricity in year t-1 (kWh)

δ_1 = depreciation rate of electricity-using appliances

Y = service area income in dollars

TG = consumption of natural gas in year t (mcf)

TG_{-1} = consumption of natural gas in year t-1 (mcf)

δ_2 = depreciation rate of natural gas using appliances

P_1 = average price of electricity in dollars

P_2 = average price of natural gas in dollars

∂ = a general utility scale function

∂_1 = an electricity-related utility scale function

∂_2 = a natural gas-related utility scale function.

An iterative least squares estimation procedure was used to estimate the parameters α_1, α_2, α_3, ∂, ∂_1, and ∂_2. From estimates of these parameters, the following equations are estimated.

$$ES_t = 0.5 \cdot \alpha_3 \cdot \left\{ Y_t^{\partial} \cdot Y_t / \left[NO_t \cdot NG_t \cdot (P_1 \cdot P_2)^{0.5} \right] \right\}$$

$$PEND_t = 0.5 \cdot \alpha_3 \, (P_{2t}/P_{1t})^{0.5} \, (Y_t^{\partial}/NO_t)$$

$$PENG_t = 0.5 \cdot \alpha_3 \, (P_{1t}/P_{2t})^{0.5} \, (Y_t^{\partial}/NG_t)$$

where ES_t = the elasticity of substitution between natural gas and electricity in period t

$PEND_t$ = the price elasticity of electricity in period t

$PENG$ = the price elasticity of natural gas in period t.

Table 47 presents the major results of the study. Beginning in 1953, the electricity price elasticity was -1.13; it reached a peak of -1.30 in 1958 and declined thereafter until 1970 when a value of -0.64 is observed.

Table 47

Annual Price Elasticities

Year	Residential and Commercial Market ND(a)	NG	ES	Residential Market ND	NG	ES
1953	-0.91	-2.93	3.83	-1.13	-3.08	4.21
1954	-0.85	-3.91	4.76	-1.03	-4.09	5.12
1955	-0.87	-4.67	5.53	-1.08	-4.49	5.57
1956	-0.94	-2.60	3.54	-1.17	-2.52	3.69
1957	-1.01	-2.28	3.29	-1.29	-2.14	3.43
1958	-1.03	-1.79	2.82	-1.30	-1.72	3.02
1959	-0.95	-2.72	3.67	-1.24	-2.29	3.54
1960	-0.85	-3.39	4.23	-1.11	-2.84	3.94
1961	-0.82	-5.59	6.43	-1.04	-4.81	5.85
1962	-0.84	-2.53	3.36	-1.00	-2.53	3.54
1963	-0.76	-2.98	3.75	-0.86	-3.10	3.97
1964	-0.72	-2.91	3.63	-0.82	-3.14	3.96
1965	-0.73	-2.77	3.50	-0.85	-3.06	3.92
1966	-0.77	-2.66	3.42	-0.89	-3.17	4.07
1967	-0.80	-2.28	3.07	-0.98	-2.52	3.50
1968	-0.74	-1.93	2.69	-0.86	-2.16	3.02
1969	-0.68	-1.54	2.21	-0.76	-1.69	2.46
1970	-0.58	-1.61	2.19	-0.64	-1.88	2.52
Mean	-0.82	-2.84	3.66	-1.00	-2.84	3.85
Standard Deviation	0.11	1.01	1.03	0.18	0.87	0.89
Normalize at $\overline{X}$ and $\overline{p}$	-0.76	-2.54	3.12	-0.91	-2.60	3.26

a. ND = new demand for electricity, NG = new demand for natural gas, ES = elasticitiy of substitution between electricity and natural gas.

Source: Liew 1972.

Natural gas price elasticity also declines over this period, but the variation in price elasticity estimates between periods is much greater, indicating greater instability in the demand for natural gas.

The most important feature of the study relates to consumer substitution of natural gas and electricity over time. Larger values for ES indicate a greater willingness to substitute the types of appliances, and a reluctance to substitute appliances is indicated by lower values. Declining elasticity of substitution coefficients over the sample period (from 5.57 in 1955 to 2.52 in 1970) implies a stronger attachment by consumers to their present type of appliance.

Conclusion: The variable elasticity approach (VE) employed by Liew is the first known attempt to determine the variation in elasticity estimates over time, and the only VE model applied to a utility service area. Offsetting these very positive benefits is the specter of the possibility that the estimation procedure and the procedures used to control for factors such as weather (moving averages of the data) and deriving new demand are arbitrary. Further work is needed to clarify the importance of these issues.

27. Southern California Edison Company (1974)

Title: Edison Electric Service. 1974. Estimation and Application of Price Elasticity. Southern California Edison Company.

Aim: Southern California Edison Company (SCE) (1974) estimates a residential price elasticity specific to its service area in order to develop a better model for forecasting effects of electricity price changes on future electrical energy use.

Approach: This in-house study of the demand for electricity within the SCE service area has these principle characteristics:

1. data are limited to those available within the service area
2. the data base is expanded by considering different rate schedules as cross-sectional observations
3. the average price of electricity is used as the appropriate price variable
4. pooled cross-section time series data are used to estimate the coefficients
5. the influence of weather on the demand for electricity is considered
6. some attempts are made to estimate the dynamic adjustment of electricity consumption to a change in price.

The characteristics mentioned above are discussed in the following paragraphs.

Data Limited to the Service Area

Studies of the demand for electricity, reviewed to date except for Liew (1972), cover a wider geographical area than the SCE study. Choice of the geographical region to cover in elasticity studies might be based on data collected from different countries throughout the world, or on data from a particular service area. That such studies do exist suggests that there is not one best level of aggregation, but that both types of studies yield information about price elasticities. The basic trade-off in selecting a geographical basis is between homogeneity of the population and variation in the explanatory variables. A good data base will exhibit a variety in the included variables (prices, income, housing size, weather) while being relatively homogenous in the excluded variables. The assumption that is frequently made is that the consumers are identical except for the fact that they face different values of the explantory variable.

It is clear that the assumption of homogeneity is more filled with data from a small geographical area. However, the variety of prices and incomes is clearly greater in data taken from a wide geographical area. In addition, interstate or interutility studies have the advantage that the price and income differentials have persisted for far longer periods of time, so that the long-run effect of a price change can be more accurately gauged from this data.

The SCE study is based on a small geographical area, and consequently faces the problem of insufficient variation in the data. This problem is compounded by the fact that the data base only extends over a period of 10 years. The attempt to overcome this problem is discussed in the next section. But, because SCE (1974) correctly points out that the interstate or interutility price elasticity studies do not adequately depict the characteristics of their service area and therefore are subject to an omitted variable bias if applied to their service area, the study is worthwhile despite these limitations.

Data Base Expansion

The data base is extended by considering different rate schedules on cross-sectional data as the demand for electricity. The SCE has six basic rate schedules. For residential customers, these rate schedules differ for two particular types of uses--employees of the electric company and multiple-account customer. There are consequently 18 different rate schedules facing residential customers.

In assessing the validity of this data base, it is worthwhile to recall the homogenity characteristic of good data. Are the customers facing these rate schedules different in any characteristic other than prices and income, and if so will these characteristics influence their demand for electricity? If the answer to these questions is affirmative, then the estimates of the price characteristics derived from these data will be biased, if the other characteristics are correlated with the price of electricity. The nature of this bias is illustrated in Figure 1.

In Figure 1, the demand curves for three distinct customer groups are shown by D_1, D_2, and D_3. The first customer group has the smallest demand for electricity, in the sense that for any price, this group would consume less than the other groups. The prices, P_1, P_2, and P_3, are the prices facing each of the groups, due to the different rate schedules, and the asterisks denote the observed price-quantity combinations. If the demand curve is fitted by connecting these price-quantity points, the observed demand curve is found to be more sensitive to price than the actual demand curves. The nature of the bias in the elasticity estimate is therefore self-evident.

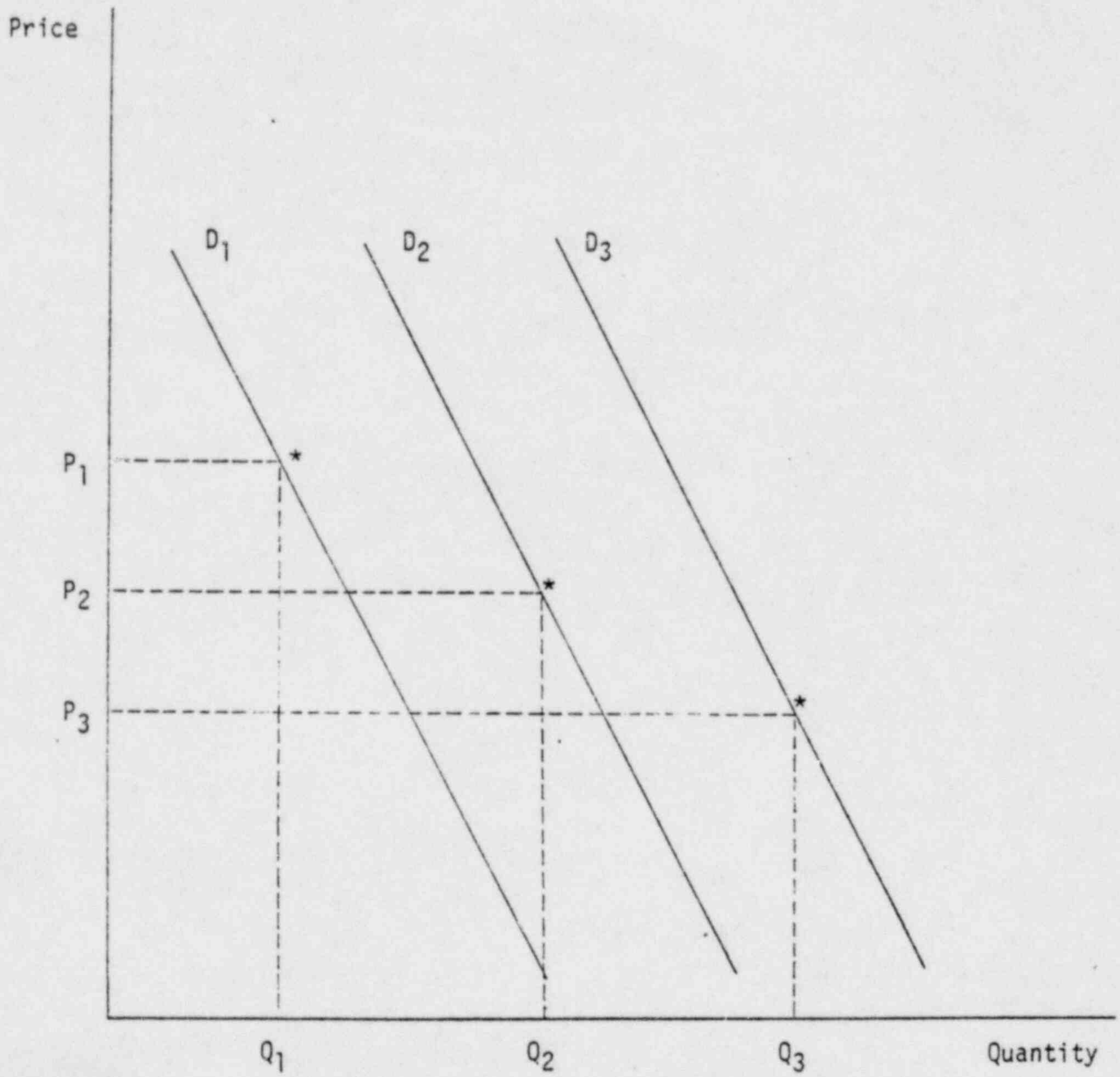

Figure 1. Possible Bias in SCE Study

To what extent is this bias present in the SCE data? The SCE data are classified by a number of characteristics, of which the most important for the bias is the housing density and employment by SCE. One would expect that both of these characteristics would be correlated with the demand for electricity. Previous studies have indicated a significant influence of the degree of urbanization on the demand for electricity, and one would expect that the employees of an electric company would have a bias toward more electrical appliances.

If these suppositions are correct, the SCE elasticity estimates would be raised upwards. This is because some of the increase in electricity consumption due to increased housing density is being wrongly attributed to the lower price of electricity faced by these customers.

The opposite effect may be at work with regard to the income elasticity. Housing density and income would presumably be negatively correlated, so that this study should produce estimates of the income elasticity of demand, which are biased downwards. The estimated income elasticity of 0.17, which is substantially below the estimates of other studies, also suggests that bias exists in the data.

The lesson is simply that there are advantages and disadvantages in using a data base from a small geographical area. In the SCE study, insufficient attention has been paid to the nature and extent of the bias introduced by the data used.

Average Price Rather than Marginal Price

The SCE study uses the average price of electricity as the price upon which consumers make their decisions.

The problems associated with the use of average price have been discussed elsewhere in this review, and the continued use of this measure is a major weakness of the SCE study. SCE's justifications for using average price--(1) normalizing usage for weather reduces the definitional relation between usage and average price, (2) forecasting impacts of sales use average price, and (3) pooling the data reduces any bias in the price elasticity--are all either incorrect or not relevant to the problem. Normalizing the usage by the described procedure is statistically equivalent to including weather as an independent variable, and does not in any way correct for the fact that average price is still a function of usage, regardless of how that usage is actually defined. Using average price in order to be consistent with the average price for forecasting merely insures that any bias present in the estimation of the price elasticity will be continued into the future. Finally, as discussed below, the estimation procedure does not affect the cause of the bias in using average price.

The Econometric Technique

The final data base for the econometric analysis is composed of a time series of cross-sectional data, where the cross-sectional data are derived from the rate structures. The classifical assumptions of the simple regression model are unlikely to apply to the errors of a pooled cross-section time series regression. It is possible to envisage a wide range of possible error structures, and the choice of the appropriate structure is part of the art of econometric analysis. The

SCE study assumes that the errors are autoregressive through time and hetroscedastic across the cross sections. The principal difficulty with these assumptions is that there is no evidence that the SCE study tested their validity or explored other alternatives to them. Without any knowledge of these tests, it is impossible to evaluate the work of the econometric procedure employed.

Bias in the average price concept cannot be corrected for using the pooled cross-section time series data. This bias occurs as the result of simultaneity between average price and usage. Autocorrelation and heteroscedasticity affect estimates of the standard error of the parameter estimate, not the parameter estimate itself, so these procedures can in no way be expected to have any effect on the simultaneous equation bias associated with average price.

Treatment of the Climate Variable

The SCE study gathered data on heating and cooling degree-days to account for the influence of climate on electricity usage. Other studies have found that the inclusion of these variables in the demand function significantly improves the predictive performance of the regression. The procedure adopted by the SCE study is not, however, equivalent to the procedures in these other studies and is likely to distort the estimates of the price and income elasticities. The nature of this distortion is illustrated with a simple demand equation:

$$q = \alpha_0 + \alpha_1 p + \alpha_2 w + u_1 \qquad (1)$$

where q = log of quantity demanded

p = log of electricity price

w = variable representing temperature, i.e., heating degree-days.

The accepted procedure is to estimate α_1 and α_2 by an appropriate econometric technique. The SCE study does not follow this procedure, but rather proceeds in two stages. First, demand is related to the temperature variable

$$q = b_0 + b_1 w + u_2 \quad (2)$$

The b_1 coefficients are estimated by regression techniques. Having found the estimated coefficients, $\hat{b}$, the normalized variable, is regressed upon prices:

$$q - \hat{b}_1 w = c_0 + c_1 p + u_3 \quad (3)$$

There are two problems with this procedure. The first is simply that the estimates will appear to have smaller variances than they actually have, since the final operation does not take into account that the coefficient $\hat{b}_1$ also had to be estimated. In technical terms, the final equation overstates the degrees of freedom in the regression. The second and more serious problem is that the procedure is likely to result in biased estimated of the elasticities--the c_1 coefficient in the final equation is unlikely to be the same as the α_1 coefficient in the first equation. The reason for the bias is a special case of the missing variable problem.

Attempts at Dynamic Estimation

The SCE study attempts to measure the time path of electricity consumption following an increase in the price of electricity. The basic techniques here are those of using cross-sectional data to estimate long-run elasticities and using Almon lags to estimate the dynamic response.

The idea that cross-sectional data can be used to estimate long-run elasticities is common in electricity demand studies. The basis for this idea is that over a range of data, different observations will be at different points along their adjustment toward an equilibrium and that the extent of the disequilibrium in consumption will be small compared to the cross-sectional variation. However, these conditions are not likely to be met within the SCE data base, since all of the cross-sectional units face the same temporal changes in the rate structure. It is likely, therefore, that all of the cross-sectional observations will be out of equilibrium at the same time, so that the necessary conditions for estimating the long-run elasticity are unlikely to be met.

Conclusion: The SCE proceeds from a correct premise that price elasticity studies based upon interstate or interutility comparisons might not be representative of a particular service area as the result of major differences in the structural characteristics of the service area. Weaknesses in the procedures employed in the study, as discussed above, suggest an absence of attention paid to several, possibly severe, biases that cast some doubt about the accuracy of the final results, and a lack of understanding of the problems facing elasticity estimation.

A further failing of the study relates to the forecasting model. The price elasticity computed from the model (a point elasticity measure) is reduced through the use of the arc price elasticity formula. The value of this exercise is unclear, although SCE's point that, if the point price elasticity is -1.0 and price changes by 100 percent, usage will not be reduced to 0, is well made. Again, this represents a distortion of economic concepts, especially for forecasting future energy usage.

To illustrate the shortcoming of the SCE use of the arc elasticity formula, it is important to first recognize that most changes in electricity price in a given year are less than 10 percent and that the SCE elasticity coefficient of -1.26 relates to the long run, a period often considered to be more than 5 years. The first issue is of what use is the arc elasticity formula when price changes are approximately 10 percent. Plugging a 10 percent price change and an elasticity of -1.26 into the SCE arc elasticity formula gives an equation of $Q_2 = Q_1/0.88$, or a 12 percent reduction in usage in year 2. A 12 percent reduction in usage is extremely close to the 12.6 percent reduction predicted by the point elasticity. For price changes of less than 10 percent, the point and arc elasticity formulas will become even closer.

An even greater criticism of the SCE concerns the value of its basic objective, forecasting the effect of electricity price on usage. The typical issue facing utilities is predicting the effect of a price change on revenues, and, since usage is affected by many factors other than price, revenue forecasts must consider these factors. A simple illustration demonstrates this point. Suppose that use in year t (Q_t) is explained by electricity price (P_t) and income (Y) and is given by the equation $Q_t = -1.26\ P_t + 1.0\ Y$. If electricity price increases by 10 percent and income does not change, utility revenues are reduced 2.6 percent. But, if income increases 10 percent at the same time price increases, the actual reduction in usage is -12.6 + 10 = -2.6 percent, which, when combined with the 10 percent increase in price, actually increases utility revenues. SCE's consideration of electricity price effects really does not have much value for most utility forecasting needs.

28. Beauvais (1973)

Title: Beauvais, E. C. 1973. Econometric Estimates, Residential Section, Demand Elasticities. Virginia Electric Power Company.

Aim: To determine the response of electricity ene. y use to changes in electricity price, income, and other socioeconomic variables.

Approach: This study estimates price and income elasticities from cross-section and time series data in the Virginia Electric Power Company service area. The following elasticity estimates were obtained:

Variable	Elasticity
Cost of electricity	-0.7999
Cost of fuel oil	+0.9103
Appliance saturation	+0.1234
Household income	+0.1591

In order to evaluate these estimates, it is necessary to initially examine the theoretical methodology of the study, before proceeding to the econometrics.

The central characteristic of this study is the division of total demand into "locked" and "flexible" demand. It is assumed that a fraction, ψ, of the customers in the service area are unwilling to change their stock of appliances in the current period. These customers are presumed to have purchased appliances in the recent past, and, due to the absence of an efficient secondhand market in electrical appliances, are unwilling to change their appliance stock.

A further, but unreasonable, assumption is that these customers will also not be influenced by the price of electricity in utilizing their stock of appliances. The experience with the higher prices of home heating oil tends to cast doubt upon the validity of this assumption. Reducing the thermostat by 5 degrees can result in a substantial decline in the consumption of electricity, and the heating-oil crisis suggests that residential consumers do adjust their thermostats in response to higher energy prices.

The total demand for electricity is given by the relationship

$$Q_t^D = \psi \, Q_{t-1}^D + f\,(\lambda)\,(c_t - \psi\, c_{t-1})$$

Consider the first term Q_{t-1}^D in the demand for electricity in the previous period. However, in the new period, $1-\psi$ of the old demand will become flexible as appliances are replaced. $\psi\, Q_{t-1}^D$ is consequently the currently locked-in demand for electricity. (This approach is similar to that discussed by Liew 1972.) In the second term, c_t is the total number of customers. Of these, $\psi\, C_{t-1}$ are locked in, so that $c_t - \psi\, c_{t-1}$ is the number of flexible customers. Flexible customers are those that are in the market for an appliance in the current year. The function $f(\lambda)$ then defines the average demand for electricity per flexible customer.

The problem associated with this formulation is that changes in energy use due to changes in the utilization of the appliance stock are ignored. Second, customers are not locked in, but their appliances are. A customer may be locked in to a refrigerator but flexible for an air conditioner. Seen in these terms, the adjustment parameter, ψ, is determined by the portfolio of the appliance stock at any point in time, and this portfolio is unlikely to remain constant over time, as assumed in the model. The introduction of color televisions, frost-free refrigerators, or home freezers will change the depreciation profile of the appliance stock and consequently change the parameter ψ. This parameter itself may also be influenced by the price of electricity, thus making it extremely difficult to disentangle the true price elasticity of demand.

The basic model will be rewritten as

$$\frac{(Q_t - \psi\, Q_{t-1})}{(C_t - \psi\, C_{t-1})} = f(\lambda)$$

The function $f(\lambda)$ is assumed to be dependent upon prices, incomes, temperature, family size, and appliance saturation. The actual estimation of the equation proceeds two stages. In the first stage, the following equation is estimated from 1970 cross-section data:

$$1\left[\frac{Q_t - 0.75\, Q_{t-1}}{C_t - 0.75\, C_{t-1}}\right] = -\,2.408 + \underset{(4.1177)}{0.1591 \log(\text{income})} + \underset{(5.4253)}{2.6098\ \text{STEMP}}$$

$$-\ \underset{(3.1197)}{0.6884\ \text{WTEMP}} \qquad + \underset{(1.8599)}{0.2813\ \text{SoH}}$$

$$R^2 = 0.3512$$

where STEMP = average summer temperature

WTEMP = average winter temperature

SoH = average number of persons per household.

T-statistics are in brackets beneath the coefficients.

The noticeable feature of this equation is the absence of any price variables. Since prices do influence the demand for electricity, the omission of this variable must be based on the assumption that the price is the same for all customers. The presence of declining block rates invalidates this assumption.

The equation is therefore subject to the missing variable problem. Since the elasticity of interest in this equation is the income elasticity, the omission of prices biases the estimate of this elasticity in an indeterminate manner. If only the electricity price had been omitted, the procedure would probably result in overestimation of the income elasticity, because higher income induces greater consumption, which, through the rate schedule, induces lower prices. The lower prices will also stimulate consumption; hence, if this influence is not corrected first, the income variable would also "pick up" demand due to price variation.

The issue is complicated, however, by the omission of competing fuel prices, which are often subject to declining rate schedules. It is consequently difficult to specify the direction of the bias.

Having found an estimate of the income elasticity, the study uses this estimate in the following time series regression.

$$1 \left[\frac{Q_t - 0.75\ Q_{t-1}}{C_t - 0.75\ C_{t-1}} \right] - 0.1591 \ln (\text{INCOME}) = 2.81880 \underset{(2.757)}{-0.8761} \ln Pebc$$

$$\underset{(0.7759)}{-0.1838} \ln Pgas + 0.1234\ SAT + 0.9103 \ln Poil$$

$$R^2 = 0.9884$$

where SAT = saturation of electrical appliances.

In this equation, average prices of electricity, gas, and oil are used along with an appliance saturation variable to predict electricity consumption over time.

<u>Conclusions</u>: A number of points can be made about this study.

a. The income elasticity is taken from the cross-section study, rather than reestimated in the time series equation. Since it has been shown that this elasticity is likely to be biased, the study should at least have shown that imposing this restriction on the elasticity does not result in a significantly greater standard error. Economic theory also suggests that income elasticities will tend to differ between time-series and cross-section studies. The reason is that a cross section is based on income relative to others, while a time series regression also indicates an increase in the real price of labor. Since this price will tend to induce substitution toward electrical labor-saving appliances, the time-series elasticity should exceed the cross-section elasticity. One should also note that the time-series elasticity is more important for utility planning, since the distribution of income is not likely to change rapidly over time.

b. The use of average price is again a problem, and will not be discussed here, since this issue has been dealt with earlier (see SCE 1974, No. 26).

c. The inclusion of an appliance saturation variable as an explanatory variable makes it impossible to estimate the total price elasticity from the equation. The price elasticity measure therefore is interpreted as the response of appliance utilization to a price change, not the more common definition of an energy-use elasticity.

d. This study has a number of flaws. It is not possible to fully assess the nature of the biases that are introduced by these errors because of insufficient technical discussion of the estimation procedures.

29. Lacy and Street (1975)

Title: Lacy, A. W. and D. R. Street. 1975. An Econometric Analysis of Residential Electricity Demand for Alabama Power Company. Alabama Power Company.

Aim: To estimate econometrically elasticities for important factors affecting the residential electricity.

Approach: The Lacy and Street (1975) study estimates an equation of the following type in double lag form by OLS.

$$\ln Q = A + B_1 \ln Pm + \beta_2 \ln P_g + \beta_3 \ln Y + \beta_4 \ln C_1 + \beta_5 \ln C_2 + B_6 \ln E + B_7 \ln D + B_8 \ln T$$

where Q = average kWh per household per month per division

Pm = marginal real price of electricity in cents per kWh by division

P_g = average real price of natural gas in cents per MCF

Y = per capita real income, seasonally adjusted

C_1 = cooling degree-days per month

C_2 = heating degree-days per month

E = monthly rate of unemployment for the state

D = patriotism dummy

T = trend variable to pick up linear growth patterns of stocks of appliances and other factors

ln = natural logarithm.

This equation, fitted to six regions and the utility service area monthly data from January 1967 through March 1975, produces price elasticity estimates that vary from -0.21 to -0.87 for the six regions, and an estimate of -0.53 for the total service area.

Several innovations made in the study are to be commended. Among these are use of regional data to estimate variations in regional residential price elasticities and a concentrated effort to evaluate the extent of the bias in average price elasticities. Offsetting these contributions are the absence of a detailed explanation of the procedures actually employed and some significant faults with the procedures that are discernible.

Definition of marginal electricity price is never clearly stated. In fact, according to the report, following the description of their model, the authors state, "the data are...average cents per kWh for the price of electricity (Lacy and Street 1975, p. 19)." If the authors actually did as this quotation suggests and divided regional sales by regional usage, their marginal price is nothing but an average price under an assumed name. But, if this interpretation of the author's marginal price definition is correct, then the definition of average price used in the study is indeterminate. As a result of this uncertainty over the definition of electricity price, both marginal and average, all of the results must remain in doubt.

Some interesting insights can be seen by comparing the total firm equations in Tables 2 and 3. In Table 2, the marginal price elasticity is -0.43 and statistically insignificant; it is -0.53 and statistically significant in Table 3. The only difference in the models is the addition of a patriotism dummy in Table 2, which is highly insignificant and should therefore not affect the electricity price coefficient. In Table 15, which is equivalent to Table 3, all of the coefficients are equivalent, except for the marginal price elasticity (-0.49). The same standard error for the marginal price in the two equations suggests that a typographical error may be the problem; nevertheless, it does indicate the discrepancies that do exist in the report that make efforts at interpreting the results difficult.

The marginal price variable problems lead next to the simulations reported in the appendixes to evaluate the bias associated with the use of average price. As a preliminary step, it is important to point out a minor error in the author's general conclusion of a significant bias in average price elasticities. Table 14 shows no significant difference between the actual and estimated price elasticities when the actual price elasticity is -1.0. A significant difference does exist for all other assumed price elasticities, however, and none of the income elasticities even closely resembles the assumed elasticity.

Possible explanations of these findings, aside from the authors' conclusions that average price elasticities are significantly biased estimates of the true price elasticity, can be found. Beginning with Appendix B, several basic objections can be raised about the simulation procedure. First, the simulation model is designed first for a cross section of households (50 people). Any results obtained from the simulation are therefore limited to cross-section samples corresponding to monthly data. Second, it would be useful to know whether the calculated values for Qi are truly random. In the absence of support data, it is impossible to determine if the finding that average price produces elasticity estimates where none exists is really valid, because if the calculated Qi's are not random, a correlation between average price and Q could exist.

A third useful step would have been to use the rate structure prices assumed to see if they produced significantly different price-elasticity estimates. These regressions would further help in evaluating the usefulness of the simulations by providing additional information on whether the data are truly random.

Fourth, the authors err in stating that "the usages are basically random numbers with only a 10 percent tie-in with income." Income, in fact, accounts for anywhere from almost 100 percent to 30 percent of the value of Qi, as the illustration at the bottom of page 55 indicates; therefore, Qi is not basically a random number, and the authors contention that "the usages are basically random numbers, [and] other than the block structure, there is no reason why data should exhibit any particular price elasticity and certainly not one that is statistically significant" is highly questionable. Contrary to the study conclusions, it is not clear that the price elasticities are, in fact, due to the declining block structure. Next, the simulation results cannot be used to justify the use of marginal price, however defined, in the body of the report. The major shortcoming of a simulation analytic procedure is that the results hold only for the type of model employed in the simulation. Since the actual data deal with aggregate regional data and the simulated data are for individual observations, the results are unlikely to be an accurate aggregate data measure of the bias in price-elasticity estimates, and therefore have little to say on the general issue of the bias in average price.

Finally, the lack of thorough discussion about how the simulated quantity data were matched with actual data is again unclear. Simulated quantity data are for a sample of 50 individuals in a given time, but actual data are monthly. How are the data matched? Until this question can be answered, the meaningfulness of Table 15 must be questioned, and the authors strong contentions about the effect of a declining block structure on average price elasticity are completely unwarranted because of likely biases in the way the simulations are performed.

Conclusions: The major finding that the intermediate-term price elasticity is between -0.35 and -0.87 for the six Alabama Power Company divisions seems perfectly reasonable, considering that monthly data such as those used in the study will produce less responsive elasticities than yearly data. Beyond this, however, not much can be said with any degree of confidence. Actual variable definitions, procedures for estimating the coefficients, and simulation procedures are inadequately explained to analyze the study in great detail. Some possible serious flaws may exist in the analysis from what is discernible, and may be of significant magnitude to reject all of the findings.

Several possible problems of lesser importance relating to common practice may also exist, such as errors in the X-11 deseasonalization of the monthly data, the question of whether data should be deseasonalized at all, the deseasonalization of monthly population figures that are linearly interpolated from year-end figures and therefore have no seasonal variation, and the merits of combining heating and cooling degree-days into one variable when using monthly data. The severity of these problems are unclear, although, in conjunction with the problems raised earlier, they create a distinct feeling of apprehension about how meaningful the elasticity estimates are.

APPENDIX B

DERIVATION OF WEIGHTS FOR AGGREGATION OF COUNTY DATA TO THE DIVISIONAL LEVEL

As explained in Section IV, county data had to be aggregated to the divisional level to be compatible with other Consumers Power data. A weighting scheme was utilized, the weights for which were described in Section IV. It is the purpose of this appendix to demonstrate how these weights were derived. In order to expedite the exposition, a hypothetical example is created in Figure B-1. In this figure, everything to the west and south of the dashed line is within the service area of the utility under consideration. Thus, townships A-1, A-2, A-5, A-9, and A-13 of county A, and townships B-1, one half of B-2, B-5, B-6, B-9, B-10, B-11, B-12, B-13, B-14, B-15, and B-16 are included within the service area. To determine what fraction of the county is within the service area, it is necessary to determine the fraction of population by township included within the service area. Hypothetical populations are presented in Table B-1.

For county A, with a total population of 13,267, the population of the included townships is 5,453 (= 723 + 1,002 + 1,507 + 1,617 + 604). Therefore, the weight assigned to county A is 5,453/13,267 or 0.41. Similarly, for county B with a total population of 9,548, the population within the included townships is 6,199 (= 422 + 1/2 * 570 + 301 + 604 + 909 + 774 + 321 + 250 + 120 + 417 + 1,069 + 727). Thus, the weight for county B is 6,199/9,548 or 0.65.

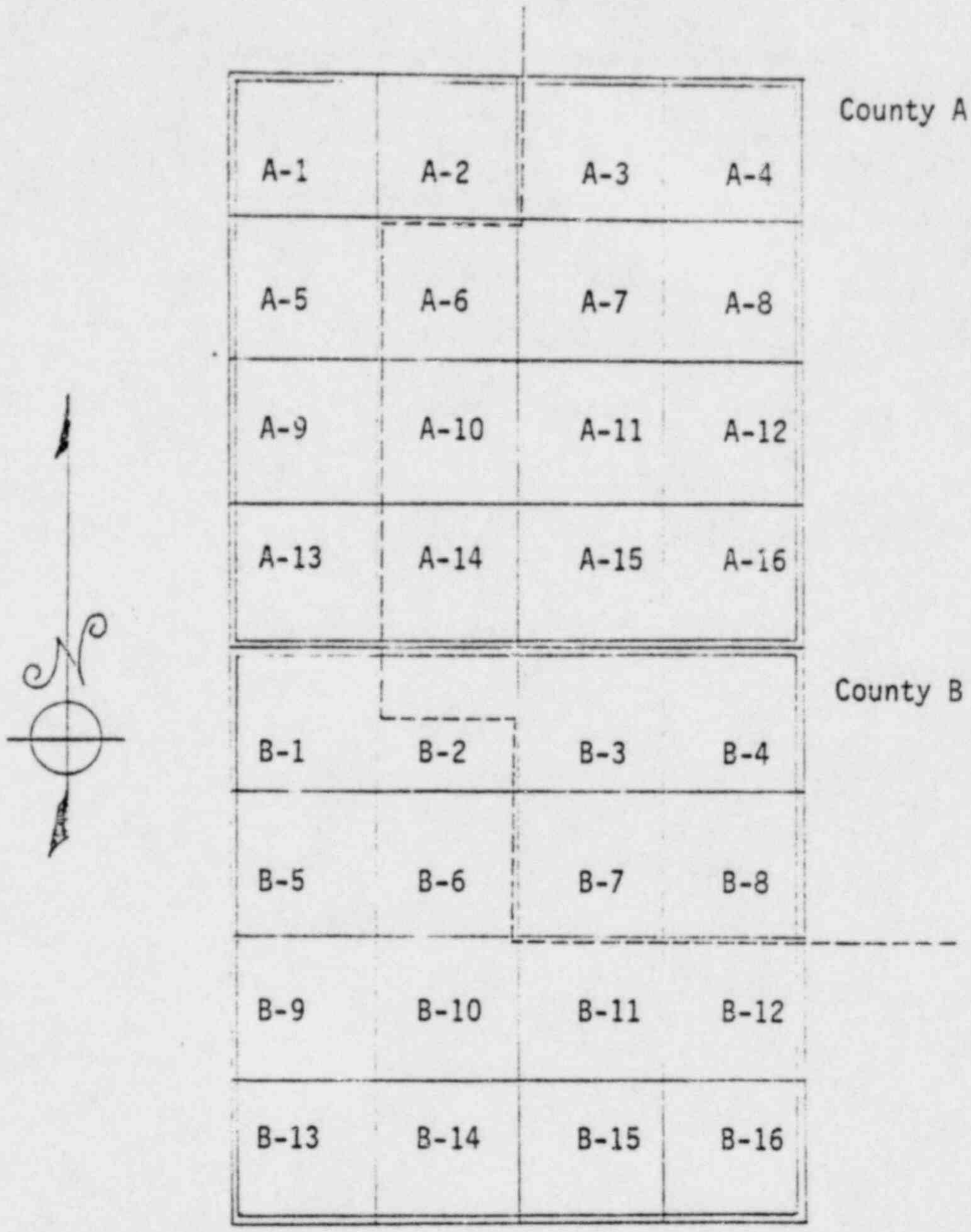

Figure B-1. Service area of utility under consideration.

Table B-1

Hypothetical County and Township Populations

COUNTY A		COUNTY B	
Township A-1	723	Township B-1	422
Township A-2	1002	Township B-2	570
Township A-3	914	Township B-3	1124
Township A-4	1211	Township B-4	227
Township A-5	1507	Township B-5	301
Township A-6	989	Township B-6	604
Township A-7	621	Township B-7	497
Township A-8	427	Township B-8	1216
Township A-9	1617	Township B-9	909
Township A-10	819	Township B-10	774
Township A-11	1727	Township B-11	321
Township A-12	596	Township B-12	250
Township A-13	604	Township B-13	120
Township A-14	129	Township B-14	417
Township A-15	212	Township B-15	1069
Township A-16	169	Township B-16	727
Total	13267	Total	9548

Note that only one-half of the population of township B-2 is included since the service area boundary bisects this township. The assumption here, and also when utilizing the actual Michigan data, is that populations are uniformly distributed across townships, except when city or town populations within a township permit this assumption to be relaxed.

In the interest of conserving space, the method adopted for illustrating the weights applicable to Consumers Power divisions is as follows. Since a county normally has a maximum of 16 townships, then by listing either the number of townships included or excluded from the service area, a maximum of 8 townships need be listed. Thus, for example, if 14 of 16 townships in a county are within a service area, then a large space savings can be effected by listing the 2 townships excluded from the service area rather than the 14 that are included.

Table B-2 illustrates the method of aggregation utilized in this appendix. Township populations that are not within parentheses indicate that these townships are within the service area. In this case, the weight derived for this county is merely the sum of the township populations divided by the county population (county A of the hypothetical main division). On the other hand, those township populations enclosed in parentheses indicate that these townships are excluded from the service area. In this case, the county weight is calculated by deducting the sum of these townships' populations from the county population and then dividing by the county population

Table B-2

Derivation of County Specific Weights

MAIN DIVISION

County	Township	Population		Weight
A		13,267		
	A-1		723	
	A-2		1,002	
	A-5		1,507	
	A-9		1,617	
	A-13		604	
			5,453	0.41
B		9,548		
	B-2 (1/2)		(285)	
	B-3		(1,124)	
	B-4		(227)	
	B-7		(497)	
	B-8		(1,216)	
			(3,349)	0.65

(county B of the hypothetical main division). The parenthetical fraction adjacent to township B-2 indicates only a fraction of the township is to be excluded since the service area boundary partitions this township.

Table B-4 presents the actual data utilized in deriving the weights for counties within the Consumers Power divisions. The divisions are listed in the numerically sequential order as determined by the Consumers Power numbering scheme. These weights are based upon the data presented in the 1970 Census of Population, Characteristics of the Population, part 24/Michigan. A summary of these weights is provided in Table B-3. These weights are those actually used in the data processing for this study.

Table B-3

Weights Assigned to Counties for Aggregation of Data to Divisional Level

CENTRAL DIVISION

County	Weight
ROSCOMMON	.02
CLARE	.98
GLADWIN	.75
OSCEOLA	.63
LAKE	.13
NEWAYGO	.05
MESCOTA	1.00
ISABELLA	1.00
MIDLAND	.11
MONTCALM	.96
IONIA	.08
CLINTON	.02
GRATIOT	.97

BATTLE CREEK DIVISION

County	Weight
BARRY	.82
BRANCH	.75
CALHOUN	1.00
ST. JOSEPH	.33

FLINT DIVISION

County	Weight
CLINTON	.11
GENESEE	1.00
GRATIOT	.01
LIVINGSTON	.11
SAGINAW	.08
SHIAWASSEE	1.00

NORTHEAST DIVISION

County	Weight
PRESQUE ISLE	.05
MONTMORENCY	.04
OSCEOLA	.93
ALCONA	1.00
OGEMAW	1.00
IOSCO	1.00
GLADWIN	.25
ARENAC	1.00
MIDLAND	.75
BAY	.99
SAGINAW	.01

PONTIAC DIVISION

County	Weight
OAKLAND	1.00

KALAMAZOO DIVISION

County	Weight
ALLEGAN	.87
BARRY	.18
KALAMAZOO	.95
VAN BUREN	.21

GRAND RAPIDS DIVISION

County	Weight
MUSKEGON	.02
OTTOWA	.82
KENT	1.00
ALLEGAN	.13

JACKSON DIVISION

County	Weight
BRANCH	.25
HILLSDALE	1.00
INGHAM	.02
JACKSON	1.00
LENAWEE	.95
LIVINGSTON	.03
MONROE	.32
WASHTENAW	.04

Table B-3 (Cont.)

LANSING DIVISION

County	Weight
CLINTON	.89
EATON	.75
INGHAM	.20
IONIA	.92

MUSKEGON DIVISION

County	Weight
MASON	.95
LAKE	.42
OCEANA	.92
NEWAGYO	.87
MUSKEGON	.98
MONTCALM	.02
OTTOWA	.07

SAGINAW DIVISION

County	Weight
SAGINAW	.92
MIDLAND	.01
BAY	.01

NORTHWEST DIVISION

County	Weight
EMMET	.75
CHEBOYGAN	.90
CHARLEVOIX	.92
OTSEGO	.84
ANTRIM	.91
LEELANAU	1.00
BENZIE	.96
GRAND TRAVERSE	1.00
KALKASKA	.59
PRESQUE ISLE	.39
CRAWFORD	1.00
MANISTEE	1.00
WEXFORD	1.00
MISSAUKEE	1.00
ROSCOMMON	.98
LAKE	.18
OSCEOLA	.37
CLARE	.02

Table B-4

Derivation of County Specific Weights for Consumers Power Divisions

CENTRAL DIVISION

County	Township	Population	Weight
ROSCOMMON		9892	
	Nester	178	
		178	0.02
CLARE		16695	
	Winterfield	(335)	
		(335)	0.98
GLADWIN		13471	
	Clement	(362)	
	Bourret	(225)	
	Secord	(398)	
	Grim	(62)	
	Billings	(959)	
	Bentley	(599)	
	Tobacco (1/2)	(740)	
		(3345)	0.75
OSCEOLA		14838	
	Burdell	(737)	
	Sherman	(608)	
	Highland	(712)	
	Marion	(1427)	
	LeRoy	(644)	
	Rose Lake	(380)	

(CENTRAL DIVISION - Cont.)

County	Township	Population		Weight
	Hartwick		(406)	
	Middle Branch		(541)	
			(5455)	0.63
LAKE		5661		
	Chase		752	
			752	0.13
NEWAYGO		27992		
	Barton		482	
	Norwich		416	
	Goodwill		374	
			1272	0.05
MESCOTA				1.00
ISABELLA				1.00
MIDLAND		63769		
	Warren		1283	
	Edenville (2/3)		780	
	Jerome (1/3)		1050	
	Lee (1/4)		633	
	Geneva		683	
	Greendale		1105	
	Jasper		826	
	Porter		899	
			7259	0.11

(CENTRAL DIVISION - Cont.)

County	Township	Population		Weight
MONTCALM		39660		
	Reynolds (1/3)		(609)	
	Pierson (2/3)		(891)	
			(1500)	0.96
IONIA		45848		
	Otisco		1479	
	Orleans		1707	
	Ronald (1/3)		414	
			3600	0.08
CLINTON		48492		
	Essex (1/4)		359	
	Greenbush (1/3)		537	
			896	0.02
GRATIOT		39246		
	Elba (3/4)		(1158)	
			(1158)	0.97

BATTLE CREEK DIVISION

County	Township	Population		Weight
BARRY		38166		
	Yankee Springs (1/2)		(741)	
	Orangeville		(1932)	
	Prairieville		(2519)	
	Barry (3/4)		(1866)	
			(7058)	0.82

(BATTLE CREEK DIVISION - Cont.)

County	Township	Population		Weight
BRANCH		37906		
	Butler		(934)	
	Quincy		(3295)	
	Algansee		(1352)	
	California		(616)	
	Girard (1/2)		(759)	
	Coldwater (1/3)		(1947)	
	Ovid (1/3)		(570)	
			(9473)	0.75
CALHOUN				1.00
ST. JOSEPH		47392		
	Menden		2065	
	Leonidas		935	
	Colon		2580	
	Nottawa		2421	
	Sherman		2101	
	Burr Oak		2189	
	Fawn River		1471	
	Lockport (1/2)		945	
	Park (1/2)		1104	
			15811	0.33

NORTHEAST DIVISION

County	Township	Population		Weight
PRESQUE ISLE		12836		
	Presque Isle		698	
			698	0.05
MONTMERENCY		5247	193	
			193	0.04
OSCODA		4726		
	Greenwood		(315)	
			(315)	0.93
ALCONA				1.00
OGEMAW				1.00
IOSCO				1.00
GLADWIN		13471		
	Clement		362	
	Bourret		225	
	Secord		398	
	Grim		62	
	Tobacco (1/2)		720	
	Billings		959	
	Bentley		599	
			3325	0.25
ARENAC				1.00

(NORTHEAST DIVISION - Cont.)

County	Township	Population		Weight
MIDLAND		63769		
	Edenville (1/3)		390	
	Jerome (2/3)		2104	
	Lee (3/4)		1898	
	Mount Haley		1262	
	Ingersoll (2/3)		1524	
	Mills		1005	
	Larkin		2509	
	Midland		2521	
	Midland (City)		34921	
			48134	0.75
BAY		117339		
	Frankenlust (1/3)		(677)	
			(677)	0.99
SAGINAW		219743		
	Buena Vista (1/6)		2281	
			2281	0.01

FLINT DIVISION

County	Township	Population		Weight
CLINTON		48492		
	Duplain		2221	
	Ovid (2/3)		2011	
	Victor (2/3)		1015	
			5247	0.11
GENESEE				1.00

(FLINT DIVISION - Cont.)

County	Township	Population		Weight
GRATIOT		39246		
	Elba (3/4)		515	
			515	0.01
LIVINGSTON		58967		
	Cohoctac		1454	
	Deerfield		1734	
	Tyrone		3437	
			6625	0.11
SAGINAW		219743		
	Chapin		853	
	Brady		1951	
	Chesaning		5278	
	Maple Grove		2555	
	St. Charles		3619	
	Brant		1371	
	Marion		679	
	Albee (1/3)		747	
			17053	0.08
SHIAWASSEE				1.00

GRAND RAPIDS DIVISION

County	Township	Population		Weight
MUSKEGON		157426		
	Ravenna (2/3)		1602	
	Casnovia		1879	
			3481	0.02

GRAND RAPIDS DIVISION (Cont.)

County	Township	Population		Weight
OTTAWA		128181		
	Spring Lake		(8013)	
	Grand Haven (1/4)		(1372)	
	Grand Haven (City)		(11844)	
	Crockery (1/2)		(1430)	
			(22659)	0.82
KENT		411044		
	Spencer (1/3)		(486)	
	Oakfield (1/2)		(1079)	
	Bowne (1/3)		(477)	
			(2523)	1.00
ALLEGAN		66575		
	Dorr (2/3)		2037	
	Fillmore (1/2)		1063	
	Laketown (2/3)		1450	
	Leighton (1/2)		1177	
	Overisel (1/2)		941	
	Salem		1744	
			8412	0.13

JACKSON DIVISION

County	Township	Population		Weight
BRANCH		37906		
	Butler		934	
	Quincy		3295	
	Algansee		1352	
	California		616	
	Girard (1/2)		759	
	Coldwater (1/3)		1947	
	Ovid (1/3)		570	
			9473	0.25
HILLSDALE				1.00
INGHAM		261039		
	Bunker Hill		1464	
	Stockbridge		2526	
			3990	0.02
JACKSON				1.00
LENAWEE		81609		
	Clinton		(2540)	
	Macon		(1316)	
			(3856)	0.95
LIVINGSTON		58967		
	Unadilla		1793	
			1793	0.03

(JACKSON DIVISION - Cont.)

County	Township	Population		Weight
MONROE		118479		
	Whiteford		4059	
	Bedford		20875	
	Erie		4451	
	LaSalle		4151	
	Monroe		4676	
			38212	0.32
WASHTENAW		234103		
	Lyndon		1373	
	Sylvan		5086	
	Sharon		831	
	Manchester		2856	
			10146	0.04

KALAMAZOO DIVISION

County	Township	Population		Weight
ALLEGAN		66575		
	Dorr (2/3)		(2037)	
	Fillmore (1/2)		(1063)	
	Laketown (2/3)		(1450)	
	Leighton (1/2)		(1177)	
	Overisel (1/2)		(941)	
	Salem		(1744)	
			(8412)	0.87

KALAMAZOO DIVISION (Cont.)

County	Township	Population		Weight
BARRY		38166		
	Yankee Springs (1/2)		741	
	Orangeville		1932	
	Prairieville		2519	
	Barry (3/4)		1866	
			7058	0.18
KALAMAZOO		201550		
	Prairie Ronde		(777)	
	Schoolcraft		(5289)	
	Brady		(3060)	
			(9126)	0.95
VAN BUREN		56173		
	Geneva		2392	
	Columbia		1866	
	Arlington		1645	
	Lawrence		2345	
	Pine Grove		1835	
	Almena		1845	
			11928	0.21

LANSING DIVISION

County	Township	Population		Weight
IONIA		45848		
	Otisco		(1479)	
	Orleans		(1707)	
	Ronald (1/3)		(414)	
			(3600)	0.92

(LANSING DIVISION (Cont.)

County	Township	Population		Weight
CLINTON		48492		
	Duplain		(2221)	
	Ovid (2/3)		(2011)	
	Victor (2/3)		(1015)	
			(5247)	0.89
INGHAM		261039		
	Meridian		23817	
	Alaiedon		2487	
	Delhi		13795	
	Aurelius		1987	
	Onondaga		1981	
	Leslie		3612	
	Vevay		1916	
	Ingham		1498	
			51093	0.20
EATON		68892		
	Delta		(17396)	
			(17396)	0.75

MUSKEGON DIVISION

County	Township	Population		Weight
MASON		22612		
	Mead		(59)	
	Sheridan		(433)	
	Eden		(414)	
	Logan		(154)	
			(1060)	0.95
LAKE		5661		
	Sweetwater		115	
	Webber		614	
	Pleasant Place		1211	
	Yates		425	
			2365	0.42
OCEANA		17984		
	Crystal		(453)	
	Colfax		(222)	
	Elbridge		(799)	
			(1474)	0.92

(MUSKEGON DIVISION - Cont.)

County	Township	Population		Weight
NEWAYGO		27992		
	Troy		(80)	
	Lilley		(429)	
	Home		(132)	
	Barton		(482)	
	Merrill		(376)	
	Monroe		(120)	
	Norwich		(416)	
	Wilcox		(519)	
	Goodwill		(374)	
	Everett		(844)	
			(3772)	0.87
MUSKEGON		157426		
	Casnovia		(1879)	
	Ravenna		(800)	
			(2679)	0.98
MONTCALM		39660		
	Reynolds (1/3)		610	
	Pierson (1/6)		210	
			820	0.02
OTTOWA		128181		
	Crockery (1/2)		1430	
	Spring Lake		8013	
			9443	0.07

SAGINAW DIVISION

County	Township	Population		Weight
SAGINAW		219743		
	Marion		(679)	
	Brant		(1371)	
	St. Charles		(3619)	
	Albee (1/3)		(747)	
	Taymouth (1/6)		(533)	
	Chapin		(853)	
	Brady		(1951)	
	Chesaning		(5278)	
	Maple Grove		(2555)	
			(17586)	0.92
MIDLAND		63769		
	Ingersoll (1/3)		761	
			761	0.01
BAY		117339		
	Frankenlust (1/3)		677	
			677	0.01

NORTHWEST DIVISION

County	Township	Population		Weight
EMMET		18332		
	Wa-Watam		431	
	Carp Lake		439	
	McKinely		835	
	Maple River		415	
	Lake Traverse		985	
	Littlefield		1266	
	Petoskey (city)		6342	
	Bear Creek		2450	
	Springvale		663	
			13826	0.75
CHEBOYGAN		16573		
	Grant		(431)	
	Waverly		(285)	
	Walker		(227)	
	Forest		(675)	
			(1618)	0.90
CHARLEVOIX		16541		
	Norwood		(325)	
	Marion		(694)	
	Chandler		(89)	
	Hudson		(219)	
			(1327)	0.92

(NORTHWEST DIVISION - Cont.)

County	Township	Population		Weight
OTSEGO		10422		
	Elmira		(486)	
	Dover		(317)	
	Chester		(332)	
	Charlton		(573)	
			(1708)	0.84
ANTRIUM		12612		
	Echo		(542)	
	Jordan		(303)	
	Warner		(249)	
			(1094)	0.91
LEELANAU				1.00
BENZIE		8593		
	Inland		(370)	
			(370)	0.96
GRAND TRAVERSE				1.00
KALKASKA		5272		
	Clearwater		884	
	Rapid River		249	
	Kalkaska		1964	
			3097	0.59
PRESQUE ISLE		12836		
	Rogers		727	
	Rogers (city)		4275	
			5002	0.39

(NORTHWEST DIVISION - Cont.)

County	Township	Population		Weight
CRAWFORD				1.00
MANISTEE				1.00
WEXFORD				1.00
MISSAUKEE				1.00
ROSCOMMON		9892		
	Nester		(178)	
			(178)	0.98
LAKE		5661		
	Newkirk		426	
	Dover		201	
	Elsworth		376	
			1003	0.18
OSCEOLA		14838		
	Burdell		737	
	Sherman		608	
	Highland		712	
	Marion		1427	
	LeRoy		644	
	Rose Lake		380	
	Hartwick		406	
	Middle Branch		541	
			5455	0.37
CLARE		16695		
	Winterfield		335	
			335	0.02

APPENDIX C

DOCUMENTATION OF DEVELOPMENT OF REGIONAL DATA BASE FROM RAW DATA SOURCES

The development of a regional time-series model required collection and transformation of data from various sources into a single data base. Because much of the processing was done utilizing a large-scale computer, the documentation is in the form of two FORTRAN coded computer programs, one applicable to each company. These programs are for reference purposes, and should not be considered operable as programs because the input and output conventions between any two computer installations are different, and vary with time.

These programs are useful as reference tools in that the entire data transformation procedure from data collection to insertion into the usable data base for the regression analysis is recorded. The transformation of each type of data used is performed in a single major subroutine. This simplifies future modification. Any changes - either in data transformation procedures or in adding new variables -- can be incorporated through the modification of just one section of the program without explicit consideration about what happens to the rest of the data base (provided the COMMON area is kept up to date).

Input for the programs consists of the various kinds of data. Data from individual electrical utilities is input on a regional basis — divisions for Consumers Power and counties for Detroit Edison. Gas data is brought in on a division basis for Consumers Power and on a company basis for the other gas utilities whose sales data have been collected. Michigan Consolidated Gas Company data is entered for both the Detroit and non-Detroit portions of the company. The income and other socioeconomic data are entered on a county basis for all eighty two counties. From this data set either the correct counties are selected (Detroit Edison) or counties are aggregated to form divisional data (Consumers Power).

The output for these programs consists of the regional time-series data base stored in the COMMON area ready for use in a statistical package. The detailed form of the output is determined by the input requirements of the particular statistical package to be used. The output subroutine is not included, but output from the COMMON storage area into any desired format is a simple programming task. Again, to programmers, the input functions on this listing are not universally acceptable. They are sufficient for use in conjunction with the FORTRAN compiler on COMSHARE, Inc.'s timesharing system. This may not be the case at other computer installations. The documentation for each company, Consumers Power first, followed by Detroit Edison, is given in the remainder of this appendix.

CONSUMERS POWER COMPANY

```
      C****  [illegible]
      C****  [illegible]
      C****  [illegible]      NUMBER OF [illegible]
      C****  [illegible]      DEMAND FOR ELEC[illegible]
      C****  [illegible]      AVERAGE PRICE FOR ELECT[illegible]
      C****  [illegible]      MARGINAL PRICE FOR [illegible]
      C****  GASDMD           DEMAND FOR NATURAL GAS.
      C****  GASAVG           AVERAGE PRICE FOR GAS
      C****  [illegible]      MARGINAL PRICE FOR GAS
      C****  [illegible]      PER CAPITA INCOME
      C****  URBAN            PERCENT URBAN POPULATION
      C****  [illegible]      PERCENT [illegible]
      C****  TEMP             ANNUAL HEATING DEGREE DAYS
      C****  USCPI            U.S. CPI FOR ALL ITEMS
      C****  DETCPI           DETROIT CPI FOR ALL ITEMS
      C
            COMMON ELEDMD(13,26),ELEAVG(13,26),[illegible](13,26)
            COMMON GASDMD(13,26),GASAVG(13,26),[illegible](13,26)
            COMMON [illegible](13,26),URBAN(13,26),PMU[illegible](13,26),TEMP([illegible])
            NREGN = 11
            NYEARS = [illegible]
      C****    THE MAJOR ROUTINES HAVE THE FOLLOWING FUNCTIONS:
      C****                CDATA          [illegible] CONSUMPTION DATA
      C****                MARGLE         [illegible] MARGINAL ELECTRICITY PRICES
      C****                MARGAS         [illegible] MARGINAL GAS PRICES
      C****                INCOME         GENERATE PER CAPITA INCOME DATA
      C****                SOCIO          GENERATE SOCIO-ECONOMIC DATA
      C****                WEATHR         GENERATE HEATING DEGREE DAY DATA
      C****                OUTPUT         OUTPUT THE ENTIRE DATA [illegible] INTO A FILE
      C****                               [illegible] NOT PROV[illegible]
      C
      C
      C****    THE FOLLOWING NUMBERS CONTAIN [illegible] FOR THE INDICATED REGION
      C****             1                CENTRAL
      C****             2                BATTLE CREEK
      C****             3                NORTHEAST
      C****             4                FLINT
      C****             5                GRAND RAPIDS
      C****             6                JACKSON
      C****             7                KALAMAZOO
      C****             8                LANSING
      C****             9                MUSKEGON
      C****            10                SAGINAW
      C****            11                NORTHWEST
            CALL CDATA
            CALL MARGLE
            CALL MARGAS
            [illegible]
            CALL SOCIO
            CALL WEATHR
            CALL OUTPUT
```

```
      [illegible]
C***  [illegible]
C***  [illegible] TOTAL [illegible] AND GAS
      [illegible]
      COMMON [illegible]
      COMMON [illegible]
      COMMON [illegible]
      DIMENSION [illegible] 26),GAL(13,26) [illegible]
      DIMENSION [illegible] 26) [illegible] 26) [illegible]
      DO 10 I=1,NREGN
      DO 10 J=1,NYEARS
C***     READ IN GAS AND ELECTRICITY DATA [illegible] CONSUMPTION,CUSTOMERS
      READ,$ [illegible](I,J),GAL(I,J),ELCT(I,J) [illegible] GSALES(I,J) [illegible]
C***     CALCULATE AVERAGE PRICES AND [illegible] FOR GAS AND ELECTRICITY
      ELEAVG(I,J)=100.*REV(I,J)/(GAL(I,J)*1000.)
      ELSPUR(I,J)=GAL(I,J)*1000./CUST(I,J)
      GASAVG(I,J)=GREV(I,J)/(GSALES(I,J) [illegible])
      GASWAS(I,J)=GSALES(I,J)*1000./GCUST(I,J)
   10 CONTINUE
      RETURN
      END
      SUBROUTINE [illegible]
C***     ROUTINE TO INSERT MARGINAL ELECTRICITY PRICES FOR ALL REGIONS
      COMMON NYEARS,NREGN,USCPI [illegible]
      COMMON ELEDMD(13,26),ELE [illegible] ELELAN [illegible]
      COMMON GASDMD [illegible]
      COMMON ENCUMS(13,26),URBAN [illegible]
      CALL REED(NYEARS,NREGN,ELLAN)
      RETURN
      END
      SUBROUTINE [illegible]
C***     ROUTINE TO INSERT THE MARGINAL GAS PRICES FOR ALL REGIONS
      COMMON NYEARS,NREGN,USCPI [illegible]
      COMMON ELEDMD(13,26),ELEA [illegible]
      COMMON GASDMD(13,26),GASAVG(13,26),GASMAR [illegible]
      COMMON ENCUMS(13,26),URBAN [illegible]
      CALL REED(NYEARS,NREGN,GASMAR)
      RETURN
      END
      SUBROUTINE REED (N,K,VAR)
C***     SUBROUTINE TO READ IN A SET OF [illegible] AND ASSIGN THEM TO
C***     ALL THE REGIONS (SUCH AS MARGINAL PRICE OF ELECTRICITY)
      DIMENSION VAR(13,26)
      READ,$ (VAR [illegible] J=1,N)
      DO 10 J=1,N
      A=VAR(1,J)
      VAR( 2, [illegible]
      VAR( 3, [illegible]
      VAR( 4, [illegible]
      VAR( 5, [illegible]
      VAR( 6, [illegible]
      VAR( [illegible]
      VAR( 8, [illegible]
```

```
      [illegible]
      RETURN
      END
      SUBROUTINE [illegible]
      COMMON [illegible]
      COMMON [illegible]
      COMMON LABOR [illegible]
      COMMON INCOM [illegible]
      DIMENSION [illegible]
      DIMENSION [illegible]
      N=11
C****   READ IN INCOME AND POPULATION [illegible] FOR YEARS
C       1950,59,62,65,7[illegible]
      READ(5, [illegible]) (PERS(I,J),J=1, [illegible])
      READ(5, [illegible]) (PERS(I,J),J=1, [illegible])
      READ(5, [illegible]) (POP(I,J),J=1, [illegible])
      READ(5, [illegible]) (POP(I,J),J=1, [illegible])
C****   AGGREGATE DATA INTO [illegible]
      CALL [illegible] (N,PERS,DIVI[illegible])
      CALL [illegible] (N,POP,[illegible])
C****   CALCULATE PER CAPITA [illegible]
      DO [illegible]
      DO [illegible]
      [illegible]
   [illegible] CONTINUE
C****   [illegible]
C       [illegible]
      READ [illegible]
      READ [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
   20 CONTINUE
      CALL [illegible] (STATE, [illegible]
      DO 30 [illegible],NYEARS
      ENCODE [illegible]
   30 CONTINUE
   40 CONTINUE
      RETURN
      END
      SUBROUTINE [illegible]
C****   [illegible] TO STATE
      DIMENSION [illegible],IYEARS( [illegible]
      [illegible]
C****   [illegible] DATA
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
```

```
      DO 20 I=1,NYEARS
      ...
   20 DO 40 ...
      ...
      SUBROUTINE ...
      COMMON NYEARS,NREGN,USCPI(26),PUTCPI(26)
      COMMON ELEDMD(13,26),ELLA..(13,26),ELRAN(13,26)
      COMMON GASDMD(13,26),GA...(13,26),...(13,26)
      COMMON INCOME(13,26),URBAN(13,26),PMUL..(13,26),TEMP(13,26)
       READ,*,(USCPI(I),I=1,NYEARS)
       READ,*,(PUTCPI(I),I=1,NYEARS)
      CALL ...
      CALL ...
      RETURN
      END
      ...
C**** ... URBAN BY REGION FROM CENSUS DATA
      ...
      COMMON ELEDMD(13,26),...
      COMMON GASDMD(13,26),...
      COMMON INCOME(13,26),...
```

```
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      CALL [illegible]
      [illegible]
      [illegible]
      [illegible]
C     [illegible] INTERPOLATION ROUTINE
      CALL [illegible]
      RETURN
      END
      [illegible]
C     [illegible] WHICH [illegible] [illegible] COUNTY [illegible]
      COMMON N[illegible]LINES,NREGN,[illegible]
      COMMON [illegible]
      DIMENSION [illegible]
      [illegible]
      DIMENSION VAR(23,2[illegible]
      N = [illegible]
C     READ IN CENSUS DATA FOR [illegible]
      READ([illegible]
C     FORM COUNTY [illegible]
      CALL [illegible]
C     GROUP DATA FOR [illegible]
      DO 10 [illegible]NREGN
      [illegible] = 100[illegible]
      [illegible] = 100[illegible]
      [illegible] = 100[illegible]
   10 CONTINUE
C     GO TO SUBROUTINE WHERE INTERPOLATION IS PERFORMED
      [illegible]
      RETURN
      END
      SUBROUTINE CENSUS [illegible]
C     [illegible]
      DIMENSION VAR(13,25)
      DO 30 I=1,NREGN
      CALL SLOPE (VAR(I,[illegible]
      DO 10 J=1,9
      L = J + 1
      VAR(I,L) = A[illegible]
   10 CONTINUE
      CALL SLOPE (VAR(I,[illegible]),VAR(I,21),[illegible]
      DO 20 J = 11,25
      L = J + 1
      VAR(I,L) = A[illegible]
   20 CONTINUE
   30 CONTINUE
      RETURN
      END
      [illegible]
      [illegible]
```

```
[illegible]
T[illegible](1,1) = STORE([illegible])
[illegible]
TEMP(2,1) = STOR[illegible]
CONTINUE
RETURN
END
SUBROUTINE CALIBR(I,VAR,[illegible])
C   [illegible] FOR CONSUMER [illegible]
C   FROM DATA FOR ALL [illegible]
DIMENSION VAR(93,24),[illegible]
DO 100 I=1,N
 T1= [illegible]VAR(12,I)[illegible]
 T2= .02*VAR(31,I)*VAR(2,I)[illegible]
 T3= .03*VAR(59,I)[illegible]
DIVVAR(1,I) = T1 + T2 + T3
 T1= [illegible]
DIVVAR(2,I) = T1
 T1= [illegible]
 T2= [illegible]
 T3= [illegible]VAR(7,I)[illegible]
DIVVAR(3,I) = T1 + T2 + T3
 T1= [illegible]VAR(9,I)[illegible]
 T2= .05*VAR(72,I)*VAR([illegible])
DIVVAR(4,I) = T1 + T2
 T1= .02*VAR(31,I)[illegible]
DIVVAR(5,I) = T1
 T1= .05*VAR(12,I)*VAR(30,I)[illegible]
 T2= .03*VAR(17,I)[illegible].02*VAR(52,I)[illegible]
DIVVAR(6,I) = T1 + T2
 T1= [illegible].10*VAR([illegible])[illegible]
DIVVAR(7,I) = T1
 T1= [illegible]VAR([illegible],I)*.75*VAR([illegible])[illegible]VAR(24,I)
DIVVAR(8,I) = T1
 T1= [illegible]
 T2= [illegible]
DIVVAR([illegible],I) = T1 + T2
 T1= [illegible]
DIVVAR(10,I) = [illegible]
 T1= [illegible]
```

```
      T2= [illegible],I)+VAR(40,I)+[illegible]
       T3= [illegible]VAR(20,[illegible]
       T4= [illegible](2,I)[illegible]
      BIVVAR(I[illegible]) = T1 + T2 + T[illegible] + T4
  100 CONTINUE
      RETURN
      END
```

DETROIT EDISON COMPANY

[illegible]

1	[illegible]
[illegible]	LAPEER
[illegible]	MACOMB
4	MONROE
5	LENAWEE
[illegible]	OAKLAND
[illegible]	SANILAC
[illegible]	ST. CLAIR
[illegible]	TUSCOLA
[illegible]	WASHTENAW
[illegible]	LIVINGSTON
[illegible]	INGHAM
[illegible]	WAYNE

```
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
DIMENSION [illegible](20),[illegible](20)
C***      READ IN [illegible] DATA
      DO 10 I=1,NRECN
      DO 10 J=1,[illegible]
      READ(*,*) SAL(I,J),REV(I,J),CUST(I,J)
      [illegible]
      [illegible](I,J)=SAL(I,J)/CUST(I,J)
   10 CONTINUE
C***      READ IN GAS DATA
      DO 20 I=1,[illegible]
      READ(*,*)[illegible]
      REV(6,I)=[illegible]
      SAL(6,I)=SAL([illegible]
      CUST(6,I)=CUST(5,I)[illegible]
   20 CONTINUE
      DO 30 I=[illegible]
      DO 30 J=[illegible]
      READ(*,*)GREV(I,J)[illegible]
   30 CONTINUE
C***      [illegible]
      DO 40 J=1,NYEARS
      GREV([illegible]
      GSALES([illegible]
      GCUST([illegible]
      GREV([illegible]
      GREV([illegible]
      GREV([illegible]
      GSALES([illegible]
      GSALES(12,J)=GSALES([illegible],J)
      GSALES([illegible]=GSALES([illegible])
      GCUST(13,J)=GCUST( 8,J)
      GCUST(12,J)=GCUST(11,J)
      GCUST( 8,J)=GCUST( 7,J)
   40 CONTINUE
C***      CALCULATE AVERAGE GAS PRICES AND AVERAGE GAS CONSUMPTION
      DO 50 I=1,NRECN
      DO 50 J=1,NYEARS
      GASAVG(I,J)=GREV(I,J)/GSALES(I,J)
      GASDMD(I,J)=GSALES(I,J)/GCUST(I,J)
   50 CONTINUE
      RETURN
      END
      SUBROUTINE [illegible]
C***      [illegible]
      COMMON [illegible]
      COMMON [illegible]
      COMMON GASDMD(13,[illegible]
```

```
      [illegible]
      STOP
      END
      FUNCTION [illegible]
     [illegible]
      GAMMA [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      [illegible]
      CONT [illegible]
      DO 20 J=1,N
      A=GASMAR(1,J)
      B=GASMAR(2,J)
      C=GASMAR(3,J)
      D=GASMAR(4,J)
      E=GASMAR(5,J)
      GASMAR(1,J)=A
      GASMAR(2,J)=A
      GASMAR(3,J)=A
      GASMAR(4,J)=A
      GASMAR(5,J)=A
      GASMAR(6,J)=A
      GASMAR(7,J)=A
      GASMAR(8,J)=A
      GASMAR(9,J)=A
      GASMAR(10,J)=A
      GASMAR(11,J)=A
      GASMAR(12,J)=A
      GASMAR(13,J)=A
      CONTINUE
      RETURN
      END
      SUBROUTINE [illegible]
C****    SUBROUTINE TO READ IN A SET OF OBSERVATIONS AND ASSIGN THEM TO
C****    ALL THE REGIONS (SUCH AS MARGINAL THINGS IN ELECTRICITY)
      DIMENSION VAR(13,26)
      READ,*,(VAR(1,J),J=1,N)
      DO 10 J=1,N
      A=VAR(1,J)
      VAR(2,J)=A
      VAR(3,J)=A
      VAR(4,J)=A
      VAR(5,J)=A
      VAR(6,J)=A
      VAR(7,J)=A
      VAR(8,J)=A
      VAR(9,J)=A
      VAR(10,J)=A
      VAR(11,J)=A
      VAR(12,J)=A
      VAR(13,J)=A
      CONTINUE
      RETURN
      END
```

```
[illegible]
      CONTINUE
[illegible]
    3 CONTINUE
      RETURN
      END
      SUBROUTINE [illegible]
[illegible]
```

```
[illegible]
      ... DATA FOR EACH ...
      ... I=1,... ...
[illegible]
      DO 20 J = 11,25
[illegible]
[illegible]
      CONTINUE
[illegible]
      RETURN
      END
[illegible]
```

APPENDIX D

Data Listing

This appendix presents a detailed listing of all data utilized in the regional time-series and cross-section regressions. For each region, there are two pages of data. The symbols and definitions of the variables are as follows:

YEAR - the year to which the data correspond.

DEMAND - average annual electricity consumption in kWh.

BILL 10 - electricity price variable calculated as the cost per kWh of a 10% variation from average monthly consumption.

INCOME - average annual per capita income.

MAR GAS - gas price variable calculated as the cost per Mcf of the first 10 Mcf of consumption.

FUEL OIL - the wholesale price of fuel oil No. 2 in cents per gallon as quoted in Detroit.

DEGREE DAYS - average annual heating degree-days.

URBAN - percentage urban.

MULTIUNIT - percentage multi-unit housing.

TEB 500 - the typical electric bill for 500 kWh of electricity divided by 500.

TEB 750 - the difference between the typical electric bills for 750 and 500 kWh of electricity divided by 250.

AVG ELEC - electricity price variable calculated as total revenues divided by total consumption.

AVG GAS - gas price variable calculated as total revenues divided by total consumption.

SPACE HEAT - the saturation level for electric space heating installations.

WATER HEAT - the saturation level for electric water heating appliances.

AC - the saturation level for electric air-conditioning units.

CPI - the U.S. consumer price index for all commodities. The base is defined as 1.000 for 1967.

The tables are listed in the following regional order:

In addition to the regional data, the company level time series data are also presented, beginning on page D-52. The first four pages are similar to the regional data except it is by company. Following that the intermediate data necessary in forming a gas price are presented for each of the gas utilities whose sales were felt to be significant, and the weights used to finally form the weighted average gas price variables for each of the electric utilities.

Following this company level data, a complete documentation of all the variables used in the individual customer work is given. Actual data is not presented, but the definitions of the variables are all that should be of interest to future investigations.

CENTRAL

YEAR	DEMAND	BILL 10	INCOM.	NAT GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
50	2133.0	2.0000	1057.0	.95000	10.240	7220.0	[illegible]	11.700
51	2352.0	2.0000	1270.0	.99000	10.650	7030.0	27.000	11.400
52	2512.0	2.0000	1433.0	.99000	10.610	6650.0	27.400	11.100
53	2722.0	2.0000	1574.0	1.1400	10.570	6120.0	27.700	10.800
54	2951.0	2.0000	[illegible]	1.1100	10.920	6710.0	28.100	10.500
55	3092.0	2.0000	[illegible]	1.1100	11.320	6650.0	28.400	10.200
56	[illegible]	2.0000	1511.0	1.1300	11.620	6900.0	28.800	10.000
57	[illegible]	2.0000	1622.0	1.1400	12.080	6811.0	29.100	9.7000
58	3656.0	2.0000	1577.0	1.1400	11.200	7025.0	29.500	9.4000
59	3834.0	2.0000	1684.0	1.1100	10.820	7057.0	29.800	9.1000
60	3861.0	2.0000	1705.0	1.1100	10.340	7070.0	30.100	8.8000
61	3999.0	2.0000	1686.0	1.1100	10.010	6675.0	30.200	9.6000
62	4086.0	2.0000	1832.0	1.2000	10.080	7112.0	30.500	10.400
63	4141.0	2.0000	1879.0	1.1800	10.110	6988.0	30.800	11.200
64	4242.0	1.7900	2041.0	1.1800	9.2400	6470.0	31.000	12.000
65	4353.0	1.8200	2278.0	1.1600	9.6400	6939.0	31.200	12.700
66	4564.0	1.8900	2485.0	1.1600	9.8400	[illegible]	31.400	[illegible]
67	4741.0	1.8300	2525.0	[illegible]	10.140	6978.0	[illegible]	14.200
68	5011.0	1.8200	2768.0	1.1500	10.450	[illegible]	[illegible]	15.100
69	5377.0	1.9000	2951.0	1.1400	10.640	[illegible]	32.000	15.900
70	5658.0	1.9200	3019.0	1.3700	11.160	6929.0	32.200	16.700
71	5910.0	1.9300	3157.0	1.3700	11.220	6705.0	32.100	17.500
72	[illegible]	2.2500	3427.0	1.3900	12.010	7121.0	32.600	18.200
73	6316.0	2.3200	2747.0	1.3700	13.790	6314.0	32.800	19.100
74	6435.0	2.7300	3223.0	1.4700	16.230	6814.0	33.000	19.900

CLHIGH

YEAR	TEB 500	TEB750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	AC	CPI
50	[illegible]	1.3400	2.5900	1.0000	.50000	.00000	.00000	.72100
51	[illegible]	1.6700	2.5600	.97000	.40000	.00000	.30000	.77000
52	1.7060	1.6700	2.4900	.97000	.30000	.00000	.50000	.79500
53	1.7060	1.6700	2.4400	1.1200	.30000	.00000	.80000	.80100
54	1.7060	1.6700	2.3700	1.0700	.20000	.00000	1.0000	.80500
55	1.7060	1.6700	2.3400	1.0700	.10000	25.800	1.2000	[illegible]
56	1.7060	1.6700	2.2900	1.0100	.10000	27.500	1.6000	.81100
57	1.7060	1.6700	2.2500	1.0100	.20000	29.300	1.9000	.84300
58	1.7060	1.6700	2.2300	1.0100	.20000	31.100	2.1000	.86500
59	1.7060	1.6700	2.3000	.99000	.20000	32.800	2.4000	[illegible]
60	1.7940	2.0700	2.3300	1.0600	.20000	34.600	2.7000	.88600
61	1.7940	2.0700	2.3600	1.0200	.20000	36.400	2.9000	.89600
62	1.7940	2.0700	2.2500	1.0600	.30000	38.300	3.2000	.90600
63	1.7940	2.0700	2.3400	1.0500	.30000	40.100	3.4000	.91700
64	1.7940	2.0700	2.3300	1.0500	.30000	41.900	3.7000	.92900
65	1.7940	1.9400	2.2800	1.0400	.70000	42.100	4.7000	.94500
66	1.7880	1.8800	2.2100	1.0400	1.1000	42.200	5.7000	.97200
67	1.7880	1.8800	2.1800	1.0300	1.3000	42.400	6.7000	1.0000
68	1.7880	1.8800	2.1600	1.0400	1.8000	42.500	7.6000	1.0420
69	1.7880	1.8800	2.1500	1.0300	2.2000	42.700	8.6000	[illegible]
70	1.9520	1.7100	2.2500	1.1300	2.6000	42.800	9.6000	[illegible]
71	1.9520	1.7100	2.2300	1.1400	3.2000	44.600	10.700	1.2130
72	2.1140	1.5800	2.3100	1.1800	3.8000	46.400	10.700	1.2530
73	2.3380	1.8800	2.5200	1.2900	4.3000	48.300	11.300	1.3310
74	2.5540	2.1000	3.6500	1.6500	4.9000	50.100	11.800	1.4770

BATTLE CREEK

YEAR	DEMAND	FILL 10	INCOME	MAR GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
50	2773.0	2.0000	1572.0	.99000	10.240	7203.0	55.800	22.000
51	2941.0	2.0000	1647.0	.99000	10.650	7022.0	55.400	21.300
52	3130.0	2.0000	1725.0	.99000	10.610	6649.0	55.100	20.500
53	3282.0	2.0000	1911.0	1.1400	10.570	6065.0	54.700	19.800
54	3434.0	2.0000	1791.0	1.1400	10.820	6532.0	54.400	19.100
55	3593.0	2.0000	1931.0	1.1400	11.320	6523.0	54.000	18.300
56	3831.0	2.0000	1959.0	1.1400	11.620	6429.0	53.700	17.400
57	4056.0	2.0000	1973.0	1.1400	12.080	6460.0	53.400	16.900
58	4220.0	2.0000	1914.0	1.1400	11.200	6702.0	53.000	16.200
59	4376.0	2.0000	1979.0	1.1400	10.820	6567.0	52.700	15.400
60	4416.0	2.0000	2080.0	1.1400	10.340	6702.0	52.200	14.700
61	4556.0	2.0000	2056.0	1.1400	10.010	6409.0	51.900	15.000
62	4663.0	2.0000	2208.0	1.2000	10.090	7088.0	51.300	15.200
63	4753.0	2.0000	2332.0	1.1800	10.110	7026.0	50.700	15.500
64	4886.0	1.9800	2516.0	1.1800	9.2400	6632.0	50.200	15.900
65	5021.0	1.8800	2736.0	1.1600	9.6400	6757.0	49.700	16.000
66	5286.0	1.8900	2921.0	1.1600	9.8400	6973.0	49.200	16.300
67	5478.0	1.8300	3072.0	1.1600	10.140	7052.0	48.600	16.600
68	5813.0	1.8200	3401.0	1.1600	10.350	6926.0	48.100	16.900
69	6180.0	1.9000	3683.0	1.1600	10.610	6620.0	47.600	17.100
70	6446.0	1.9200	3719.0	1.3700	11.160	6842.0	47.000	17.300
71	6848.0	1.9800	4071.0	1.3700	11.330	6472.0	46.500	17.700
72	7147.0	2.2500	4436.0	1.3900	12.010	7192.0	46.000	17.900
73	7229.0	2.3200	4876.0	1.4700	13.790	6052.0	45.500	18.200
74	7243.0	2.7300	5280.0	1.4700	16.230	6536.0	44.900	18.500

BATTLE CREEK

YEAR	TFR 500	TER750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	AC	CPI
50	1.6930	1.3400	2.4500	.91000	.50000	.00000	.00000	.72100
51	1.7060	1.6700	2.4200	.87000	.40000	.00000	.30000	.77800
52	1.7060	1.6700	2.3800	.87000	.40000	.00000	.70000	.79500
53	1.7060	1.6700	2.3500	.98000	.30000	.00000	1.0000	.80100
54	1.7060	1.6700	2.3200	.82000	.30000	.00000	1.4000	.80500
55	1.7060	1.6700	2.3000	.81000	.20000	31.000	1.7000	.80200
56	1.7060	1.6700	2.2700	.79000	.20000	31.900	2.0000	.81400
57	1.7060	1.6700	2.2400	.76000	.10000	32.700	2.2000	.84300
58	1.7060	1.6700	2.2200	.72000	.00000	33.600	2.4000	.86600
59	1.7060	1.6700	2.2900	.70000	.00000	34.500	2.7000	.87700
60	1.7940	2.0700	2.3500	.70000	.10000	34.600	3.1000	.88500
61	1.7940	2.0700	2.3700	1.0100	.20000	34.700	3.5000	.89600
62	1.7940	2.0700	2.3500	1.0100	.20000	34.700	3.9000	.90600
63	1.7940	2.0700	2.3400	1.0300	.30000	34.800	4.3000	.91700
64	1.7940	2.0700	2.3300	1.0300	.40000	34.900	4.7000	.92900
65	1.7940	1.9400	2.2800	1.0200	.70000	35.000	6.6000	.94500
66	1.7880	1.8800	2.2100	1.0200	1.0000	35.200	8.4000	.97200
67	1.7880	1.8800	2.1900	1.0200	1.4000	35.300	10.200	1.0000
68	1.7880	1.8800	2.1600	1.0200	1.7000	35.400	12.100	1.0420
69	1.7880	1.8800	2.1500	1.0300	2.0000	35.600	14.000	1.0980
70	1.9520	1.7100	2.2400	1.1100	2.3000	35.700	15.800	1.1620
71	1.9520	1.7100	2.2000	1.1200	2.7000	37.000	17.700	1.2130
72	2.1140	1.5800	2.2900	1.1700	3.0000	38.300	18.800	1.2530
73	2.3380	1.8800	2.4900	1.2700	3.4000	39.500	20.400	1.3310
74	2.5540	2.1000	3.0200	1.6300	3.7000	40.800	21.900	1.4770

NORTHEAST

YEAR	DEMAND	BILL 10	INCOME	MAR GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
50	1935.0	2.0000	1315.0	.99000	10.240	6879.0	42.600	12.200
51	2071.0	2.0000	1581.0	.99000	10.650	6816.0	43.100	12.000
52	2169.0	2.0000	1659.0	.99000	10.610	6215.0	43.700	11.800
53	2325.0	2.0000	1825.0	1.1400	10.570	5787.0	44.300	11.500
54	2519.0	2.0000	1720.0	1.1400	10.820	6319.0	44.800	11.200
55	2680.0	2.0000	1854.0	1.1400	11.320	6229.0	45.400	11.000
56	2914.0	2.0000	1881.0	1.1400	11.620	6628.0	46.000	10.700
57	3127.0	2.0000	1895.0	1.1400	12.030	6458.0	46.600	10.400
58	3261.0	2.0000	1838.0	1.1400	11.200	5717.0	47.100	10.100
59	3447.0	2.0000	1899.0	1.1400	10.820	6954.0	47.700	9.9000
60	3485.0	2.0000	1998.0	1.1400	10.340	7053.0	48.300	9.6000
61	3606.0	2.0000	1974.0	1.1400	10.010	6879.0	48.500	10.200
62	3734.0	2.0000	2100.0	1.2000	10.080	7196.0	48.700	10.800
63	3791.0	2.0000	2240.0	1.1800	10.110	7244.0	48.900	11.300
64	3929.0	1.9800	2417.0	1.1800	9.2400	6794.0	49.100	11.900
65	4038.0	1.8900	2702.0	1.1600	9.6400	7378.0	49.400	12.500
66	4241.0	1.8900	2870.0	1.1600	9.8400	7458.0	49.600	13.100
67	4452.0	1.8300	3055.0	1.1600	10.140	7393.0	49.800	13.700
68	4718.0	1.8200	3383.0	1.1600	10.350	6925.0	50.000	14.200
69	5050.0	1.9000	3597.0	1.1600	10.640	7151.0	50.200	14.800
70	5273.0	1.9200	3642.0	1.3700	11.160	7191.0	50.400	15.400
71	5512.0	1.9800	3914.0	1.3700	11.330	6999.0	50.600	16.000
72	5842.0	2.2500	4172.0	1.3900	12.010	7581.0	50.900	16.600
73	5902.0	2.3200	4558.0	1.4700	13.790	6371.0	51.100	17.100
74	5916.0	2.7300	5060.0	1.4700	16.230	6965.0	51.300	17.700

NORTHEAST

YEAR	TEB 500	TEB750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	AC	CPI
50	1.5980	1.3400	2.6600	.99000	.30000	.00000	.00000	.72100
51	1.7060	1.6700	2.6100	.97000	.30000	.00000	.30000	.77800
52	1.7060	1.6700	2.5700	.97000	.30000	.00000	.60000	.79500
53	1.7060	1.6700	2.5100	1.1200	.20000	.00000	.90000	.80100
54	1.7060	1.6700	2.4400	1.0800	.20000	.00000	1.2000	.80500
55	1.7060	1.6700	2.4000	1.0400	.20000	23.300	1.5000	[illegible]
56	1.7060	1.6700	2.3700	1.0200	.20000	25.100	1.6000	[illegible]
57	1.7060	1.6700	2.2900	1.0200	.10000	27.000	1.7000	[illegible]
58	1.7060	1.6700	2.2600	1.0200	.00000	28.800	1.8000	.85600
59	1.7060	1.6700	2.3500	1.0000	.00000	30.600	1.9000	.87200
60	1.7940	2.0700	2.4100	1.0000	.10000	32.100	2.1000	[illegible]
61	1.7940	2.0700	2.4200	1.0300	.10000	33.600	2.3000	[illegible]
62	1.7940	2.0700	2.4000	1.0700	.20000	35.200	2.5000	[illegible]
63	1.7940	2.0700	2.3900	1.0600	.20000	36.700	2.9000	.91700
64	1.7940	2.0700	2.3700	1.0500	.30000	38.200	3.1000	.92900
65	1.7940	1.9400	2.3200	1.0400	.60000	38.300	4.4000	.94500
66	1.7880	1.8800	2.2500	1.0300	1.0000	38.500	5.9000	.97200
67	1.7880	1.8800	2.2200	1.0300	1.3000	38.600	7.2000	[illegible]
68	1.7880	1.8800	2.1900	1.0400	1.6000	38.700	8.5000	1.0420
69	1.7880	1.8800	2.1900	1.0500	2.0000	38.900	9.9600	1.0950
70	1.9520	1.7100	2.3000	1.1300	2.3000	39.000	11.200	1.1630
71	1.9520	1.7100	2.2800	1.1300	2.8000	41.300	12.000	1.2130
72	2.1140	1.5800	2.3600	1.1700	3.3000	43.500	12.800	1.2530
73	2.3380	1.8800	2.5700	1.2700	3.9000	45.800	13.500	1.3310
74	2.5510	2.1000	3.1000	1.5100	4.4000	48.000	14.300	[illegible]

FLINT

YEAR	DEMAND	BILL 10	INCOME	MAR GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
50	2504.0	2.0000	1713.0	.99000	10.240	7218.0	[illegible]	21.900
51	2642.0	2.0000	1998.0	.99000	10.650	7068.0	69.100	21.100
52	2771.0	2.0000	2081.0	.99000	10.610	6672.0	69.400	20.400
53	2997.0	2.0000	2277.0	1.1400	10.570	6277.0	69.800	19.600
54	3306.0	2.0000	2151.0	1.1400	10.820	7125.0	70.200	18.900
55	3571.0	2.0000	2299.0	1.1400	11.320	6746.0	70.500	18.100
56	3866.0	2.0000	2329.0	1.1400	11.620	7120.0	70.900	17.400
57	4093.0	2.0000	2344.0	1.1400	12.080	7106.0	71.200	[illegible]
58	4228.0	2.0000	2281.0	1.1400	11.200	7381.0	71.600	15.900
59	4429.0	2.0000	2501.0	1.1400	10.820	7335.0	72.000	15.100
60	4506.0	2.0000	2458.0	1.1400	10.340	7382.0	72.300	14.400
61	4682.0	2.0000	2431.0	1.1400	10.010	7007.0	72.200	14.900
62	4815.0	2.0000	2727.0	1.2000	10.080	7424.0	72.100	15.300
63	4920.0	2.0000	2724.0	1.1800	10.110	7404.0	71.900	15.800
64	5111.0	1.9800	2919.0	1.1800	9.2400	6762.0	71.800	16.200
65	5272.0	1.8800	3227.0	1.1600	9.6400	6847.0	71.700	16.700
66	5580.0	1.8900	3369.0	1.1600	9.8400	7406.0	71.500	17.200
67	5767.0	1.8300	3475.0	1.1600	10.140	7335.0	71.400	17.600
68	6103.0	1.8200	3794.0	1.1600	10.350	7092.0	71.300	18.100
69	6438.0	1.9000	4100.0	1.1600	10.640	7198.0	71.200	18.500
70	6741.0	1.9200	4004.0	1.3700	11.160	7161.0	71.000	19.000
71	6919.0	1.9800	4650.0	1.3700	11.330	6778.0	70.900	19.500
72	7240.0	2.2500	5036.0	1.3900	12.010	7324.0	70.800	19.900
73	7287.0	2.3200	5577.0	1.4700	13.790	6254.0	70.700	20.400
74	7157.0	2.7300	5707.0	1.4700	16.230	6895.0	70.500	20.800

FLINT

YEAR	FEB 500	FEB750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	AC	CPI
50	1.5980	1.3400	2.5200	1.9500	.10000	.00000	.90000	[illegible]
51	1.7960	1.5700	2.5100	1.0000	.10000	.00000	.40000	.77900
52	1.7060	1.6700	2.4700	1.0000	.20000	.00000	.70000	.79500
53	1.7060	1.6700	2.4200	1.1500	.20000	.00000	1.1000	.80130
54	1.7060	1.6700	2.3600	1.1160	.20000	.00000	1.3000	.80500
55	1.7060	1.6700	2.3100	1.0600	.20000	23.500	1.5000	.80[illegible]
56	1.7060	1.6700	2.2600	1.0400	.20000	26.000	2.0000	.81400
57	1.7060	1.6700	2.2200	1.0400	.20000	29.500	2.1000	.84400
58	1.7060	1.6700	2.2000	1.0400	.10000	31.100	2.2000	.85800
59	1.7060	1.6700	2.2700	1.0200	.10000	32.700	2.4000	.87300
60	1.7940	2.0700	2.3500	1.0300	.10000	33.800	3.2000	.88600
61	1.7940	2.0700	2.3400	1.0500	.10000	33.900	4.0000	.89400
62	1.7940	2.0700	2.3300	1.0200	.20000	34.100	4.2000	.90600
63	1.7940	2.0700	2.3200	1.0700	.20000	34.200	5.5000	.91200
64	1.7940	2.0700	2.3100	1.0600	.20000	34.200	6.3000	.92000
65	1.7930	1.9400	2.2700	1.0400	.40000	33.300	8.0000	.94500
66	1.7830	1.8800	2.2000	1.0400	.60000	32.300	9.7000	.97200
67	1.7380	1.8800	2.1900	1.0100	.80000	31.300	11.400	[illegible]
68	1.7030	1.8300	2.1600	1.0100	1.0000	30.300	13.100	1.0120
69	1.7980	1.8800	2.1500	1.0500	1.2000	29.300	14.000	1.0590
70	1.9520	1.7100	2.2400	1.1300	1.4000	29.300	16.500	1.1630
71	1.9520	1.7100	2.2300	1.1300	1.5000	28.900	19.600	1.2130
72	2.1140	1.5800	2.3100	1.1800	1.6000	29.500	20.700	1.2550
73	2.3380	1.9800	2.5300	1.2800	1.8000	30.000	22.900	1.3310
74	2.5540	2.1000	3.0500	1.6400	1.9000	30.600	25.000	1.4275

GRAND RAPIDS

YEAR	DEMAND	BILL 10	INCOME	MAR GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
50	2102.0	2.0000	1718.0	1.1600	10.240	6698.0	35.300	28.700
51	2220.0	2.0000	1827.0	1.1600	10.650	6620.0	39.200	27.700
52	2378.0	2.0000	1907.0	1.1600	10.610	6175.0	43.100	26.700
53	2568.0	2.0000	2087.0	1.1600	10.570	5728.0	47.000	25.700
54	2749.0	2.0000	1969.0	1.1800	10.820	6136.0	50.900	24.700
55	2983.0	2.0000	2107.0	1.1500	11.320	6121.0	54.300	23.600
56	3163.0	2.0000	2136.0	1.1700	11.620	6810.0	58.700	22.600
57	3378.0	2.0000	2149.0	1.1700	12.080	6791.0	62.500	21.600
58	3502.0	2.0000	2091.0	1.1700	11.200	7006.0	66.400	20.600
59	3701.0	2.0000	2274.0	1.2000	10.820	6930.0	70.300	19.600
60	3786.0	2.0000	2255.0	1.2000	10.340	6887.0	74.200	18.600
61	3957.0	2.0000	2231.0	1.2500	10.010	6667.0	74.300	19.000
62	4130.0	2.0000	2374.0	1.2500	10.090	6987.0	74.400	19.400
63	4219.0	2.0000	2504.0	1.2400	10.110	6996.0	74.500	19.800
64	4366.0	1.9800	2686.0	1.2400	9.2400	6656.0	74.600	20.200
65	4523.0	1.8800	2919.0	1.2400	9.6400	6881.0	74.700	20.600
66	4791.0	1.8900	3100.0	1.2300	9.8400	6821.0	74.800	20.900
67	4988.0	1.8300	3247.0	1.2300	10.140	7015.0	74.900	21.300
68	5318.0	1.8200	3488.0	1.2300	10.350	6981.0	75.000	21.700
69	5617.0	1.9000	3769.0	1.2300	10.640	7439.0	75.100	22.100
70	5864.0	1.9200	3894.0	1.2600	11.160	7205.0	75.200	22.500
71	6139.0	1.9800	4153.0	1.2200	11.330	6876.0	75.300	22.900
72	6377.0	2.2500	4581.0	1.2500	12.010	7499.0	75.400	23.300
73	6437.0	2.3200	5034.0	1.2900	13.790	6347.0	75.500	23.700
74	6096.0	2.7300	5504.0	1.3560	16.230	7213.0	75.600	24.100

GRAND RAPIDS

YEAR	TEB 500	TEB750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	AC	CPI
50	1.5990	1.3400	2.6400	.78000	.20000	.09600	[illegible]	.72100
51	1.7060	1.6700	[illegible]	.77000	.30000	[illegible]	[illegible]	.77900
52	1.7060	1.6700	2.5700	.82000	.40000	.00000	1.2000	[illegible]
53	1.7060	1.6700	2.5100	.89000	.50000	.00000	1.9000	.80100
54	1.7060	1.6700	2.4600	.87000	.60000	.00000	2.5000	.80600
55	1.7060	1.6700	2.4100	.88000	.70000	12.800	[illegible]	[illegible]
56	1.7060	1.6700	2.4700	.89000	.50000	13.800	[illegible]	.81100
57	1.7060	1.6700	2.3300	.88000	.40000	13.700	[illegible]	[illegible]
58	1.7060	1.6700	2.3000	.91000	.20000	13.700	3.2200	.86500
59	1.7560	1.6700	2.3700	.91000	.00000	12.700	3.5000	.87300
60	1.7940	2.0700	2.4600	.92000	.00000	19.600	3.7000	.88400
61	1.7940	2.0700	2.4300	.96000	.10000	20.500	4.1000	.89400
62	1.7940	2.0700	2.4200	.95000	.10000	21.100	4.5000	.90600
63	1.7940	2.0700	2.4100	.94000	.20000	22.300	4.9000	.91700
64	1.7940	2.0700	2.4000	.94000	.20000	23.200	5.3000	.92900
65	1.7940	1.9400	2.3400	.93000	.30000	22.300	7.1000	.94500
66	1.7890	1.8800	2.2800	.93000	.40000	21.400	8.8000	.97200
67	1.7880	1.8800	2.2500	.92000	.60000	20.500	10.500	1.0000
68	1.7880	1.8800	2.2300	.92000	.70000	17.500	12.400	1.0420
69	1.7880	1.8800	2.2100	.93000	.80000	13.600	14.100	1.0920
70	1.9520	1.7100	2.3100	.91000	.90000	17.700	15.900	1.1630
71	1.9520	1.7100	2.2900	.96000	.90000	18.700	19.300	1.2130
72	2.1140	1.5800	2.3800	1.0100	1.0000	19.700	20.700	1.2530
73	2.3380	1.8800	2.5800	1.0800	1.0000	20.700	23.200	1.3310
74	2.5540	2.1000	3.1300	1.1400	1.1000	21.700	25.600	1.4770

JACKSON

YEAR	DEMAND	BILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	URBAN	[illegible]
50	2731.0	2.0000	1498.0	.99000	10.240	7290.0	44.700	[illegible]
51	2916.0	2.0000	1570.0	.99000	10.650	7001.0	44.800	19.[illegible]
52	3131.0	2.0000	1657.0	.99000	10.610	6616.0	44.900	18.000
53	3340.0	2.0000	1853.0	1.1400	10.570	6146.0	45.000	17.500
54	3566.0	2.0000	1725.0	1.1400	10.920	6568.0	45.100	16.900
55	3742.0	2.0000	1875.0	1.1400	11.320	6540.0	45.300	16.[illegible]
56	4007.0	2.0000	1906.0	1.1400	11.620	6858.0	45.400	15.700
57	4232.0	2.0000	1920.0	1.1400	12.080	6771.0	45.500	15.100
58	4412.0	2.0000	1857.0	1.1400	11.200	6970.0	45.600	14.200
59	4646.0	2.0000	1918.0	1.1400	10.820	6851.0	45.700	14.000
60	4723.0	2.0000	2036.0	1.1400	10.340	6996.0	45.800	13.400
61	4870.0	2.0000	2009.0	1.1400	10.010	6758.0	45.830	13.900
62	4968.0	2.0000	2143.0	1.2000	10.080	7141.0	45.700	14.300
63	5071.0	2.0000	2306.0	1.1800	10.110	7212.0	45.700	14.900
64	5218.0	1.9800	2503.0	1.1800	9.2400	6630.0	45.600	15.400
65	5395.0	1.8800	2719.0	1.1600	9.6400	7072.0	45.500	15.900
66	5 40.0	1.8900	2950.0	1.1600	9.8400	7100.0	45.500	16.500
67	5960.0	1.8300	3092.0	1.1600	10.140	6857.0	45.400	17.0[illegible]
68	6329.0	1.8200	3[illegible]2.0	1.1600	10.350	6582.0	45.300	17.500
69	6696.0	1.9000	3803.0	1.1600	10.640	6866.0	45.300	18.000
70	6998.0	1.9200	3943.0	1.3700	11.160	6870.0	45.200	18.500
71	7279.0	1.9800	4068.0	1.3700	11.330	7018.0	45.200	19.000
72	7654.0	2.2500	4563.0	1.3900	12.010	7442.0	45.100	19.500
73	7696.0	2.3200	5087.0	1.4700	13.790	5966.0	45.000	20.000
74	7731.0	2.7300	5409.0	1.4700	15.230	6705.0	45.000	19.500

JACKSON

YEAR	TEB 500	TEB750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	NG	CPI
50	1.5930	1.3400	2.4200	1.0200	.30000	.00000	.00000	.72100
51	1.7060	1.6700	2.4000	.95000	.30000	.00000	.30000	.77900
52	1.7060	1.6700	2.3500	.96000	.20000	.00000	.60000	.79500
53	1.7060	1.6700	2.3100	1.1200	.20000	.00000	1.0000	.80100
54	1.7060	1.6700	2.2600	1.0700	.10000	.00000	1.3000	.80500
55	1.7060	1.6700	2.2300	1.0300	.10000	34.700	1.6000	.80200
56	1.7060	1.6700	2.1900	1.0100	.10000	26.200	1.2000	.81400
57	1.7060	1.6700	2.1700	1.0100	.20000	38.000	1.7000	.84300
58	1.7060	1.6700	2.1400	1.0100	.20000	39.700	1.7000	.86600
59	1.7060	1.6700	2.2100	.99000	.20000	41.300	1.7000	.87300
60	1.7940	2.0700	2.2900	1.0000	.20000	42.500	2.4000	.88200
61	1.7940	2.0700	2.2800	1.0300	.20000	43.700	3.2000	.89200
62	1.7940	2.0700	2.2700	1.0500	.20000	44.900	3.9000	.90200
63	1.7940	2.0700	2.2600	1.0500	.30000	46.100	4.7000	.91700
64	1.7940	2.0700	2.2500	1.0500	.30000	47.300	5.4000	.92900
65	1.7940	1.9400	2.2000	1.0400	.60000	47.400	6.9000	.94500
66	1.7980	1.8800	2.1300	1.0400	.80000	47.500	8.5000	.97200
67	1.7980	1.8800	2.1100	1.0500	1.0000	47.700	10.100	[illegible]
68	1.7980	1.8800	2.0900	1.0400	1.3000	47.800	11.600	1.0420
69	1.7980	1.8600	2.0800	1.0500	1.5000	47.900	12.300	1.0980
70	1.9520	1.7100	2.1700	1.1300	1.5000	48.000	14.700	1.1630
71	1.9520	1.7100	2.1500	1.1300	2.1000	48.100	15.800	1.2130
72	2.1140	1.5800	2.2400	1.1800	2.5000	48.300	19.300	1.2530
73	2.3380	1.8900	2.3600	1.2800	2.8000	48.400	21.100	1.3310
74	2.5540	2.1000	2.9900	1.4500	3.2000	48.600	22.300	1.4770

KALAMAZOO

YEAR	DEMAND	BILL 10	INCOME	MAR GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
50	2718.0	2.0000	[illegible]	.99000	10.240	6593.0	52.400	20.900
51	2873.0	2.0000	1706.0	.79000	10.650	6381.0	52.800	20.000
52	3101.0	2.0000	1788.0	.99000	10.610	6024.0	53.200	19.600
53	3234.0	2.0000	1973.0	1.1400	10.570	5602.0	53.700	19.000
54	3455.0	2.0000	1852.0	1.1400	10.820	5914.0	54.200	18.400
55	3676.0	2.0000	1993.0	1.1400	11.320	6064.0	54.600	17.800
56	3940.0	2.0000	2022.0	1.1400	11.620	6216.0	55.000	17.200
57	4190.0	2.0000	2036.0	1.1400	12.080	6227.0	55.500	16.800
58	4403.0	2.0000	1977.0	1.1400	11.200	6489.0	55.900	16.000
59	4531.0	2.0000	2098.0	1.1400	10.820	6422.0	56.300	15.400
60	4607.0	2.0000	2145.0	1.1400	10.240	6525.0	56.400	14.800
61	4729.0	2.0000	2120.0	1.1400	10.010	6233.0	57.100	15.500
62	4836.0	2.0000	2273.0	1.2000	10.680	6605.0	57.500	16.100
63	4886.0	2.0000	2399.0	1.1800	10.110	6533.0	57.800	16.800
64	5060.0	1.9800	2585.0	1.1800	9.2400	6060.0	58.100	17.400
65	5191.0	1.8800	2840.0	1.1600	9.6400	6112.0	58.500	18.000
66	5441.0	1.8900	3014.0	1.1600	9.8400	6446.0	58.800	18.700
67	5636.0	1.8300	3203.0	1.1600	10.140	6416.0	59.100	19.300
68	5926.0	1.8200	3542.0	1.1600	10.250	6196.0	59.500	20.000
69	6246.0	1.9000	3786.0	1.1600	10.640	6328.0	59.800	20.600
70	6508.0	1.9200	3851.0	1.3700	11.160	6310.0	60.200	21.300
71	6741.0	1.9800	4073.0	1.3700	11.330	6017.0	60.500	21.900
72	6954.0	2.2500	4403.0	1.3900	12.010	6553.0	60.800	22.600
73	6953.0	2.3200	4948.0	1.1700	13.790	5520.0	61.200	23.300
74	6795.0	2.7300	5443.0	1.1700	16.230	6173.0	61.500	23.900

[illegible]

YEAR	[illegible]	TEB750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	AC	CP2
50	[illegible]	1.3400	[illegible]	[illegible]	.20000	.00000	[illegible]	[illegible]
51	[illegible]	1.6700	2.4500	1.0000	.30000	.00000	[illegible]	[illegible]
52	1.7060	1.6700	2.4100	.99000	.40000	.00000	.50000	.79000
53	1.7060	1.6700	2.3800	1.1500	.40000	.00000	.70000	.80100
54	1.7060	1.6700	2.3500	1.1000	.50000	.00000	1.0000	.86500
55	1.7060	1.6700	[illegible]	[illegible]	.50000	33.500	[illegible]	[illegible]
56	1.7060	1.6700	2.2800	1.0100	.10000	35.600	1.8900	.81400
57	[illegible]	1.6700	2.2500	1.0400	.30000	37.900	[illegible]	.83300
58	1.7060	1.6700	2.2200	1.0100	.22000	40.300	[illegible]	[illegible]
59	1.7060	1.6700	2.2900	1.0200	.10000	[illegible]	[illegible]	[illegible]
60	1.7940	2.0700	2.3800	1.0100	.10000	42.300	[illegible]	.88400
61	1.7940	2.0700	[illegible]	1.0400	.10000	41.900	4.1000	[illegible]
62	1.7940	2.0700	2.4300	1.0800	.20000	41.400	4.2000	.90000
63	1.7940	2.0700	2.3600	1.0700	.20000	41.000	5.3000	.91700
64	1.7940	2.0700	2.3400	1.0600	.20000	40.600	5.8000	.92500
65	1.7940	1.9400	2.2900	1.3500	.40000	40.100	7.8000	.94500
66	1.7880	1.8800	2.2100	1.2500	.60000	37.500	9.8000	.95200
67	1.7880	1.8800	2.1200	1.0400	.80000	39.000	[illegible]	[illegible]
68	1.7880	1.8800	2.1600	1.0500	.90000	38.500	13.800	1.0400
69	1.7880	1.8800	2.1500	1.0100	1.1000	37.900	15.200	1.0900
70	1.9520	1.7100	2.2600	1.1700	1.2000	37.400	17.800	1.1220
71	1.9520	1.7100	2.2700	1.1100	1.4000	37.700	[illegible]	[illegible]
72	2.1140	1.5900	2.3300	1.1900	1.6000	38.100	22.500	[illegible]
73	2.3360	1.8800	2.5300	1.2900	1.7000	38.400	24.900	1.3310
74	2.5540	2.1000	3.0700	1.3600	1.9000	38.800	27.200	1.4270

LANSING

YEAR	DEMAND	BILL 10	INCOME	MAR GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
50	2731.0	2.0000	1220.0	.99000	10.240	7198.0	44.600	[illegible]
51	3013.0	2.0000	1576.0	.99000	10.650	7068.0	44.800	17.100
52	3270.0	2.0000	1660.0	.99000	10.610	6710.0	44.900	16.500
53	3508.0	2.0000	1851.0	1.1400	10.570	6181.0	45.000	16.000
54	3776.0	2.0000	1726.0	1.1400	10.820	6598.0	45.200	15.400
55	4043.0	2.0000	1872.0	1.1400	11.320	6209.0	45.300	[illegible]
56	4317.0	2.0000	1902.0	1.1400	11.620	6626.0	45.400	11.400
57	4595.0	2.0000	1916.0	1.1300	12.080	6487.0	45.600	13.800
58	4832.0	2.0000	1855.0	1.1400	11.200	6697.0	45.700	13.300
59	5063.0	2.0000	1999.0	1.1400	10.820	6937.0	45.800	12.700
60	5130.0	2.0000	2028.0	1.1400	10.340	7214.0	46.000	12.200
61	5334.0	2.0000	2002.0	1.1400	10.010	6950.0	46.100	13.000
62	5487.0	2.0000	2180.0	1.2000	10.080	7308.0	46.300	13.800
63	5611.0	2.0000	2291.0	1.1900	10.110	7307.0	46.400	14.600
64	5791.0	1.9800	2482.0	1.1800	9.2400	6635.0	46.600	15.400
65	5963.0	1.8800	2755.0	1.1600	9.6400	7052.0	46.700	16.100
66	6286.0	1.8900	3082.0	1.1600	9.8400	7368.0	46.900	16.900
67	6540.0	1.8300	3157.0	1.1600	10.140	7289.0	47.000	17.700
68	6926.0	1.8200	3464.0	1.1600	10.350	7107.0	47.100	18.500
69	7366.0	1.9000	3698.0	1.1600	10.640	7133.0	47.300	19.300
70	7733.0	1.9200	3692.0	1.3700	11.160	7257.0	47.400	20.100
71	8171.0	1.9800	4079.0	1.3700	11.330	6773.0	47.600	20.900
72	8566.0	2.2500	4515.0	1.3900	12.010	7710.0	47.700	21.700
73	8563.0	2.3200	4984.0	1.4700	13.790	6565.0	47.900	22.500
74	8463.0	2.7300	5190.0	1.4700	16.230	7105.0	48.000	23.300

[illegible]

[illegible]	[illegible]	IE3750	[illegible]	[illegible]	[illegible]	WATER [illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.2100	[illegible]	1.0100	[illegible]	.00200	[illegible]	[illegible]
[illegible]	1.70[illegible]	1.6700	[illegible]	.97000	.10000	.00000	[illegible]	[illegible]
[illegible]	1.7060	1.6700	2.3200	.98000	.30000	.00000	.70000	[illegible]
53	1.7060	1.6700	[illegible]	1.1300	.20000	.00000	1.000[illegible]	.2910[illegible]
54	1.7060	1.6700	2.2700	1.0900	.10000	.00000	1.[illegible]	[illegible]
[illegible]	[illegible]	1.6700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1.7060	1.6700	2.1900	[illegible]	.30000	15.500	1.[illegible]	[illegible]
[illegible]	1.7060	1.6700	2.1700	1.0200	.30000	[illegible]	[illegible]	[illegible]
[illegible]	1.7060	1.6700	2.1400	1.0200	.50000	10.100	[illegible]	[illegible]
[illegible]	1.7060	1.6700	2.2100	[illegible]	.60000	[illegible]	[illegible]	[illegible]
[illegible]	1.7240	2.0700	2.3000	[illegible]	.50000	12.200	[illegible]	[illegible]
[illegible]	[illegible]	2.0700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.0700	[illegible]	[illegible]	[illegible]	11.200	[illegible]	[illegible]
[illegible]	[illegible]	2.0700	[illegible]	[illegible]	[illegible]	11.400	[illegible]	[illegible]
[illegible]	[illegible]	2.0700	2.2600	1.0500	.70000	11.400	[illegible]	[illegible]
[illegible]	[illegible]	1.7400	[illegible]	[illegible]	1.2000	11.500	[illegible]	[illegible]
[illegible]	[illegible]	1.8800	2.1200	[illegible]	1.7000	11.700	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11.800	[illegible]	[illegible]
[illegible]	[illegible]	1.8800	[illegible]	[illegible]	2.4000	[illegible]	11.10[illegible]	[illegible]
[illegible]	[illegible]	1.8800	[illegible]	[illegible]	3.1000	12.100	[illegible]	[illegible]
[illegible]	1.9520	1.7100	2.1500	1.1300	3.6000	12.200	11.[illegible]	1.1[illegible]
[illegible]	[illegible]	1.7100	2.1300	1.1200	4.1000	12.200	[illegible]	[illegible]
[illegible]	2.1140	1.5800	[illegible]	1.1700	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2.3380	1.8300	2.4400	[illegible]	5.0000	12.200	[illegible]	[illegible]
[illegible]	2.5540	2.1000	2.9700	1.6400	5.4000	12.400	21.[illegible]	[illegible]

OREGON

YEAR	DEMAND	BILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
50	2159.0	2.0000	[illegible]	1.1600	10.240	6699.0	54.200	[illegible]
51	2204.0	2.0000	1597.0	1.1600	10.650	6520.0	54.100	17.500
52	2352.0	2.0000	1655.0	1.1600	10.610	6175.0	54.000	16.700
53	2553.0	2.0000	1809.0	1.1600	10.570	5728.0	53.900	15.900
54	2788.0	2.0000	1708.0	1.1800	10.820	6136.0	53.800	15.100
55	2975.0	2.0000	1826.0	1.1500	11.320	6121.0	53.700	14.400
56	3236.0	2.0000	1850.0	1.1700	11.620	6810.0	53.600	13.600
57	3454.0	2.0000	1852.0	1.1700	12.080	6791.0	53.500	12.800
58	3609.0	2.0000	1912.0	1.1700	11.200	7006.0	53.400	12.000
59	3730.0	2.0000	[illegible]	1.2000	10.920	6980.0	53.300	11.200
60	3849.0	2.0000	1952.0	1.2000	10.340	6887.0	53.200	10.400
61	3994.0	2.0000	[illegible]	1.2500	10.010	6657.0	53.200	10.900
62	4133.0	2.0000	2015.0	1.2500	10.090	6957.0	53.200	11.400
63	4254.0	2.0000	2165.0	1.2400	10.110	6993.0	53.300	11.900
64	4356.0	1.9800	2320.0	1.2400	9.2400	6656.0	53.300	12.400
65	4486.0	1.8800	2537.0	1.2400	9.6400	6381.0	53.400	12.900
66	4732.0	1.8700	2740.0	1.2300	9.8100	6321.0	53.400	13.400
67	4912.0	1.8300	2857.0	1.2300	10.140	7015.0	53.500	13.900
68	5157.0	1.8200	3066.0	1.2300	10.350	6981.0	53.500	14.400
69	5461.0	1.9000	3345.0	1.2300	10.640	7439.0	53.600	14.900
70	5636.0	1.9200	3149.0	1.2600	11.160	7205.0	53.600	15.400
71	5873.0	1.9800	3558.0	1.2200	11.330	5876.0	53.600	15.900
72	6077.0	2.2500	3914.0	1.2500	12.010	7497.0	53.700	16.100
73	6088.0	2.3200	4202.0	1.2900	13.790	6347.0	53.700	15.900
74	6086.0	2.7300	4669.0	1.3500	16.230	7213.0	53.800	15.400

MUSKEGON

YEAR	TFB 500	TFB750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	SC	CPI
50	1.5980	1.3400	2.5500	.78000	.20000	.00000	[illegible]	.72100
51	1.7060	1.6700	[illegible]	.77000	.20000	.00000	.20000	[illegible]
52	1.7060	1.6700	2.4300	.82000	.20000	.00000	.40000	[illegible]
53	1.7060	1.6700	2.5200	.89000	.20000	.00000	.70000	.80100
54	1.7060	1.6700	2.4100	.87000	.20000	.00000	.90000	.80500
55	1.7060	1.6700	[illegible]	.89000	.20000	23.400	[illegible]	[illegible]
56	1.7060	1.6700	2.3000	.89000	.20000	24.200	[illegible]	[illegible]
57	1.7060	1.6700	2.2600	.88000	.20000	25.100	1.1000	.84300
58	1.7060	1.6700	2.2200	.91000	.10000	25.900	1.5000	.86600
59	1.7060	1.6700	2.3000	.91000	.10000	26.700	[illegible]	.87300
60	1.7940	2.0700	2.3800	.92000	.10000	27.200	[illegible]	.88630
61	1.7940	2.0700	2.3700	[illegible]	[illegible]	27.600	[illegible]	[illegible]
62	1.7940	2.0700	2.3500	.95000	.30000	28.100	[illegible]	[illegible]
63	1.7940	2.0700	2.3400	.94000	[illegible]	28.500	[illegible]	[illegible]
64	1.7940	2.0200	2.3200	.94000	.30000	29.000	2.0000	[illegible]
65	1.7940	1.9400	2.2900	.93000	.60000	28.700	2.5000	.94500
66	1.7880	1.8800	2.2300	.92000	.90000	28.400	3.0000	[illegible]
67	1.7880	1.8800	2.2100	.92000	1.2000	28.100	[illegible]	[illegible]
68	1.7880	1.8800	2.1900	.93000	1.6000	27.900	4.1000	[illegible]
69	1.7880	1.8800	2.1000	.93000	1.9000	27.500	4.5000	[illegible]
70	1.9520	1.7100	2.2800	.91000	2.2000	27.200	5.1000	[illegible]
71	1.9520	1.7100	2.2600	.94000	2.3000	28.300	6.5000	1.1300
72	2.1110	1.5800	2.3500	1.0100	2.3000	29.300	[illegible]	[illegible]
73	2.3380	1.9800	2.5600	1.0900	2.4000	30.400	9.4000	[illegible]
74	2.5540	2.1000	3.1000	1.1400	2.4000	31.400	10.200	[illegible]

SAGINAW

YEAR	DEMAND	BILL 10	INCOME	AVR GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
50	2111.0	2.0000	1585.0	.99000	10.240	7345.0	[illegible]	[illegible]
51	2065.0	2.0000	1662.0	.97000	10.450	7580.0	68.700	21.800
52	2413.0	2.0000	1751.0	.99000	10.610	7001.0	68.900	21.000
53	2620.0	2.0000	1952.0	1.1400	10.570	6504.0	69.000	20.100
54	2913.0	2.0000	1821.0	1.1400	10.820	7041.0	69.200	19.300
55	3086.0	2.0000	1974.0	1.1400	11.320	6876.0	69.000	18.400
56	3753.0	2.0000	2005.0	1.1400	11.620	7307.0	69.000	17.600
57	3571.0	2.0000	2021.0	1.1400	12.080	7115.0	69.100	16.200
58	3705.0	2.0000	1955.0	1.1400	11.200	7232.0	69.100	15.900
59	3940.0	2.0000	2139.0	1.1400	10.820	7351.0	69.100	15.100
60	4027.0	2.0000	2132.0	1.1400	10.240	7223.0	69.100	14.200
61	4195.0	2.0000	2112.0	1.1400	10.010	6972.0	69.200	14.600
62	4335.0	2.0000	2294.0	1.1600	10.080	7527.0	69.200	15.100
63	4450.0	2.0000	2416.0	1.1800	10.110	7492.0	69.200	15.500
64	4615.0	1.9800	2618.0	1.1800	9.2400	6789.0	69.400	16.000
65	4813.0	1.8800	2881.0	1.1600	9.6400	7118.0	69.400	16.400
66	5109.0	1.8900	3059.0	1.1600	9.8400	7150.0	69.500	16.900
67	5360.0	1.8300	3164.0	1.1600	10.140	7181.0	69.500	17.300
68	5657.0	1.8200	3497.0	1.1400	10.350	6894.0	69.600	17.700
69	6031.0	1.9000	3791.0	1.1600	10.540	7018.0	69.600	18.200
70	6352.0	1.9200	3828.0	1.3700	11.160	7224.0	69.700	18.600
71	6620.0	1.9800	4408.0	1.3700	11.330	6709.0	69.700	19.300
72	7012.0	2.2500	4831.0	1.3900	12.910	7761.0	69.900	19.500
73	7038.0	2.3200	5355.0	1.4600	13.790	6625.0	67.800	19.930
74	6930.0	2.7300	5599.0	1.4700	[illegible]	7054.0	69.900	20.400

SAVED

YEAR	TPP 500	TEB750	AVE ELEC	AVE GAS	SPACE HEAT	WATER HEAT	AC	CPI
50	1.5280	1.3400	[illegible]	1.0120	.20000	.00000	.00000	.72100
51	1.7040	1.6700	[illegible]	.98000	.20000	.00000	.70000	[illegible]
52	1.7060	1.6700	2.6100	.97000	.20000	.00000	1.5000	[illegible]
53	1.7060	1.6700	2.5500	1.1100	.20000	.00000	2.3000	.80100
54	1.7060	1.6700	2.4800	1.0900	.30000	.00000	3.3000	[illegible]
55	1.7060	1.6700	2.4100	1.0500	.70000	[illegible]	[illegible]	[illegible]
56	1.7060	1.6700	2.4000	1.0300	.20000	24.200	2.7300	.81400
57	1.7060	1.6700	2.3400	1.0300	.20000	25.500	[illegible]	[illegible]
58	1.7060	1.6700	2.3100	1.0300	.10000	24.300	[illegible]	.86300
59	1.7060	1.6700	2.3700	1.0100	.00000	28.100	3.2000	[illegible]
60	1.7240	2.0700	2.4100	1.0100	.00000	27.200	[illegible]	.88600
61	1.7240	2.0700	2.4100	1.0400	.00000	26.300	4.4000	.89400
62	1.7240	2.0700	2.4200	1.0200	.10000	25.300	4.3000	.90400
63	1.7940	2.0700	2.4200	1.0400	.10000	24.300	5.1000	.91700
64	1.7940	2.0700	2.4000	1.0300	.10000	23.500	5.4000	.92900
65	1.7940	1.9400	2.3400	1.0100	.40000	23.400	7.5000	.94500
66	1.7280	1.8800	2.2700	1.0400	.50000	23.300	9.3000	.97200
67	1.7880	1.8800	2.2400	1.0200	.70000	23.200	12.400	1.0000
68	1.7880	1.8800	2.2100	1.0100	.80000	23.100	14.200	1.0420
69	1.7880	1.8800	2.3000	1.0500	1.0000	23.000	16.500	1.0980
70	1.9520	1.7100	2.2300	1.1300	1.2000	22.900	18.700	1.1630
71	1.9520	1.7100	2.2600	1.1300	1.4000	23.200	20.700	1.2130
72	2.1140	1.5800	2.3400	1.1700	1.6000	23.500	22.700	1.2530
73	2.3380	1.8800	2.5500	1.2800	1.9000	23.800	24.600	1.3310
74	2.5540	2.1000	3.0700	1.6400	2.1000	24.100	[illegible]	1.4770

JURCHASE

YEAR	DEMAND	BILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	URBAN	SALTIUM?
50	1992.0	2.0000	1021.0	1.1600	10.270	8544.0	31.900	8.5000
51	2054.0	2.0000	1243.0	1.1600	10.650	8242.0	31.900	8.3000
52	2190.0	2.0000	1331.0	1.1600	10.610	7788.0	31.900	8.2000
53	2325.0	2.0000	1482.0	1.1500	10.570	7404.0	31.900	8.1000
54	2569.0	2.0000	1386.0	1.1800	10.820	7986.0	32.000	7.9000
55	2756.0	2.0000	1505.0	1.1500	11.320	7855.0	32.000	7.8000
56	3014.0	2.0000	1529.0	1.1700	11.620	9223.0	32.100	[illegible]
57	3263.0	2.0000	1541.0	1.1700	12.080	8320.0	32.100	7.5000
58	3420.0	2.0000	1491.0	1.1700	11.200	8333.0	32.100	7.4000
59	3556.0	2.0000	1422.0	1.2000	10.020	8223.0	32.100	7.2000
60	3623.0	2.0000	1633.0	1.2000	10.340	8159.0	32.100	7.1000
61	3774.0	2.0000	1611.0	1.2500	10.010	7776.0	31.700	7.6000
62	3899.0	2.0000	1728.0	1.2500	10.080	8068.0	31.200	8.2000
63	3943.0	2.0000	1847.0	1.2400	10.110	8266.0	30.900	8.7000
64	4017.0	1.9800	2003.0	1.2400	9.2400	7685.0	30.400	9.3000
65	4142.0	1.8800	2180.0	1.2400	9.6400	8058.0	30.000	9.8000
66	4354.0	1.8900	2377.0	1.2300	9.8400	8161.0	29.500	10.300
67	4561.0	1.8300	2484.0	1.2300	10.140	8758.0	29.100	10.900
68	4827.0	1.8200	2726.0	1.2300	10.350	8324.0	28.700	11.[illegible]
69	5215.0	1.9000	3050.0	1.2300	10.640	8197.0	28.200	12.000
70	5443.0	1.9200	3228.0	1.2500	11.160	8099.0	27.800	12.500
71	5693.0	1.9800	3365.0	1.2200	11.330	7982.0	27.400	13.000
72	6126.0	2.2500	3643.0	1.2500	12.010	8539.0	26.900	13.600
73	6102.0	2.3200	3910.0	1.2900	13.790	7250.0	26.500	14.100
74	6261.0	2.7300	4245.0	1.3500	16.230	8604.0	26.100	14.700

NORTHWEST:

YEAR	[illegible]	TERP50	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	[illegible]	[illegible]
[illegible]	[illegible]	1.3400	[illegible]	[illegible]	.30000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.6700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.6700	[illegible]	.92000	.50000	[illegible]	[illegible]	[illegible]
[illegible]	1.7060	1.6700	[illegible]	.89000	[illegible]	.00000	.20000	.80100
54	[illegible]	1.6700	2.3400	.87000	.70000	.00000	.20000	.80500
55	[illegible]	1.6700	[illegible]	.98000	.70000	37.700	.30000	.80200
[illegible]	[illegible]	1.6700	2.2100	.89000	.80000	41.100	.40000	.81400
57	[illegible]	1.6700	2.1600	.88000	.90000	44.600	.40000	.84300
[illegible]	[illegible]	1.6700	2.1200	.91000	1.0000	48.000	.50000	.86600
[illegible]	[illegible]	1.6700	2.1900	.91000	1.1000	51.400	.50000	.87300
[illegible]	[illegible]	2.0700	[illegible]	[illegible]	1.1000	52.100	.70000	.88600
[illegible]	[illegible]	2.0700	[illegible]	[illegible]	[illegible]	52.800	.80000	.89600
[illegible]	[illegible]	2.0700	[illegible]	[illegible]	1.2000	[illegible]	[illegible]	.90600
[illegible]	[illegible]	2.0700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.0700	[illegible]	[illegible]	1.3000	[illegible]	[illegible]	[illegible]
[illegible]	1.7740	1.9400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1.7800	1.8800	2.1000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.8800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.8800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.8800	[illegible]	[illegible]	[illegible]	57.000	[illegible]	[illegible]
[illegible]	[illegible]	1.7100	[illegible]	.91000	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.7100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2.1100	1.8300	[illegible]	[illegible]	[illegible]	52.700	[illegible]	[illegible]
[illegible]	[illegible]	1.8800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2.5540	2.1900	[illegible]	[illegible]	[illegible]	61.000	[illegible]	[illegible]

HURON

YEAR	[illegible]	BILL 10	[illegible]	NAT GAS	FUEL OIL	DEG DAYS	[illegible]	[illegible]
50	[illegible]	2.7500	[illegible]	.99600	10.240	[illegible]	9.0000	[illegible]
51	[illegible]	2.7500	[illegible]	.99000	10.550	[illegible]	9.0000	7.8000
52	[illegible]	2.7500	[illegible]	.99000	10.610	5215.0	9.0000	[illegible]
53	3397.0	2.7500	1261.0	1.1100	10.570	5787.0	8.9000	7.1000
54	3637.0	2.7500	1124.0	1.1100	10.820	6319.0	8.9000	[illegible]
55	3741.0	2.7500	[illegible]	1.1400	11.320	[illegible]	8.9000	[illegible]
56	4065.0	2.7500	1313.0	1.1400	11.620	5638.0	[illegible]	[illegible]
57	4210.0	2.7500	1328.0	1.1400	12.080	5458.0	[illegible]	5.7000
58	4415.0	2.7500	1265.0	1.1400	11.200	5717.0	8.8000	5.3000
59	4702.0	2.7500	1489.0	1.1400	10.820	6751.0	8.8000	5.9000
60	4733.0	2.7500	1143.0	1.1400	10.340	7055.0	8.8000	[illegible]
61	4972.0	2.6700	1416.0	1.1400	10.010	6579.0	8.8000	[illegible]
62	5151.0	2.5600	1636.0	1.2000	10.030	7196.0	8.8000	[illegible]
63	5372.0	2.3800	1711.0	1.1800	10.110	7244.0	8.8000	5.8000
64	5562.0	2.2500	1968.0	1.1800	9.2400	6794.0	8.8000	6.2000
65	5756.0	2.2500	2160.0	1.1600	9.6400	7378.0	8.8000	6.6000
66	5810.0	2.2400	2352.0	[illegible]	9.8100	7459.0	8.9000	6.9000
67	[illegible]	2.2400	2288.0	1.1800	10.140	7394.0	8.8000	7.3000
68	[illegible]	2.2400	2755.0	1.1600	10.350	6925.0	8.8000	7.7000
69	6706.0	2.2300	3076.0	1.1600	10.640	7151.0	8.8000	8.1000
70	7056.0	2.1000	3199.0	1.3700	11.160	7191.0	8.8000	8.5000
71	7023.0	2.0900	3248.0	1.3700	11.330	6999.0	8.8000	8.9000
72	[illegible]	2.0800	3781.0	1.3900	12.010	7581.0	8.8000	9.3000
73	7219.0	2.5800	4380.0	1.4700	13.790	6371.0	8.8000	9.7000
74	7289.0	2.8100	5376.0	1.4700	16.230	6965.0	8.8000	10.100

[illegible]	2.6100	2.1900	2.5100	1.0100	.10000	25.500	.00500	.2160
[illegible]	[illegible]	2.1900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	.97000	.30000	32.000	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.50000	34.500	[illegible]	[illegible]
54	2.6300	2.1800	[illegible]	[illegible]	.50000	37.300	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
58	2.6400	2.1800	2.2100	1.0300	[illegible]	45.200	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	2.1700	1.0100	.90000	48.300	[illegible]	[illegible]
[illegible]	2.6400	2.1800	[illegible]	[illegible]	[illegible]	49.100	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	49.900	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	2.1200	1.0000	.70000	50.300	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	2.1200	[illegible]	[illegible]	51.200	[illegible]	[illegible]
[illegible]	2.6400	2.1800	2.1100	[illegible]	.10000	51.400	14.800	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	1.0400	.40000	[illegible]	15.300	[illegible]
[illegible]	2.5900	1.5500	1.9900	[illegible]	.80000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	1.1500	53.100	[illegible]	[illegible]
[illegible]	2.5900	1.5500	1.7800	1.0400	1.6000	54.200	19.500	[illegible]
[illegible]	2.5900	1.5500	1.8600	[illegible]	2.1000	[illegible]	[illegible]	[illegible]
[illegible]	2.5900	1.5500	1.7200	1.1200	2.4000	55.400	[illegible]	[illegible]
[illegible]	[illegible]	1.8400	2.1000	[illegible]	2.8000	[illegible]	[illegible]	[illegible]
[illegible]	2.6200	1.8400	2.2100	[illegible]	3.2000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.3300	2.3000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
74	2.8300	2.6000	2.8000	[illegible]	[illegible]	51.200	[illegible]	[illegible]

[illegible]

YEAR [illegible]	[illegible]	BILL 10	INCOME [illegible]	NAT GAS [illegible]	FUEL OIL	DEG DAYS	URBAN	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	.99000	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	10.610	6677.0	[illegible]	[illegible]
53	[illegible]	2.7500	[illegible]	1.1400	10.570	6277.0	16.100	11.400
54	3625.0	2.7500	[illegible]	1.1400	[illegible]	7125.0	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	1913.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
58	[illegible]	2.7500	1759.0	[illegible]	11.200	7381.0	[illegible]	[illegible]
59	[illegible]	2.7500	1906.0	1.1400	10.820	7335.0	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	1912.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.6700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	5311.0	2.5600	[illegible]	[illegible]	10.080	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.3800	2143.0	[illegible]	10.110	7401.0	[illegible]	[illegible]
[illegible]	[illegible]	2.2500	[illegible]	1.1800	9.2400	[illegible]	13.600	11.500
65	6230.0	2.2500	2596.0	1.1800	9.6400	6947.0	17.400	12.300
[illegible]	[illegible]	2.2400	[illegible]	[illegible]	[illegible]	[illegible]	13.100	[illegible]
[illegible]	[illegible]	2.2400	[illegible]	1.1600	[illegible]	7335.0	[illegible]	14.000
[illegible]	7317.0	2.2400	3166.0	[illegible]	[illegible]	7092.0	12.500	[illegible]
[illegible]	[illegible]	2.2300	[illegible]	1.1600	10.640	7198.0	[illegible]	15.700
[illegible]	[illegible]	2.1000	4477.0	[illegible]	11.160	7161.0	12.000	16.500
71	[illegible]	2.0900	[illegible]	[illegible]	11.330	6778.0	11.700	[illegible]
72	[illegible]	2.0800	[illegible]	[illegible]	12.310	7321.0	[illegible]	[illegible]
73	[illegible]	2.5800	[illegible]	[illegible]	13.790	6251.0	11.200	[illegible]
74	[illegible]	2.8100	[illegible]	1.4700	14.230	6875.0	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2.6400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
52	2.6400	2.1800	[illegible]	[illegible]	.30000	21.[illegible]	4.[illegible]	[illegible]
53	2.6400	2.1800	2.5[illegible]	1.1800	[illegible]	[illegible]	[illegible]	[illegible]
54	2.6400	2.1800	2.4700	1.1[illegible]	.20000	27.[illegible]	[illegible]	.90[illegible]
55	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
56	2.6400	2.1800	[illegible]	[illegible]	.20000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	2.35[illegible]	[illegible]	[illegible]	33.100	[illegible]	[illegible]
58	[illegible]	2.1800	2.31[illegible]	1.07[illegible]	.20000	[illegible]	18.500	[illegible]
59	[illegible]	2.1800	2.2400	1.0[illegible]	[illegible]	38.500	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	2.2300	[illegible]	[illegible]	40.500	23.100	[illegible]
61	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	42.[illegible]	[illegible]	[illegible]
64	[illegible]	2.1800	2.1700	1.0800	.50000	43.500	[illegible]	[illegible]
65	[illegible]	1.5500	[illegible]	[illegible]	.50000	43.600	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	1.7500	[illegible]	1.3000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	2.5900	1.5500	1.9800	1.1200	3.1000	47.800	[illegible]	[illegible]
[illegible]	[illegible]	1.8400	2.1000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.8400	[illegible]	[illegible]	4.7900	[illegible]	[illegible]	[illegible]
[illegible]	2.9700	2.3200	[illegible]	[illegible]	5.5000	46.300	[illegible]	[illegible]
74	2.8000	2.6000	2.7500	1.6300	6.6000	47.400	11.900	[illegible]

SANILAC

YEAR	DEMAND	BILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51	[illegible]	2.7500	[illegible]	[illegible]	10.850	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	3451.0	2.7500	[illegible]	1.3800	10.570	[illegible]	.00000	[illegible]
[illegible]	3745.0	2.7500	[illegible]	1.3800	10.920	6680.0	[illegible]	5.6000
55	3832.0	2.7500	[illegible]	1.3800	11.320	4553.0	.00000	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	11.290	[illegible]	[illegible]	[illegible]
[illegible]	5084.0	2.7500	[illegible]	1.3300	10.830	7153.0	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
61	[illegible]	2.4700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.5400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.3800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2500	2159.0	[illegible]	[illegible]	7268.0	.00000	[illegible]
[illegible]	[illegible]	2.2400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2400	2571.0	[illegible]	[illegible]	7297.0	[illegible]	[illegible]
[illegible]	[illegible]	2.2400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2300	3155.0	[illegible]	10.640	7085.0	[illegible]	[illegible]
[illegible]	[illegible]	2.1000	[illegible]	[illegible]	[illegible]	7200.0	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6951.0	[illegible]	[illegible]
[illegible]	[illegible]	2.0800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
73	[illegible]	2.5800	4074.0	[illegible]	[illegible]	[illegible]	.00000	[illegible]
74	[illegible]	2.8100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

YEAR	GEB 500	IEB750	AVG ELEC	[illegible]	STOCK HEAT	WATER HEAT	[illegible]	[illegible]
50	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51	2.6400	2.1800	2.4000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
52	[illegible]	2.1800	[illegible]	[illegible]	.50000	[illegible]	[illegible]	[illegible]
53	2.6400	2.1800	[illegible]	[illegible]	.65000	[illegible]	[illegible]	.80100
54	2.6400	2.1800	[illegible]	[illegible]	.60000	[illegible]	[illegible]	[illegible]
55	2.6400	2.1800	2.2100	[illegible]	.50000	[illegible]	11.500	[illegible]
56	[illegible]	2.1800	2.2900	[illegible]	.50000	[illegible]	[illegible]	.81300
57	[illegible]	2.1800	2.2400	1.1700	.50000	[illegible]	[illegible]	[illegible]
58	2.6400	2.1800	[illegible]	[illegible]	.50000	45.200	18.500	[illegible]
59	2.6400	2.1800	2.1700	1.0700	.50000	47.000	20.800	[illegible]
60	[illegible]	2.1800	[illegible]	[illegible]	.55000	[illegible]	[illegible]	[illegible]
61	[illegible]	2.1800	2.1300	[illegible]	.60000	[illegible]	21.500	[illegible]
62	[illegible]	2.1800	2.1100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
63	2.6400	2.1800	2.1000	[illegible]	.70000	52.100	[illegible]	[illegible]
64	2.6400	2.1800	[illegible]	[illegible]	.70000	51.600	[illegible]	[illegible]
65	2.6400	1.5500	[illegible]	[illegible]	1.1000	54.400	15.200	.94500
66	2.5900	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
67	2.5900	1.5500	[illegible]	[illegible]	1.7000	[illegible]	[illegible]	[illegible]
68	2.5900	1.5500	[illegible]	[illegible]	2.5000	55.900	[illegible]	[illegible]
69	2.5900	1.5500	1.8500	[illegible]	2.9000	53.000	[illegible]	1.0980
70	2.5900	1.5500	1.9000	[illegible]	3.5000	53.200	[illegible]	[illegible]
71	[illegible]	1.8400	[illegible]	[illegible]	3.8000	53.500	[illegible]	[illegible]
72	[illegible]	1.8400	2.1800	[illegible]	[illegible]	57.000	[illegible]	[illegible]
73	[illegible]	2.3300	2.3600	1.2200	4.9000	[illegible]	15.700	[illegible]
74	2.8800	2.6000	[illegible]	[illegible]	5.1000	51.800	11.700	[illegible]

ST.CLAIR

YEAR	DEMAND	PILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	URBAN	SUBURBAN
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	10.850	5513.0	[illegible]	[illegible]
[illegible]	3959.0	2.7500	[illegible]	[illegible]	10.810	5171.0	[illegible]	[illegible]
53	4210.0	2.7500	[illegible]	1.3800	10.570	5724.0	52.500	14.200
54	4494.0	2.7500	1630.0	1.3800	10.830	6197.0	52.150	13.700
55	3563.0	2.7500	1825.0	[illegible]	11.320	6125.0	[illegible]	[illegible]
56	[illegible]	2.7500	1855.0	[illegible]	11.620	[illegible]	[illegible]	[illegible]
57	4008.0	2.7500	1849.0	[illegible]	12.080	6387.0	50.800	12.290
58	4144.0	2.7500	1808.0	1.3700	11.200	6561.0	52.400	11.100
59	4356.0	2.7500	1887.0	1.3200	10.820	6507.0	49.900	11.100
60	4506.0	2.7500	1981.0	[illegible]	10.340	5523.0	[illegible]	[illegible]
61	4567.0	2.6700	1955.0	1.3300	10.010	6298.0	[illegible]	11.100
[illegible]	4796.0	2.5500	2088.0	1.3300	10.080	6575.0	[illegible]	[illegible]
[illegible]	4930.0	2.3800	2242.0	1.3300	10.110	6594.0	[illegible]	[illegible]
64	5035.0	2.2500	2433.0	1.3300	9.2400	6051.0	48.100	12.600
65	5199.0	2.2500	2610.0	1.3300	9.6400	6415.0	47.600	[illegible]
[illegible]	5378.0	2.2400	2875.0	1.3300	9.8400	6671.0	[illegible]	[illegible]
[illegible]	5651.0	2.2400	3051.0	1.3300	10.140	6620.0	47.000	[illegible]
[illegible]	5974.0	2.2400	3111.0	[illegible]	10.350	6454.0	46.700	14.500
[illegible]	6336.0	2.2300	3537.0	1.3500	10.640	6625.0	46.300	15.000
70	6680.0	2.1000	3894.0	1.3700	11.140	6619.0	[illegible]	15.500
71	6839.0	2.0900	4026.0	1.3300	11.330	6223.0	45.600	16.000
[illegible]	7295.0	2.0800	4362.0	1.4000	12.010	6927.0	45.300	17.500
73	7243.0	2.5900	4831.0	1.6700	12.790	5905.0	44.900	17.000
74	7340.0	2.8100	5190.0	1.7700	16.230	5341.0	44.600	17.500

[illegible]

YEAR	ELE 500	TED750	[illegible]	[illegible]	SPACE HEAT	WATER HEAT	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.20000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.50000	[illegible]	[illegible]	[illegible]
[illegible]	2.6150	2.1800	[illegible]	[illegible]	.50000	26.100	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.50000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.50000	30.100	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.40000	[illegible]	[illegible]	[illegible]
59	2.6400	2.1800	2.2200	[illegible]	.40000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.40000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	2.3000	[illegible]	.40000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.40000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.40000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	2.2700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	.50000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	.70000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	1.2000	[illegible]	10.536	[illegible]
[illegible]	2.5000	1.5500	[illegible]	[illegible]	1.5000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	2.1000	[illegible]	1.9000	[illegible]	[illegible]	[illegible]
71	[illegible]	1.8400	[illegible]	[illegible]	2.4000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.8400	[illegible]	[illegible]	[illegible]	17.100	[illegible]	[illegible]
[illegible]	2.9200	2.3300	2.5000	[illegible]	3.7000	24.500	[illegible]	[illegible]
[illegible]	3.0000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TUSCOLA

YEAR	DEMAND	BILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	UNEMP	RETIREIT
50	[illegible]	2.7500	[illegible]	.99050	13.240	[illegible]	[illegible]	[illegible]
51	2575.0	2.7500	[illegible]	.99000	10.650	6312.0	15.600	9.8000
52	[illegible]	2.7500	1218.0	.99000	10.410	6215.0	15.400	[illegible]
53	3135.0	2.7500	1493.0	1.1400	10.570	5787.0	15.300	8.9000
54	[illegible]	2.7500	1232.0	1.1400	10.820	6219.0	15.100	[illegible]
55	[illegible]	2.7500	[illegible]	1.1400	11.320	6229.0	15.000	[illegible]
56	4037.0	2.7500	[illegible]	1.1400	11.620	6638.0	14.900	7.5000
57	4300.0	2.7500	1466.0	1.1400	12.080	6458.0	14.700	7.0000
58	4525.0	2.7500	1407.0	1.1400	11.200	6717.0	14.600	6.5000
59	4874.0	2.7500	1647.0	1.1400	10.920	6954.0	14.400	6.1000
60	5105.0	2.7500	1576.0	1.1490	10.740	7053.0	14.300	5.5000
61	5374.0	2.6700	1550.0	1.1190	10.510	6879.0	14.200	7.4000
62	5548.0	2.5600	1955.0	1.2100	10.080	7196.0	14.100	7.7000
63	5749.0	2.3300	1831.0	1.1800	10.110	7244.0	14.000	8.0000
64	5947.0	2.2500	2017.0	1.1800	9.2400	6791.0	13.900	8.8000
65	6256.0	2.2500	2237.0	1.1560	9.5400	7378.0	13.900	9.6000
66	6451.0	2.2400	2457.0	1.1400	9.8400	7458.0	13.800	10.300
67	6774.0	2.2400	2522.0	1.1500	10.140	7393.0	13.700	11.100
68	7066.0	2.2400	2667.0	1.1600	10.750	6925.0	13.600	11.900
69	7697.0	2.2300	3093.0	1.1600	10.340	7151.0	13.500	12.700
70	8076.0	2.1000	3361.0	1.3700	11.160	7191.0	13.400	13.500
71	8239.0	2.0900	3515.0	1.3700	11.320	6999.0	13.300	14.300
72	8792.0	2.0800	3923.0	1.7900	12.010	7581.0	13.200	15.100
73	8707.0	2.5800	4337.0	1.1700	13.790	6371.0	13.100	15.900
74	8737.0	2.8100	5041.0	1.4700	15.220	6965.0	13.000	16.700

TUSCOLA

[illegible]	[illegible]	TEB750	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.10000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
54	2.6400	2.1800	[illegible]	[illegible]	.10000	[illegible]	[illegible]	[illegible]
55	[illegible]	2.1800	[illegible]	[illegible]	.40000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	14.500	[illegible]
59	[illegible]	2.1800	[illegible]	[illegible]	.20000	[illegible]	22.200	[illegible]
60	[illegible]	2.1800	[illegible]	[illegible]	.10000	[illegible]	22.100	[illegible]
61	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.30000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.10000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	2.1100	1.0100	.60000	[illegible]	[illegible]	[illegible]
[illegible]	2.5900	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
67	[illegible]	1.5500	[illegible]	[illegible]	1.4300	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	[illegible]	1.8400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.8400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.3300	[illegible]	[illegible]	1.0000	[illegible]	[illegible]	[illegible]
74	[illegible]	2.6000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

OAKLAND

YEAR	DEMAND	BILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	URBAN	[illegible]
50	[illegible]	2.7500	[illegible]	.99000	10.280	[illegible]	[illegible]	[illegible]
51	[illegible]	2.7500	2209.	.99000	10.250	6891.0	72.000	[illegible]
52	2919.0	2.7500	[illegible]	.99000	10.610	6313.0	75.400	[illegible]
53	3111.0	2.7500	2991.0	1.1400	10.570	5983.0	77.200	13.100
54	3302.0	2.7500	2819.0	1.1400	10.920	5299.0	79.300	[illegible]
55	3632.0	2.7500	3071.0	1.1400	11.020	6291.0	80.500	[illegible]
56	3938.0	2.7500	3062.0	1.1200	11.420	6627.0	81.900	[illegible]
57	4132.0	2.7500	3082.0	1.1300	12.080	6529.0	83.300	11.000
58	4208.0	2.7500	2997.0	1.1400	11.200	6723.0	85.100	10.500
59	4551.0	2.7500	3327.0	1.1400	10.020	6670.0	86.700	9.9000
60	4733.0	2.7500	3303.0	1.1100	[illegible]	5560.0	88.300	[illegible]
61	4945.0	2.6700	3900.0	1.1300	10.010	6421.0	88.100	[illegible]
62	5049.0	2.5200	3557.0	1.0900	10.090	6758.0	88.400	[illegible]
63	5194.0	2.3800	3603.0	1.1800	10.110	6274.0	88.000	[illegible]
64	5392.0	2.2500	3270.0	1.1900	9.2400	6269.0	88.900	[illegible]
65	5622.0	2.2500	4117.0	1.1600	9.6400	6510.0	89.100	14.000
66	5732.0	2.2400	4229.0	1.1400	9.2400	6932.0	89.300	13.900
67	6195.0	2.2400	4794.0	1.1500	10.110	4924.0	89.500	15.900
68	6605.0	2.2400	5243.0	1.1600	10.350	5850.0	89.600	16.200
69	7088.0	2.2300	5558.0	1.1600	10.640	6210.0	89.800	17.200
70	7549.0	2.1000	5732.0	1.3700	11.160	6277.0	90.000	18.400
71	7747.0	2.0700	6106.0	1.3200	11.730	6162.0	90.200	17.500
72	7809.0	2.0800	6697.0	1.3000	12.310	7214.0	90.300	21.500
73	7822.0	2.5800	7217.0	1.4900	13.790	6061.0	90.500	21.100
74	7551.0	2.8100	7441.0	1.4200	14.230	6783.0	90.700	[illegible]

OAKLAND

• YEAR	TEE 530	TURB750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	AC	[illegible]
50	[illegible]	2.1064	[illegible]	[illegible]	[illegible]	11.[illegible]	[illegible]	[illegible]
51	2.6380	2.1021	2.7900	1.0100	.20000	13.[illegible]	[illegible]	[illegible]
52	2.6380	2.1147	[illegible]	1.0100	.20000	15.200	[illegible]	[illegible]
53	2.6380	2.1188	2.6800	1.1800	.20000	17.000	[illegible]	[illegible]
54	2.6380	2.1229	2.6300	1.1400	.20000	18.800	5.9000	[illegible]
55	2.6380	2.1242	2.6000	1.0720	.20000	20.300	[illegible]	[illegible]
56	2.6380	2.1276	[illegible]	[illegible]	.20000	20.700	[illegible]	[illegible]
57	2.6380	2.136[illegible]	2.5200	[illegible]	.20000	21.800	[illegible]	[illegible]
58	2.6380	2.1324	[illegible]	[illegible]	.20000	23.400	[illegible]	[illegible]
59	2.6380	2.1508	2.4590	1.0400	.20000	24.500	[illegible]	.97400
60	2.6380	2.1512	[illegible]	1.0400	.20000	25.500	[illegible]	[illegible]
61	2.6380	2.1520	[illegible]	[illegible]	.20000	25.200	[illegible]	[illegible]
62	2.6380	2.1529	2.4100	[illegible]	.20000	26.500	18.[illegible]	.98900
63	2.6380	2.1538	2.4000	[illegible]	.20000	26.300	20.100	.89000
64	2.6380	2.1736	[illegible]	[illegible]	.30000	26.100	21.900	[illegible]
65	2.6380	1.5718	2.3160	1.0500	.30000	26.200	23.700	.92600
66	[illegible]	1.5741	2.2800	[illegible]	.30000	25.700	[illegible]	[illegible]
67	2.5960	1.5703	2.2500	[illegible]	.30000	25.100	27.[illegible]	1.0020
68	[illegible]	1.5695	[illegible]	[illegible]	.60000	24.700	[illegible]	[illegible]
69	2.5960	1.5658	[illegible]	[illegible]	.80000	24.100	30.000	1.1060
70	2.5960	1.5655	2.1700	[illegible]	.90000	23.600	[illegible]	1.1740
71	[illegible]	1.8341	[illegible]	[illegible]	1.1600	22.400	35.900	[illegible]
72	2.6340	1.8291	[illegible]	1.1700	1.4000	21.500	41.[illegible]	1.2250
73	2.9240	2.3120	[illegible]	1.2700	1.7000	20.400	45.[illegible]	1.3350
74	2.8760	2.5815	3.0000	[illegible]	1.7000	19.600	[illegible]	[illegible]

YEAR	[illegible]	BILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	URBAN	[illegible]
50	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51	[illegible]	2.7500	2110.0	[illegible]	[illegible]	6516.0	71.[illegible]	[illegible]
52	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	6171.0	[illegible]	1.[illegible]
53	[illegible]	2.7500	2402.0	1.1[illegible]	10.070	5725.0	74.[illegible]	[illegible]
54	[illegible]	2.7500	[illegible]	1.1[illegible]	10.120	[illegible]	[illegible]	11.[illegible]
55	[illegible]	2.[illegible]	[illegible]	[illegible]	11.320	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible].7500	[illegible]	[illegible]	11.[illegible]	[illegible]	[illegible]	[illegible]
57	[illegible]	2.7500	[illegible]	[illegible]	10.080	[illegible]	82.[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	11.[illegible]	[illegible]	[illegible]	[illegible]
59	[illegible]	2.7500	[illegible]	1.1400	10.[illegible]	6577.0	85.[illegible]	[illegible]
60	[illegible]	2.7500	[illegible]	1.1[illegible]	10.[illegible]	[illegible]	[illegible]	[illegible]
61	[illegible]	2.6700	2567.0	[illegible]	[illegible]	6298.0	[illegible]	[illegible]
62	[illegible]	2.5600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
63	[illegible]	2.5400	2675.0	1.1[illegible]	10.110	6591.0	[illegible]	10.100
64	[illegible]	2.3500	3072.0	1.1[illegible]	9.2400	6051.0	89.[illegible]	11.[illegible]
65	4559.0	2.2500	3247.0	1.1600	9.6400	6415.0	89.[illegible]	11.900
[illegible]	[illegible]	2.2400	3431.0	1.1[illegible]	9.3100	6671.0	90.[illegible]	12.[illegible]
67	5100.0	2.2400	3568.0	1.1[illegible]	10.140	[illegible]	90.[illegible]	[illegible]
68	[illegible]	[illegible].2400	3943.0	1.1[illegible]	10.350	6454.0	[illegible]	[illegible]
69	5881.0	2.2300	4368.0	1.1[illegible]	10.690	6825.0	91.[illegible]	15.400
70	[illegible]	2.1000	[illegible]	1.2700	11.160	6619.0	[illegible]	[illegible]
71	[illegible]	2.0900	4748.0	1.2700	11.330	6228.0	92.700	17.200
72	[illegible]	2.0900	5273.0	1.[illegible]	12.610	6227.0	[illegible]	19.100
73	[illegible]	2.5900	5824.0	1.[illegible]	17.790	5905.0	[illegible]	19.900
74	[illegible]	2.8100	6053.0	1.[illegible]	12.230	6244.0	[illegible]	19.900

[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.30000	13.500	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	2.7700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1000	2.7400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	15.700	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.50000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	2.5100	[illegible]	.30000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.6500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.9500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	[illegible]	1.8400	2.4100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
73	[illegible]	2.3300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
74	[illegible]	2.4000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	DEMAND	BILL 10	[illegible]	NAT GAS	FUEL OIL	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	10.450	6169.0	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	6131.0	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
54	3782.0	2.7500	[illegible]	1.1800	10.820	5122.0	65.800	[illegible]
55	3897.0	2.7500	[illegible]	[illegible]	11.320	6060.0	[illegible]	[illegible]
56	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	68.100	[illegible]
57	4142.0	2.7500	2357.0	1.1700	12.080	6314.0	68.700	[illegible]
58	[illegible]	2.7500	2299.0	1.1700	11.290	[illegible]	69.300	[illegible]
59	4426.0	2.7500	2530.0	1.2000	10.920	6594.0	69.900	[illegible]
60	4570.0	2.7500	[illegible]	[illegible]	10.740	6460.0	[illegible]	[illegible]
61	4747.0	2.6700	[illegible]	[illegible]	10.910	6418.0	71.400	30.000
62	[illegible]	2.5400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
63	4991.0	2.3800	2778.0	1.2400	10.110	7033.0	72.800	[illegible]
64	5112.0	2.2500	[illegible]	1.2400	9.2400	[illegible]	73.600	32.500
65	5208.0	2.2500	3224.0	1.2400	9.6400	6528.0	74.300	34.100
66	5491.0	2.2400	[illegible]	[illegible]	9.8400	[illegible]	75.100	35.100
67	[illegible]	2.2400	3585.0	[illegible]	10.130	[illegible]	75.900	[illegible]
68	[illegible]	2.2400	[illegible]	1.2300	10.750	[illegible]	[illegible]	[illegible]
69	6394.0	2.2300	[illegible]	[illegible]	[illegible]	[illegible]	77.400	[illegible]
70	[illegible]	2.1000	[illegible]	[illegible]	11.160	6620.0	78.200	[illegible]
71	[illegible]	2.0900	[illegible]	1.2200	11.330	6387.0	79.000	[illegible]
72	6955.0	2.0800	[illegible]	[illegible]	12.010	6929.0	[illegible]	41.000
73	6940.0	2.5800	5850.0	1.2500	13.790	5862.0	80.500	42.400
74	6615.0	2.8100	[illegible]	[illegible]	16.230	6615.0	81.300	43.100

D-40

[illegible]

[illegible]	[illegible]	TEB750	AVG [illegible]	AVG [illegible]	SPEC HEAT	WATER [illegible]	[illegible]	[illegible]
50	[illegible]	2.1800	[illegible]	.90000	[illegible]	[illegible]	[illegible]	[illegible]
51	[illegible]	2.1800	[illegible]	[illegible]	.10000	13.[illegible]	[illegible]	[illegible]
52	[illegible]	2.1900	[illegible]	.90000	.10000	18.[illegible]	[illegible]	[illegible]
53	[illegible]	2.1800	[illegible]	.90000	.20000	20.500	[illegible]	[illegible]
54	[illegible]	2.1800	[illegible]	.90000	.20000	[illegible]	[illegible]	[illegible]
55	[illegible]	2.1900	[illegible]	[illegible]	.20000	[illegible]	[illegible]	[illegible]
56	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	[illegible]	2.1800	2.5100	[illegible]	.20000	24.500	[illegible]	[illegible]
58	[illegible]	2.1800	[illegible]	.90000	.20000	[illegible]	[illegible]	[illegible]
59	[illegible]	2.1800	2.4500	[illegible]	.20000	25.900	15.500	[illegible]
60	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
61	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
62	[illegible]	2.1800	[illegible]	[illegible]	.50000	[illegible]	[illegible]	[illegible]
63	2.6400	2.1800	[illegible]	[illegible]	.50000	[illegible]	[illegible]	[illegible]
64	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
65	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	27.100	[illegible]	[illegible]
66	[illegible]	1.5500	[illegible]	[illegible]	1.1000	[illegible]	[illegible]	[illegible]
67	2.5900	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
68	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
69	2.5900	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	2.5900	1.5500	[illegible]	[illegible]	1.9000	[illegible]	[illegible]	[illegible]
71	[illegible]	1.8400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72	[illegible]	1.8400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
73	[illegible]	2.3300	[illegible]	1.6500	[illegible]	24.900	[illegible]	1.3210
74	[illegible]	2.2000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

YEAR	DEMAND	BILL 10	[illegible]	GAS	FUEL OIL	DEG DAYS	UNEMP	[illegible]
[illegible]	[illegible]	.7500	[illegible]	.9000	[illegible]	[illegible]	[illegible]	[illegible]
51	[illegible]	2.7500	[illegible]	.9060	[illegible]	5904.0	[illegible]	17.150
52	4971.0	2.7500	[illegible]	.9000	10.419	6316.0	39.600	18.300
53	5174.0	2.7500	1757.0	1.1300	10.570	6144.0	39.900	17.500
54	5455.0	2.7500	[illegible]	1.1300	10.920	6540.0	40.200	[illegible]
55	[illegible]	2.7500	1738.0	[illegible]	11.720	5540.0	40.400	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	5858.0	[illegible]	[illegible]
57	[illegible]	2.7500	[illegible]	1.1300	12.080	6771.0	[illegible]	[illegible]
58	[illegible]	2.7500	1771.0	1.1400	[illegible]	6270.0	41.300	[illegible]
59	6306.0	2.7500	[illegible]	1.1400	10.920	6851.0	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	1941.0	1.1400	[illegible]	[illegible]	[illegible]	[illegible]
61	[illegible]	2.4700	[illegible]	[illegible]	10.010	6758.0	[illegible]	12.?00
[illegible]	[illegible]	2.5400	[illegible]	[illegible]	10.050	[illegible]	[illegible]	[illegible]
63	2321.0	2.3800	2309.0	1.1800	10.110	7212.0	41.400	13.700
64	[illegible]	2.2500	[illegible]	1.1800	9.2400	6630.0	41.300	14.200
65	8397.0	2.2500	2537.0	1.1300	9.6400	7022.0	41.100	14.700
66	8851.0	2.2400	[illegible]	1.1600	[illegible]	7160.0	[illegible]	15.100
67	9347.0	2.2400	[illegible]	1.1600	10.140	6857.0	[illegible]	[illegible]
[illegible]	[illegible]	2.2400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2301	[illegible]	1.1600	10.610	[illegible]	[illegible]	[illegible]
70	[illegible]	[illegible]	[illegible]	[illegible]	11.160	[illegible]	[illegible]	[illegible]
71	[illegible]	[illegible]	3887.0	1.3700	11.320	7018.0	40.100	[illegible]
72	11532.	[illegible]	[illegible]	[illegible]	12.010	7342.0	[illegible]	[illegible]
73	11517.	[illegible]	[illegible]	1.4700	13.790	[illegible]	[illegible]	[illegible]
[illegible]	11634.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1600	[illegible]	[illegible]	.40000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
52	[illegible]	2.1800	[illegible]	1.1700	.20000	[illegible]	5.5000	[illegible]
54	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55	[illegible]	2.1800	2.2501	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.10000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	40000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	[illegible]	1.8400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.6000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

YEAR	[illegible]	BELL 10	[illegible]	KGR GAS	FUEL OIL	DEG DAYS	[illegible]	[illegible]
50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	6380.0	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	10.610	[illegible]	[illegible]	[illegible]
53	2881.0	2.7500	[illegible]	1.1400	[illegible]	6032.0	15.200	8.5000
54	[illegible]	2.7500	[illegible]	[illegible]	10.820	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
58	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	6710.0	[illegible]	[illegible]
[illegible]	4243.0	2.7500	[illegible]	[illegible]	[illegible]	6804.0	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.3000	[illegible]	1.1800	10.110	7041.0	[illegible]	[illegible]
[illegible]	5110.0	[illegible]	[illegible]	[illegible]	9.2100	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2500	[illegible]	1.1600	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

LIVINGSTON

YEAR	[illegible] 500	TEB750	[illegible]	[illegible] GAS	SPACE HEAT	WATER HEAT	[illegible]	CPI
50	[illegible]	2.1800	[illegible]	[illegible]	.10000	[illegible]	.20000	[illegible]
51	2.6400	2.1800	[illegible]	.97000	.10000	16.430	[illegible]	[illegible]
52	2.6400	2.1800	[illegible]	.98000	.10000	18.300	[illegible]	[illegible]
53	[illegible]	2.1800	2.5700	1.1300	.20000	20.000	[illegible]	[illegible]
54	2.6400	2.1800	2.5200	1.0900	.20000	22.600	[illegible]	[illegible]
55	2.6400	2.1800	[illegible]	1.0400	.20000	23.000	9.1000	.80000
56	[illegible]	2.1800	[illegible]	[illegible]	.20000	[illegible]	11.[illegible]	[illegible]
57	[illegible]	2.1800	2.4500	1.0200	.20000	24.500	12.[illegible]	[illegible]
58	2.6400	2.1800	[illegible]	1.0200	.20000	25.100	14.[illegible]	[illegible]
59	2.6400	2.1800	2.3300	1.0000	.20000	25.800	15.[illegible]	[illegible]
60	[illegible]	2.1800	[illegible]	1.0000	.30000	[illegible]	18.300	[illegible]
61	[illegible]	2.1800	[illegible]	[illegible]	.40000	26.700	18.000	[illegible]
62	[illegible]	2.1800	[illegible]	[illegible]	.50000	27.000	[illegible]	[illegible]
63	2.6400	2.1800	2.2700	1.0000	.50000	27.300	[illegible]	.91700
64	[illegible]	2.1800	[illegible]	.97000	.60000	26.800	[illegible]	[illegible]
65	2.6300	1.5500	2.1700	.97000	.80000	27.100	20.[illegible]	.94500
66	[illegible]	1.5500	2.1400	[illegible]	1.1000	27.100	[illegible]	[illegible]
67	[illegible]	1.5500	2.0900	[illegible]	[illegible]	27.100	[illegible]	[illegible]
68	[illegible]	1.5500	2.0300	.97000	[illegible]	[illegible]	[illegible]	[illegible]
69	[illegible]	1.5500	1.9900	1.0000	1.7000	25.900	22.800	[illegible]
70	[illegible]	1.5500	2.0100	[illegible]	1.9000	26.500	[illegible]	1.1430
71	2.6300	1.8400	2.1500	1.0400	[illegible]	25.900	[illegible]	[illegible]
72	[illegible]	1.8400	2.2700	[illegible]	2.7000	[illegible]	[illegible]	[illegible]
73	2.9200	2.3300	2.4000	[illegible]	3.0000	24.900	[illegible]	1.3310
74	2.8800	2.6000	2.8300	[illegible]	3.4000	21.200	[illegible]	[illegible]

[illegible]	[illegible]	SH 10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	10.570	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.4700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.5600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.3800	[illegible]	[illegible]	10.110	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2500	[illegible]	1.1800	9.2400	[illegible]	[illegible]	[illegible]
65	[illegible]	2.2500	[illegible]	1.1400	9.5400	7037.0	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.2300	4032.0	1.1500	[illegible]	7300.0	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	10125.	2.0900	[illegible]	[illegible]	11.330	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.9800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.5800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.8100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	[illegible]	IEB750	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.19000	[illegible]	[illegible]	[illegible]
51	[illegible]	2.1300	[illegible]	[illegible]	.19000	19.300	[illegible]	[illegible]
52	[illegible]	2.1800	[illegible]	[illegible]	.19000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1300	[illegible]	[illegible]	[illegible]	20.500	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	2.3900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
55	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	[illegible]	2.1800	[illegible]	1.0300	.20000	24.500	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.20000	[illegible]	[illegible]	[illegible]
59	2.6400	2.1800	[illegible]	1.0000	.20000	25.800	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	26.400	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.40000	26.700	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	[illegible]	[illegible]	.50000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.1800	2.1800	1.0300	.50000	27.300	[illegible]	[illegible]
[illegible]	2.6400	2.1800	2.1700	.97000	.60000	26.900	[illegible]	[illegible]
65	2.6400	1.5500	2.0700	[illegible]	.80000	27.100	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	[illegible]	1.1000	[illegible]	[illegible]	[illegible]
67	[illegible]	1.5500	[illegible]	1.0100	1.2000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	1.9200	[illegible]	1.5000	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.5500	[illegible]	1.0000	1.7000	26.900	[illegible]	[illegible]
70	[illegible]	1.5500	[illegible]	1.1600	[illegible]	26.500	[illegible]	[illegible]
71	[illegible]	1.8100	2.0500	[illegible]	2.3000	25.900	[illegible]	[illegible]
[illegible]	[illegible]	1.8400	[illegible]	1.2000	[illegible]	[illegible]	[illegible]	[illegible]
73	[illegible]	[illegible]	[illegible]	1.2200	[illegible]	24.900	[illegible]	[illegible]
74	2.8800	2.6000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

NURRUE

YEAR	DEMAND	BILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	URBAN	POP.
50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51	[illegible]	2.7500	[illegible]	[illegible]	10.550	[illegible]	[illegible]	[illegible]
52	[illegible]	2.7500	[illegible]	[illegible]	10.510	[illegible]	[illegible]	[illegible]
53	[illegible]	[illegible]	1812.0	1.2700	10.570	5722.0	28.800	[illegible]
54	3269.0	2.7500	[illegible]	1.2760	10.920	6134.0	[illegible]	[illegible]
55	[illegible]	[illegible]	1825.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
56	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6178.0	[illegible]	[illegible]
58	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6767.0	[illegible]	[illegible]
59	[illegible]	2.7500	1973.0	1.2700	10.920	6507.0	[illegible]	11.400
60	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
61	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
62	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
63	[illegible]	2.3300	[illegible]	[illegible]	10.110	7033.0	[illegible]	[illegible]
64	[illegible]	2.2500	[illegible]	1.0800	[illegible]	6663.0	[illegible]	12.200
65	4800.0	2.2500	2718.0	[illegible]	9.6400	6528.0	31.200	12.600
66	[illegible]	2.2400	2923.0	1.0100	9.8400	[illegible]	[illegible]	[illegible]
67	[illegible]	2.2400	[illegible]	[illegible]	10.140	[illegible]	32.800	[illegible]
68	[illegible]	2.2400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
69	[illegible]	2.2300	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	6745.0	2.1000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	[illegible]	2.0700	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72	7318.0	2.0800	[illegible]	[illegible]	12.610	[illegible]	[illegible]	[illegible]
73	[illegible]	2.5800	[illegible]	[illegible]	13.796	[illegible]	[illegible]	15.200
74	[illegible]	2.8100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

MONROE

YEAR	TEB 500	TEB750	AVG ELEC	AVG GAS	SPACE HEAT	WATER HEAT	AC	CPI
50	2.6400	2.1800	2.8300	1.1800	0.30000	12.30000	0.0000	.72100
51	2.6400	2.1800	2.7400	1.0900	0.30000	15.10000	1.8000	.77800
52	2.6400	2.1800	2.7000	1.0500	0.30000	17.20000	3.7000	.79500
53	2.6400	2.1800	2.6600	1.0500	0.20000	19.00000	5.5000	.80100
54	2.6400	2.1800	2.6100	1.0400	0.20000	20.90000	7.3000	.80500
55	2.6400	2.1800	2.6000	1.0300	0.20000	21.10000	9.1000	.80200
56	2.6400	2.1800	2.5900	0.9600	0.20000	21.50000	11.0000	.81400
57	2.6400	2.1800	2.6100	0.9600	0.10000	21.90000	12.8000	.84300
58	2.6400	2.1800	2.5400	0.9500	0.10000	22.90000	14.6000	.86600
59	2.6400	2.1800	2.5100	0.9200	0.10000	23.90000	16.5000	.87300
60	2.6400	2.1800	2.4800	0.8800	0.10000	24.90000	18.3000	.88600
61	2.6400	2.1800	2.4700	0.9200	0.10000	25.40000	18.8000	.89600
62	2.6400	2.1800	2.4500	1.1700	0.20000	25.90000	19.3000	.90600
63	2.6400	2.1800	2.4400	1.1300	0.20000	26.30000	19.8000	.91700
64	2.6400	2.1800	2.4200	1.1200	0.30000	26.40000	20.3000	.92900
65	2.6400	1.5500	2.3500	1.0600	0.40000	27.70000	20.8000	.94500
66	2.5900	1.5500	2.3100	1.0300	0.50000	28.00000	21.3000	.97200
67	2.5900	1.5500	2.2600	1.0100	0.80000	28.80000	21.8000	1.0000
68	2.5900	1.5500	2.2000	0.9900	1.10000	29.60000	22.3000	1.0420
69	2.5900	1.5500	2.1600	0.9900	1.50000	29.80000	22.8000	1.0980
70	2.5900	1.5500	2.1700	1.0600	2.00000	30.00000	23.3000	1.1630
71	2.6300	1.8400	2.2700	1.0800	2.80000	29.80000	26.4000	1.2130
72	2.6300	1.8400	2.3800	1.1700	3.70000	29.90000	29.6000	1.2530
73	2.9200	2.3300	2.5200	1.3000	4.30000	29.20000	32.7000	1.3310
74	2.8800	2.6000	2.9300	1.3500	4.50000	29.40000	35.9000	1.4770

[illegible]

YEAR	DEMAND	BILL 10	INCOME	NAT GAS	FUEL OIL	DEG DAYS	URBAN	[illegible]
50	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	6454.0	[illegible]	[illegible]
51	1929.0	2.7500	2947.0	.92000	10.550	6405.0	97.900	10.500
52	1759.0	2.7500	[illegible]	[illegible]	10.610	6081.0	[illegible]	[illegible]
53	2087.0	2.7500	2287.0	.96000	10.570	5248.0	97.100	11.900
54	2211.0	2.7500	2144.0	.98000	10.820	6110.0	97.100	10.500
55	2227.0	2.7500	2312.0	.99000	11.220	6005.0	[illegible]	10.000
56	2449.0	2.7500	[illegible]	1.0030	11.620	5792.0	[illegible]	[illegible]
57	2534.0	2.7500	2232.0	1.0010	12.580	6361.0	[illegible]	[illegible]
58	2581.0	2.7500	2292.0	1.0600	11.200	6503.0	[illegible]	[illegible]
59	2701.0	2.7500	2338.0	1.0500	10.820	6423.0	97.400	23.500
60	2757.0	2.7500	2492.0	1.0200	10.330	6493.0	[illegible]	[illegible]
61	2877.0	2.6700	[illegible]	1.0200	10.010	6317.0	97.500	[illegible]
62	2960.0	2.5600	[illegible]	[illegible]	10.380	6671.0	[illegible]	[illegible]
63	3055.0	2.3800	2794.0	1.0500	10.110	6724.0	97.700	32.500
64	3218.0	2.2500	3015.0	1.0400	9.2400	6248.0	97.900	[illegible]
65	3373.0	2.2500	3311.0	1.0600	9.6400	6371.0	97.800	33.300
66	3655.0	2.2400	3519.0	1.0400	9.8100	6578.0	97.900	33.900
67	3884.0	2.2400	3690.0	1.0600	10.110	6484.0	98.000	34.200
68	4125.0	2.2100	4030.0	1.0600	10.750	6277.0	98.100	34.700
69	4531.0	2.2300	4321.0	1.0600	10.610	6512.0	98.100	35.200
70	4842.0	2.1000	4442.0	1.0900	11.140	6541.0	98.200	35.600
71	5088.0	2.0900	4753.0	1.0500	11.330	6190.0	98.300	36.000
72	5231.0	2.0800	5258.0	1.1700	12.010	6783.0	98.300	36.500
73	5563.0	2.5000	5982.0	1.2000	12.790	5205.0	98.400	36.900
74	5280.0	2.8100	6476.0	1.2400	16.230	6310.0	98.500	37.300

WATER

50	2.6400	[illegible]	[illegible]	[illegible]	.10000	[illegible]	[illegible]	[illegible]
51	[illegible]	2.1800	[illegible]	[illegible]	.10000	2.2000	[illegible]	[illegible]
52	[illegible]	2.1800	[illegible]	[illegible]	.10000	2.5000	[illegible]	[illegible]
53	[illegible]	2.1800	[illegible]	.96000	.10000	[illegible]	[illegible]	[illegible]
54	[illegible]	2.1800	[illegible]	.95000	.15000	[illegible]	[illegible]	[illegible]
55	[illegible]	2.1800	[illegible]	[illegible]	.10000	[illegible]	[illegible]	[illegible]
56	[illegible]	2.1800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	[illegible]	2.1800	[illegible]	.82000	[illegible]	3.0000	[illegible]	[illegible]
58	2.6400	2.1800	[illegible]	[illegible]	.20000	3.4300	[illegible]	[illegible]
59	2.6400	2.1800	2.9800	[illegible]	.20000	3.5000	11.[illegible]	[illegible]
60	2.6400	2.1800	2.7100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
61	2.6400	2.1800	2.9100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
62	2.6400	2.1800	[illegible]	[illegible]	.10000	[illegible]	[illegible]	[illegible]
63	2.6400	2.1800	2.8700	[illegible]	[illegible]	4.2000	[illegible]	.09000
64	2.6400	2.1800	2.9400	[illegible]	.10000	4.3000	[illegible]	[illegible]
65	2.6400	1.5500	2.7700	.92000	.10000	4.5000	[illegible]	[illegible]
66	2.5900	1.5500	2.7800	[illegible]	.10000	[illegible]	[illegible]	[illegible]
67	2.5900	1.5500	2.6700	.92000	.20000	[illegible]	20.[illegible]	1.[illegible]
68	2.5900	1.5500	2.6100	.91000	.20000	[illegible]	[illegible]	[illegible]
69	2.5900	1.5500	2.8500	[illegible]	.30000	[illegible]	[illegible]	[illegible]
70	2.5900	1.5500	2.5600	[illegible]	.40000	[illegible]	[illegible]	[illegible]
71	2.3300	1.8400	2.8100	.95000	.50000	5.2000	[illegible]	[illegible]
72	[illegible]	1.8400	[illegible]	1.0000	[illegible]	[illegible]	[illegible]	[illegible]
73	2.9100	2.3300	2.7300	1.0700	.80000	1.2000	37.[illegible]	1.2450
74	2.3300	2.6000	[illegible]	[illegible]	.80000	[illegible]	[illegible]	1.4910

CONSUMERS POWER

YEAR	DEMAND	BILL 10	INCOME	MAR GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.0000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.0000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	2346.0	2.0000	[illegible]	[illegible]	13.570	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.0000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.0000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.0000	[illegible]	[illegible]	10.250	7309.0	[illegible]	[illegible]
[illegible]	4443.0	2.0000	[illegible]	[illegible]	[illegible]	7307.0	[illegible]	[illegible]
[illegible]	[illegible]	1.9800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1.7600	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.0200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

DETROIT EDISON

YEAR	DEMAND	BILL 10	INCOME	MAR GAS	FUEL OIL	DEG DAYS	URBAN	MULTIUNIT
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	3143.0	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
58	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
59	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
60	[illegible]	2.7500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
61	3593.0	2.6700	[illegible]	[illegible]	[illegible]	6317.0	[illegible]	[illegible]
62	[illegible]	2.5400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
63	[illegible]	2.3800	[illegible]	[illegible]	10.310	6724.0	[illegible]	[illegible]
64	4001.0	2.2500	[illegible]	[illegible]	9.2490	[illegible]	[illegible]	[illegible]
65	[illegible]	2.2500	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
66	[illegible]	2.2400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
67	[illegible]	2.2100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
68	5145.0	2.2400	[illegible]	[illegible]	10.250	[illegible]	[illegible]	[illegible]
69	5500.0	2.2200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	5378.0	2.1000	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	[illegible]	2.0900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72	[illegible]	2.0800	5125.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
73	[illegible]	2.5800	[illegible]	[illegible]	[illegible]	5905.0	[illegible]	[illegible]
74	6278.0	2.8100	[illegible]	[illegible]	[illegible]	6310.0	[illegible]	[illegible]

Weighting Factors For Company Level Gas Prices

YEAR	CPC CPC	CPC MIC	DET CPC	DET MICO	DET MIC	[illegible]	[illegible]
50	.71010	.28990	.22050	[illegible]	3.28000E-02	[illegible]	[illegible]
51	.65930	.31070	.22690	[illegible]	[illegible]	4.27000E-02	[illegible]
52	[illegible]	.30720	[illegible]	[illegible]	[illegible]	4.21000E-02	[illegible]
53	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
54	[illegible]	[illegible]	.25010	[illegible]	[illegible]	[illegible]	[illegible]
55	[illegible]	.30120	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
56	.69990	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
57	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
58	.70200	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
59	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
60	[illegible]	.29620	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
61	.70400	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
62	.70260	[illegible]	.30100	[illegible]	[illegible]	[illegible]	[illegible]
63	.70150	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
64	.70140	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
65	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
66	.70310	.29690	.32710	[illegible]	[illegible]	[illegible]	[illegible]
67	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.68000E-02	[illegible]
68	.70360	.29640	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
69	[illegible]	.29620	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
71	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
72	.70480	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
73	.70190	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
74	.70460	.29540	[illegible]	.51060	[illegible]	[illegible]	[illegible]

Prices for 10 Mcf of Natural Gas Per Month

YEAR	CONSUMERS POWER COMPANY	MICHIGAN CONSOLIDATED GAS COMPANY*	DETROIT DIVISION*	SOUTHEASTERN MICHIGAN GAS CO.	MICHIGAN GAS UTILITIES CO.
50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
51	9.9500	[illegible]	9.6400	12.500	[illegible]
52	9.9500	11.640	9.6400	12.500	[illegible]
53	11.450	11.840	9.6400	13.760	[illegible]
54	11.450	11.840	9.8400	13.760	[illegible]
55	11.450	11.540	[illegible]	13.760	12.560
56	11.450	11.700	9.9900	13.760	[illegible]
57	11.450	11.700	9.9950	13.300	[illegible]
58	11.450	11.700	[illegible]	13.300	[illegible]
59	11.450	11.500	10.270	13.300	[illegible]
60	11.450	[illegible]	[illegible]	13.300	11.210
61	11.450	12.550	10.880	13.300	[illegible]
62	12.050	12.550	10.380	13.300	[illegible]
63	11.810	12.450	10.600	13.300	10.250
64	11.810	12.450	10.600	13.300	10.910
65	11.630	12.450	10.600	13.300	10.300
66	11.630	12.320	10.600	13.300	10.010
67	11.630	12.320	10.600	13.300	9.8700
68	11.630	12.350	10.600	13.300	9.8700
69	11.630	12.320	10.600	13.300	9.8700
70	13.680	12.770	10.850	13.300	11.400
71	13.680	12.220	10.500	13.300	11.100
72	13.930	12.820	11.690	14.050	[illegible]
73	14.750	[illegible]	[illegible]	[illegible]	[illegible]
74	14.750	[illegible]	12.570	[illegible]	15.170

* The Michigan Consolidated Gas Company figures are exclusive of Detroit. Detroit Division figures are for the Detroit Division of Michigan Consolidated Gas Company.

Consumers Power Individual Customer Data Definitions

DIVISION	Division number.
ACCT. NO.	Account number.
KWH	Annual consumption for 1976.
HOME2	Second home indicator.
STOVE	Type of cooking range.
	1 - None
	2 - Other
	3 - Natural gas
	4 - Bottled gas
	5 - Electric and gas combination
	6 - Electric
MICRO OVEN	Microwave oven indicator
	1 - No
	2 - Yes
FRIDGE	Type of refrigerator.
	1 - None
	2 - Other
	3 - Electric with one door
	4 - Electric with two doors (manual defrost)
	5 - Electric with two doors (frostfree)
FRIDGE2	Second refrigerator.
	1 - No
	2 - Yes

HOUSE TYPE	Type of dwelling unit.
	1 - Resort cottage or cabin
	2 - Mobile home
	3 - Apartment
	4 - Condomium
	5 - Two-family duplex
	6 - Single-family home
TRASH	Type of trash disposal.
	1 - None
	2 - Other incinerator
	3 - Natural gas incinerator
	4 - Electric incinerator
	5 - Trash masher/compactor
AGE	Age of dwelling.
	0 - Don't know
	1 - Less than 2 years
	2 - 2 to 5 years
	3 - 6 to 10 years
	4 - 11 to 20 years
	5 - Over 20 years
ROOMS	Number of rooms excluding halls, bathrooms, and unfinished rooms.
FAMILY	Number of persons living in this household.
	1 - One
	2 - Two

FAMILY (contd.)	3 - Three
	4 - Four
	5 - Five
	6 - Six
	7 - Seven or more
	8 - None (entered as a missing observation)
INCOME	Range of income.
	1 - Under $4,000
	2 - $4,000 - 6,999
	3 - $7,000 - 7,999
	4 - $10,000 - 14,999
	5 - $15,000 - 19,999
	6 - $20,000 - 24,999
	7 - $25,000 - 49,999
	8 - $50,000 and up
FARM	Farm indicator.
SEASONAL	Seasonal indicator
	1 - Year round
	2 - Seasonal
INSULATION	Thickness of insulation in attic or ceiling.
	1 - Less than 2 inches
	2 - At least 2 but less than 4 inches.
	3 - At least 4 but less than 6 inches
	4 - 6 inches or more
	5 - None
CENTS/KWH	An average price of electricity over the entire year for this customer where the total revenue figure is the total kWh times the flat rate, plus 12 times the service charge. No allowance made for fuel cost adjustment.

AC	Central air conditioning type.
	1 - None
	2 - Furnished by landlord
	3 - Other
	4 - Electric
WATER	Type of water heating.
	1 - None
	2 - Furnished by landlord
	3 - Don't know
	4 - Natural gas
	5 - Bottled gas
	6 - Other
	7 - Electric
WASHER	Type of clothes washer.
	1 - None
	2 - Laundry room in apartment building
	3 - Other
	4 - Portable
	5 - Nonautomatic
	6 - Automatic
DRYER	Type of clothes dryer.
	1 - None
	2 - Laundry room in apartment building
	3 - Other
	4 - Natural gas
	5 - Electric

FREEZER	Type of separate freezer. 1 - None 2 - Other 3 - Upright (manual defrost) 4 - Upright (frost-proof) 5 - Chest 6 - Two or more
DISHWASHER	Type of dishwasher. 1 - None 2 - Portable 3 - Built-in
DISPOSAL	Indicator for electric garbage disposal. 1 - No 2 - Yes
SPACE	Principal fuel for heating. 1 - None 2 - Don't know 3 - Provided by landlord 4 - Natural gas 5 - Bottled gas 6 - Fuel oil 7 - Other 8 - Electric

Detroit Edison Individual Customer Data Definitions

INTERVIEW	Interview number for customer.
STOVE	Type of cooking range.
	0 - None
	1 - Other
	2 - Gas
	3 - Electric
FREEZER	Separate food freezer.
	1 - No
	2 - Yes
DRYER	Type of automatic clothes dryer.
	1 - None
	2 - Gas
	3 - Electric
AC	Type of air conditioning.
	1 - None
	2 - One window unit
	3 - Two or more window units
	4 - Central
HOUSE HEAD	Head of household.
	1 - Male
	2 - Female
	3 - Both male and female head present
	4 - Other

FAMILY	Number of persons in household.
ADULTS	Number of residents 18 years or older.
TEENS	Number of residents 6 through 17 years.
KIDS	Number of residents under 6 years old.
AGE HEAD	Age of head of household. 1 - Under 25 years 2 - 25 through 34 3 - 35 through 44 4 - 45 through 54 5 - 55 through 64 6 - 65 and over 7 - Don't know or refused
OCC HEAD	Occupation of head of household. 1 - Professional/Technical 2 - Official/Business Owner 3 - Clerical/Sales Worker 4 - Skilled Worker/Laborer 5 - Operative/Kindred Worker 6 - Service Worker/Laborer 7 - Welfare, ADC, etc. 8 - Retired 9 - Unemployed/Disabled 0 - Refused (or don't know)

TYPE HOUSE	Type of house.
	1 - Single family house
	2 - Two to four family house
	3 - Trailer
	4 - Duplex, terrace, or townhouse
	5 - Apartment in multiple apartment building
	6 - Other
OWNER	Whether house owner-occupied.
	1 - Own
	2 - Rent
ROOMS	Number of rooms, excluding bathroom.
INCOME	Income range.
	0 - Don't know or refused
	1 - $0 through 4,999
	2 - $5,000 through 9,999
	3 - $10,000 through 14,999
	4 - $15,000 through 24,999
	5 - $25,000 plus
DISTRICT	District Number
TOWN	Town code.
ZIP CODE	Last three digits of zip code.
RATE 1	Rate classes broken down into six classes.
USE NOWH	Average monthly use exclusive of special water heating.
USE GROUP	Group based on usage at 50 kWh intervals

USE WH	Average monthly use in special water heating accounts.
ERRATIC	Erratic use code.
CREDIT	Credit code.
CPA	Central postal area.
CPA TYPE	Type 1 or 2 CPA.
DETROIT	Whether or not in city of Detroit.
DIVISION	Division number.
RATE	Rate class broken down into three classes.
WH CODE	Capacity of electric water heater on special rate and indication of separately metered water heating.
KWH	Annual consumption for customers in 1973.
REVENUE	Annual revenues for customer in 1973.
CENTS/KWH	Revenue divided by KWH.
COMPLETE	Code for completeness of data, 0 if complete

APPENDIX E

REGIONAL TIME SERIES REGRESSIONS

APPENDIX E

REGIONAL TIME-SERIES REGRESSIONS

This appendix presents detailed regression results for four different regional time-series models. The first model is the one that best meets all the requirements of this study. From it, long-run and short-run elasticity estimates may be inferred. Like the other three models, it is based upon modeling the logarithms of all the data. The other features distinguishing it are the use of marginal prices (based on the 10 percent electricity prices and 10 Mcf gas prices) and the inclusion of a lagged dependent variable. All of the regressions in this appendix include an income variable, an electricity price variable of some kind, and one or more alternative fuel price variables. The alternative fuel price variable which is most statistically significant is included, and if two appear to have about the same significance, both are included. Certain regions where weather conditions appear more significant also include a heating degree day variable.

The second set of regional regressions is similar to the first except average prices are used rather than marginal prices. This set is included for the client's benefit so the effects of the bias resulting from the use of average prices are clear. As discussed in Volume 1, the use of average price variables has major shortcomings and should not be considered when other alternatives are available.

The third set of regressions uses the same marginal prices as the first set, but does not include a lagged dependent variable. This model does not separate short-term and long-term effects, but is more useful as a forecasting tool because all of its independent variables can be forecasted without reference to the dependent variable. Two other variables sometimes enter these equations -- percent urbanization and/or percent multiunit housing. As is clear from the regression results, these two variables pick up a good portion of the explanatory ability of the omitted lagged dependent variable. Most of the remaining power is picked up by the other variables because they no longer represent short run effects but more of an average effect. This set of regressions is not comparable to the first set *per se*, but does represent the specification with the best statistical properties which does not include a lagged dependent variable, thereby giving an indication of what inclusion of the lagged dependent variable does to the results.

The fourth set of regressions is identical to the third except average prices are used rather than marginal. As before, little faith should be put in these because average price is utilized. They are included only at the client's request so that they may be compared to other studies which commonly use average prices where the data required to calculate marginal prices are not usually available.

Regression results are reported for each model for each of the 24 regions for which data were collected. The following index indicates which table contains regression results for each particular model.

INDEX OF REGRESSION TABLE NUMBERS

	Model			
	Using Marginal Price		Using Average Price	
Region	Lagged Dependent Variable	No Lagged Dependent Variable	Lagged Dependent Variable	No Lagged Dependent Variable
CENTRAL	1	49	25	73
BATTLE CREEK	2	50	26	74
NORTHEAST	3	51	27	75
FLINT	4	52	28	76
GRAND RAPIDS	5	53	29	77
JACKSON	6	54	30	78
KALAMAZOO	7	55	31	79
LANSING	8	56	32	80
MUSKEGON	9	57	33	81
SAGINAW	10	58	34	82
NORTHWEST	11	59	35	83
HURON	12	60	36	84
LAPEER	13	61	37	85
SANILAC	14	62	38	86
ST. CLAIR	15	63	39	87
TUSCOLA	16	64	40	88
OAKLAND	17	65	41	89
MACOMB	18	66	42	90
WASHTENAW	19	67	43	91
LENAWEE	20	68	44	92
LIVINGSTON	21	69	45	93
INGHAM	22	70	46	94
MONROE	23	71	47	95
WAYNE	24	72	48	96

Table E-1

Regional Time Series Regressions

CENTRAL

EQUATION

$$DEMAND = 1.899*ELECTRICITY^{-.21335}*INCOME^{.052113}*FUEL\ OIL^{.087699}*DEMAND(-1)^{.87278}$$

R-SQUARED = .99748

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED =	.99695	RESIDUAL SUM SQUARE =	.0049546
STANDARD ERROR =	.016148	F-RATIO =	1,879.7
DEPENDENT MEAN =	8.3243	DEGREES OF FREEDOM =	19

STANDARD ERROR AS % MEAN DEMAND = .19399

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.21335	.92750E-01	-.11043	-2.3003	5.2914
INCOME	.52113E-01	.58091E-01	.29890E-01	.89709	.80478
FUEL OIL	.87699E-01	.55475E-01	.44011E-01	1.5809	2.4992
DEMAND(-1)	.87278	.28454E-01	.90703	30.674	940.87

Table E-2

Regional Time Series Regressions

BATTLE CREEK

EQUATION

$$DEMAND = 2.782*ELECTRICITY^{-.25164}*INCOME^{.02359}*FUEL\ OIL^{.068143}*DEMAND(-1)^{.86374}$$

R-SQUARED = .99838

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99804
STANDARD ERROR = .012078
DEPENDENT MEAN = 8.4719
STANDARD ERROR AS % MEAN DEMAND = .14256

RESIDUAL SUM SQUARE = .0027716
F-RATIO = 2,936.3
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.25164	.70102E-01	-.13940	-3.5897	12.886
INCOME	.23593E-01	.42818E-01	.15848E-01	.55100	.30360
FUEL OIL	.68143E-01	.42232E-01	.36600E-01	1.6135	2.6035
DEMAND(-1)	.86374	.26899E-01	.88483	32.110	1031.0

Table E-3

Regional Time Series Regressions

NORTHEAST

EQUATION

$$DEMAND = 1.376*ELECTRICITY^{-.12843}*INCOME^{.08355}*GAS^{.11332}*DEMAND(-1)^{.89506}$$

R-SQUARED = .99772

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99724
STANDARD ERROR = .016806
DEPENDENT MEAN = 8.2255
STANDARD ERROR AS % MEAN DEMAND = .20432

RESIDUAL SUM SQUARE = .0053666
F-RATIO = 2,075.3
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.12843	.86445E-01	-.60795E-01	-1.4857	2.2072
INCOME	.83550E-01	.59952E-01	.48706E-01	1.3936	1.9421
GAS	.11332	.72492E-01	.34803E-01	1.5633	2.4438
DEMAND(-1)	.89506	.29072E-01	.92668	30.788	947.88

Table E-4

Regional Time Series Regressions

FLINT

EQUATION

$$DEMAND = 0.208*ELECTRICITY^{-.16494}*INCOME^{.17565}*GAS^{.22914}*DEGREE\ DAYS^{.16623}*DEMAND(-1)^{.85797}$$

R-SQUARED = .99832

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99785
STANDARD ERROR = .014254
DEPENDENT MEAN = 8.4775
STANDARD MEAN AS % MEAN DEMAND = .16814

RESIDUAL SUM SQUARE = .0036574
F-RATIO = 2,133.8
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.16494	.66837E-01	-.81223E-01	-2.4677	6.0897
INCOME	.17565	.62564E-01	.87257E-01	2.8075	7.8818
GAS	.22914	.60246E-01	.73209E-01	3.8034	14.466
DEGREE DAYS	.16623	.75102E-01	.26389E-01	2.2133	4.8987
DEMAND(-1)	.85797	.28360E-01	.90045	30.253	915.22

Table E-5

Regional Time Series Regressions

GRAND RAPIDS

EQUATION

$$DEMAND = 1.601*ELECTRICITY^{-.24254}*INCOME^{.081303}*GAS^{.18347}*DEMAND(-1)^{.88662}$$

R-SQUARED = .99754

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99702
STANDARD ERROR = .017592
DEPENDENT MEAN = 8.3191
STANDARD ERROR AS % MEAN DEMAND = .21146

RESIDUAL SUM SQUARE = .00588
F-RATIO = 1,925.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.24254	.80651E-01	-.11336	-3.0072	9.0435
INCOME	.81303E-01	.79397E-01	.39582E-01	1.0240	1.0486
GAS	.18347	.73023E-01	.83882E-01	2.5125	6.3125
DEMAND(-1)	.88662	.34412E-01	.93053	25.765	663.82

Table E-6

Regional Time Series Regressions

JACKSON

EQUATION

$$DEMAND = 2.425*ELECTRICITY^{-.19787}*INCOME^{.043267}*FUEL\ OIL^{.038016}*GAS^{.029189}*DEMAND(-1)^{.86612}$$

R-SQUARED = .99842

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99798
STANDARD ERROR = .013196
DEPENDENT MEAN = 8.5282
STANDARD ERROR AS % MEAN DEMAND = .15473

RESIDUAL SUM SQUARE = .0031345
F-RATIO = 2,270.1
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.19787	.80269E-01	-.10205	-2.4651	6.0768
INCOME	.43267E-01	.43828E-01	.30985E-01	.98718	.97453
FUEL OIL	.38016E-01	.46458E-01	.19010E-01	.81828	.66958
GAS	.29189E-01	.56615E-01	.97668E-02	.51557	.26581
DEMAND(-1)	.86612	.26947E-01	.89909	32.142	1033.1

Table E-7

Regional Time Series Regressions

KALAMAZOO

EQUATION

$$DEMAND = 4.047*ELECTRICITY^{-.23063}*INCOME^{.000055891}*GAS^{.092507}*DEMAND(-1)^{.85685}$$

R-SQUARED = .99739

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99684
STANDARD ERROR = .014943
DEPENDENT MEAN = 8.4837
STANDARD ERROR AS % MEAN DEMAND = .17614

RESIDUAL SUM SQUARE = .0042426
F-RATIO = 1,816.2
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.23063	.73938E-01	-.13123	-3.1193	9.7299
INCOME	.55891E-04	.54440E-01	.37341E-04	.10267E-02	.10540E-05
GAS	.92507E-01	.65035E-01	.34150E-01	1.4224	2.0233
DEMAND(-1)	.85685	.30516E-01	.90327	28.078	788.39

Table E-8

Regional Time Series Regressions

LANSING

EQUATION

$$DEMAND = 2.722*ELECTRICITY^{-.25498}*INCOME^{.056878}*FUEL\ OIL^{.050989}*GAS^{.076856}*DEMAND(-1)^{.84194}$$

R-SQUARED = .99814

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99762
STANDARD ERROR = .015152
DEPENDENT MEAN = 8.6161
STANDARD ERROR AS % MEAN DEMAND = .17585

RESIDUAL SUM SQUARE = .0041324
F-RATIO = 1,930.3
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.25498	.89391E-01	-.12419	-2.8524	8.1362
INCOME	.56878E-01	.49897E-01	.37022E-01	1.1399	1.2994
FUEL OIL	.50989E-01	.52224E-01	.24079E-01	.97635	.95326
GAS	.76856E-01	.64403E-01	.24285E-01	1.1934	1.4241
DEMAND(-1)	.84194	.26233E-01	.88976	32.095	1030.1

Table E-9

Regional Time Series Regressions

MUSKEGON

EQUATION

$$DEMAND = 0.949*ELECTRICITY^{-0.06167}*INCOME^{0.092541}*GAS^{0.092822}*DEMAND(-1)^{0.92688}$$

R-SQUARED = .99688

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99623
STANDARD ERROR = .018914
DEPENDENT MEAN = 8.3119
STANDARD ERROR AS % MEAN DEMAND = .22755

RESIDUAL SUM SQUARE = .006797
F-RATIO = 1,519.6
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.61671E-01	.94215E-01	-.30301E-01	-.65457	.42847
INCOME	.92541E-01	.80222E-01	.47330E-01	1.1536	1.3307
GAS	.92822E-01	.70627E-01	.44415E-01	1.3143	1.7273
DEMAND(-1)	.92688	.35290E-01	.96770	26.265	689.84

Table E-10

Regional Time Series Regressions

SAGINAW

EQUATION

$$DEMAND = 0.4298*ELECTRICITY^{-.24966}*INCOME^{.090004}*GAS^{.15885}*DEGREE\ DAYS^{.1825}*DEMAND(-1)^{.8454}$$

R-SQUARED = .99845

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99802
STANDARD ERROR = .015256
DEPENDENT MEAN = 3.38
STANDARD ERROR AS % MEAN DEMAND = .18205

RESIDUAL SUM SQUARE = .0041892
F-RATIO = 2,315.8
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.24966	.71701E-01	-.11028	-3.4820	12.124
INCOME	.90004E-01	.51928E-01	.52359E-01	1.7332	3.0041
GAS	.15885	.66199E-01	.45521E-01	2.3996	5.7579
DEGREE DAYS	.18250	.83912E-01	.22329E-01	2.1749	4.7300
DEMAND(-1)	.84540	.28800E-01	.88399	29.354	861.68

Table E-11

Regional Time Series Regressions

NORTHWEST

EQUATION

$$DEMAND = 0.464*ELECTRICITY^{-.16828}*INCOME^{.12388}*FUEL\ OIL^{.17386}*GAS^{.11861}*DEMAND(-1)^{.94366}$$

R-SQUARED = .99643

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99544
STANDARD ERROR = .022202
DEPENDENT MEAN = 8.2558
STANDARD ERROR AS % MEAN DEMAND = .26892

RESIDUAL SUM SQUARE = .0088724
F-RATIO = 1,005.4
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.16828	.14248	-.77439E-01	-1.1811	1.3950
INCOME	.12388	.94195E-01	.77334E-01	1.3152	1.7296
FUEL OIL	.17386	.90984E-01	.77573E-01	1.9109	3.6515
GAS	.11861	.10880	.53157E-01	1.0901	1.1884
DEMAND(-1)	.94366	.43158E-01	.97029	21.865	478.09

Table E-12

Regional Time Series Regressions

HURON

EQUATION

$$DEMAND = 4.404 * ELECTRICITY^{-.08623} * INCOME^{-.008476} * FUEL\ OIL^{-.040802} * DEMAND(-1)^{.85932}$$

R-SQUARED = .99592

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99506
STANDARD ERROR = .019705
DEPENDENT MEAN = 8.5354
STANDARD ERROR AS % MEAN DEMAND = .23086

RESIDUAL SUM SQUARE = .0073774
F-RATIO = 1,158.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.86233E-01	.76217E-01	-.78369E-01	-1.1314	1.2801
INCOME	-.84760E-02	.52416E-01	-.92123E-02	-.16171	.26149E-01
FUEL OIL	-.40802E-01	.77183E-01	-.21359E-01	-.52864	.27946
DEMAND(-1)	.85932	.46842E-01	.91346	18.345	336.54

Table E-13

Regional Time Series Regressions

LAPEER

EQUATION

$$DEMAND = 0.4388*ELECTRICITY^{-.097831}*INCOME^{.066631}*FUEL\ OIL^{.032635}*DEGREE\ DAYS^{.15980}*DEMAND(-1)^{.87807}$$

R-SQUARED = .99897

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99869
STANDARD ERROR = .01296
DEPENDENT MEAN = 8.6306
STANDARD ERROR AS % MEAN DEMAND = .15016

RESIDUAL SUM SQUARE = .0030231
F-RATIO = 3,496
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.97831E-01	.50612E-01	-.69707E-01	-1.9330	3.7363
INCOME	.66631E-01	.55197E-01	.33683E-01	1.2072	1.4572
FUEL OIL	.32635E-01	.44936E-01	.13394E-01	.72625	.52744
DEGREE DAYS	.15980	.61092E-01	.21807E-01	2.6157	6.8419
DEMAND(-1)	.87807	.24096E-01	.91201	36.440	1327.9

Table E-14

Regional Time Series Regressions

SANILAC

EQUATION

$$DEMAND = 3.772*ELECTRICITY^{-.098839}*INCOME^{-.060355}*FUEL\ OIL^{.015218}*DEMAND(-1)^{.91142}$$

R-SQUARED = .99666

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99596
STANDARD ERROR = .020026
DEPENDENT MEAN = 8.6155
STANDARD ERROR AS % MEAN DEMAND = .23244

RESIDUAL SUM SQUARE = .0076199
F-RATIO = 1,417.1
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.98839E-01	.80629E-01	-.79941E-01	-1.2259	1.5027
INCOME	-.60355E-01	.75792E-01	-.40835E-01	-.79632	.63413
FUEL OIL	.15218E-01	.76484E-01	.70900E-02	.19898	.39592E-01
DEMAND(-1)	.91142	.37432E-01	.96719	24.349	592.86

Table E-15

Regional Time Series Regressions

ST. CLAIR

EQUATION

$$DEMAND = 4.609*ELECTRICITY^{-.14526}*INCOME^{.025796}*FUEL\ OIL^{.0045222}*DEMAND(-1)^{.81538}$$

R-SQUARED = .99763

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99713
STANDARD ERROR = .015689
DEPENDENT MEAN = 8.4783
STANDARD ERROR AS % MEAN DEMAND = .18504

RESIDUAL SUM SQUARE = .0046765
F-RATIO = 2,000.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.14526	.66767E-01	-.12629	-2.1757	4.7335
INCOME	.25796E-01	.58579E-01	.18487E-01	.44037	.19392
FUEL OIL	.45222E-02	.55858E-01	.22646E-02	.80957E-01	.65541E-02
DEMAND(-1)	.81538	.29559E-01	.86497	27.585	760.95

Table E-16

Regional Time Series Regressions

TUSCOLA

EQUATION

$$DEMAND = 3.131*ELECTRICITY^{-.09274}*INCOME^{-.050085}*FUEL\ OIL^{.008869}*DEMAND(-1)^{.92541}$$

R-SQUARED = .9982

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99782
STANDARD ERROR = .016922
DEPENDENT MEAN = 8.5995
STANDARD ERROR AS % MEAN DEMAND = .19678

RESIDUAL SUM SQUARE = .0054407
F-RATIO = 2,636.6
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.92740E-01	.69095E-01	-.65126E-01	-1.3422	1.8015
INCOME	-.50085E-01	.57756E-01	-.36062E-01	-.86719	.75201
FUEL OIL	.88690E-02	.66421E-01	.35876E-02	.13353	.17829E-01
DEMAND(-1)	.92541	.31054E-01	.97478	29.800	888.06

Table E-17

Regional Time Series Regressions

OAKLAND

EQUATION

$$DEMAND = 1.713*ELECTRICITY^{-.07026}*INCOME^{.072907}*GAS^{.071035}*DEMAND(-1)^{.87654}$$

R-SQUARED = .99646

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99571
STANDARD ERROR = .02165
DEPENDENT MEAN = 8.5311
STANDARD ERROR AS % MEAN DEMAND = .25377

RESIDUAL SUM SQUARE = .0089054
F-RATIO = 1,335.5
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.70260E-01	.70516E-01	-.53250E-01	-.99636	.99274
INCOME	.72907E-01	.84248E-01	.36981E-01	.86538	.74888
GAS	.71035E-01	.88435E-01	.20652E-01	.80325	.64520
DEMAND(-1)	.87654	.38645E-01	.92998	22.682	514.47

Table E-18

Regional Time Series Regressions

MACOMB

EQUATION

$$DEMAND = 10.99*ELECTRICITY^{-0.12759}*INCOME^{-0.042636}*FUEL\ OIL^{-0.17639}*DEMAND(-1)^{0.82452}$$

R-SQUARED = .99698

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99635
STANDARD ERROR = .0193
DEPENDENT MEAN = 8.3508
STANDARD ERROR AS % MEAN DEMAND = .23112

RESIDUAL SUM SQUARE = .0070775
F-RATIO = 1,569.3
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.12759	.78132E-01	-.10009	-1.6331	2.6669
INCOME	-.42636E-01	.10164	-.20703E-01	-.41948	.17596
FUEL OIL	-.17639	.71406E-01	-.76182E-01	-2.4703	6.1023
DEMAND(-1)	.82452	.45241E-01	.85321	18.225	332.16

Table E-19

Regional Time Series Regressions

WASHTENAW

EQUATION

$$DEMAND = 1.692*ELECTRICITY^{-.14553}*INCOME^{.088656}*GAS^{.22041}*DEMAND(-1)^{.8676}$$

R-SQUARED = .9963

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99552
STANDARD ERROR = .016341
DEPENDENT MEAN = 8.5051
STANDARD ERROR AS % MEAN DEMAND = .19213

RESIDUAL SUM SQUARE = .0050736
F-RATIO = 1,277.6
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.14553	.56680E-01	-.15189	-2.5677	6.5929
INCOME	.88656E-01	.68219E-01	.64147E-01	1.2996	1.6889
GAS	.22041	.67697E-01	.13310	3.2559	10.601
DEMAND(-1)	.86760	.49145E-01	.91344	17.654	311.66

Table E-20

Regional Time Series Regressions

LENAWEE

EQUATION

$$DEMAND = 4.934*ELECTRICITY^{-.10933}*INCOME^{.046084}*GAS^{-.08847}*DEMAND(-1)^{.79931}$$

R-SQUARED = .99588

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99501
STANDARD ERROR = .021015
DEPENDENT MEAN = 8.9506
STANDARD ERROR AS % MEAN DEMAND = .23479

RESIDUAL SUM SQUARE = .0083912
F-RATIO = 1,148.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.10933	.75623E-01	-.93564E-01	-1.4457	2.0899
INCOME	.46045E-01	.73772E-01	.32939E-01	.62428	.38972
GAS	-.88478E-01	.89280E-01	-.29186E-01	-.99102	.98211
DEMAND(-1)	.79931	.39667E-01	.85557	20.150	406.04

Table E-21

Regional Time Series Regressions

LIVINGSTON

EQUATION

$$DEMAND = 2.567*ELECTRICITY^{-.06434}*INCOME^{.054679}*FUEL\ OIL^{-.058144}*GAS^{-.070199}*DEMAND(-1)^{.86892}$$

R-SQUARED = .99811

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99759
STANDARD ERROR = .018402
DEPENDENT MEAN = 8.4893
STANDARD ERROR AS % MEAN DEMAND = .21677

RESIDUAL SUM SQUARE = .0060957
F-RATIO = 1,903.8
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.64340E-01	.78800E-01	-.43730E-01	-.81649	.66666
INCOME	.54679E-01	.57440E-01	.26585E-01	.95193	.90617
FUEL OIL	-.58144E-01	.61684E-01	-.22764E-01	-.94262	.88853
GAS	-.70199E-01	.76935E-01	-.18390E-01	-.91244	.83254
DEMAND(-1)	.86892	.33198E-01	.89900	26.173	685.05

Table E-22

Regional Time Series Regressions

INGHAM

EQUATION

$$DEMAND = 4.511*ELECTRICITY^{-.045613}*INCOME^{.03324}*FUEL\ OIL^{-.14821}*DEMAND(-1)^{.84951}$$

R-SQUARED = .99667

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99597
STANDARD ERROR = .02245
DEPENDENT MEAN = 8.8058
STANDARD ERROR AS % MEAN DEMAND = .25495

RESIDUAL SUM SQUARE = .0095763
F-RATIO = 1,421.5
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.45613E-01	.93702E-01	-.32857E-01	-.48678	.23696
INCOME	.33240E-01	.92335E-01	.16932E-01	.35999	.12959
FUEL OIL	-.14821	.81585E-01	-.61496E-01	-1.8166	3.3000
DEMAND(-1)	.84951	.39300E-01	.89736	21.616	467.25

Table E-23

Regional Time Series Regressions

MONROE

EQUATION

$$DEMAND = 6.970*ELECTRICITY^{-.14892}*INCOME^{0.011125}*FUEL\ OIL^{-.11966}*DEMAND(-1)^{.81499}$$

R-SQUARED = .99815

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99776
STANDARD ERROR = .015381
DEPENDENT MEAN = 8.4222
STANDARD ERROR AS % MEAN DEMAND = .18262

RESIDUAL SUM SQUARE = .0044948
F-RATIO = 2,565.9
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.14892	.63388E-01	-.11471	-2.3493	5.5194
INCOME	.11125E-01	.66881E-01	.75716E-02	.16634	.27670E-01
FUEL OIL	-.11966	.56688E-01	-.50744E-01	-2.1108	4.4554
DEMAND(-1)	.81499	.39756E-01	.83592	20.500	420.23

Table E-24

Regional Time Series Regressions

WAYNE

EQUATION

$$DEMAND = 2.787*ELECTRICITY^{-.22888}*INCOME^{.10671}*GAS^{.10175}*DEMAND(-1)^{.79686}$$

R-SQUARED = .99685

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99619
STANDARD ERROR = .021044
DEPENDENT MEAN = 8.0718
STANDARD ERROR AS % MEAN DEMAND = .26071

RESIDUAL SUM SQUARE = .0084143
F-RATIO = 1,502.6
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.22888	.78552E-01	-.16827	-2.9137	8.4896
INCOME	.10671	.88412E-01	.57843E-01	1.2069	1.4567
GAS	.10175	.85859E-01	.36168E-01	1.1851	1.4045
DEMAND(-1)	.79686	.49956E-01	.81245	15.951	254.44

Table E-25

Regional Time Series Model Using Average Price

CENTRAL

EQUATION

$$DEMAND = 8.4376*AVG\ ELECTRICITY^{-0.3962}*INCOME^{0.0041968}*FUEL\ OIL^{0.0087512}*AVG\ GAS^{0.13112}*DEMAND(-1)^{0.78229}$$

R-SQUARED = .99877

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99843
STANDARD ERROR = .011586
DEPENDENT MEAN = 8.3243
STANDARD ERROR AS % MEAN DEMAND = .13918

RESIDUAL SUM SQUARE = .002416
F-RATIO = 2,925.3
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.39620	.82748E-01	-.24054	-4.7881	22.926
INCOME	.41968E-02	.41856E-01	.24071E-02	.10027	.10054E-01
FUEL OIL	.87512E-02	.37869E-01	.43917E-02	.23109	.53401E-01
AVG GAS	.13112	.74629E-01	.49958E-01	1.7569	3.0868
DEMAND(-1)	.78229	.28616E-01	.81299	27.337	747.31

Table E-26

Regional Time Series Model Using Average Price

BATTLE CREEK

EQUATION

$$DEMAND = 6.824*AVG\ ELECTRICITY^{-0.28432}*INCOME^{-0.0026042}*FUEL\ OIL^{-0.0031957}*DEMAND(-1)^{0.81011}$$

R-SQUARED = .9991

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99891
STANDARD ERROR = .0090162
DEPENDENT MEAN = 8.4719
STANDARD ERROR AS % MEAN DEMAND = .10643

RESIDUAL SUM SQUARE = .0015446
F-RATIO = 5,272.7
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.28432	.45992E-01	-.17666	-6.1819	38.216
INCOME	-.26042E-02	.32041E-01	-.17493E-02	-.81277E-01	.66059E-02
FUEL OIL	-.31957E-02	.25022E-01	-.17164E-02	-.12771	.16310E-01
DEMAND(-1)	.81011	.23450E-01	.82989	34.547	1193.5

Table E-27

Regional Time Series Model Using Average Price

NORTHEAST

EQUATION

$$DEMAND = 8.0591*AVG\ ELECTRICITY^{-0.37562}*INCOME^{-0.017044}*AVG\ GAS^{0.098202}*DEMAND(-1)^{0.80752}$$

R-SQUARED = .99875

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99849
STANDARD ERROR = .012427
DEPENDENT MEAN = 8.2255
STANDARD ERROR AS % MEAN DEMAND = .15107

RESIDUAL SUM SQUARE = .0029339
F-RATIO = 3,799.9
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.37562	.84197E-01	-.21116	-4.4612	19.902
INCOME	-.17044E-01	.39775E-01	-.99361E-02	-.42851	.18362
AVG GAS	.98202E-01	.65062E-01	.35665E-01	1.5094	2.2782
DEMAND(-1)	.80752	.28089E-01	.83605	28.749	826.48

Table E-28

Regional Time Series Model Using Average Price

FLINT

EQUATION

$$DEMAND = 1.0823*AVG\ ELECTRICITY^{-0.31762}*INCOME^{0.05962}*AVG\ GAS^{0.14645}*DEGREE\ DAYS^{0.15173}*DEMAND(-1)^{0.81063}$$

R-SQUARED = .99782

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99722
STANDARD ERROR = .016202
DEPENDENT MEAN = 8.4775
STANDARD ERROR AS % MEAN DEMAND = .19112

RESIDUAL SUM SQUARE = .0047253
F-RATIO = 1,650.8
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.31762	.10871	-.17873	-2.9217	8.5366
INCOME	.59620E-01	.71039E-01	.29618E-01	.83925	.70434
AVG GAS	.14645	.87468E-01	.59270E-01	1.6744	2.8035
DEGREE DAYS	.15173	.87706E-01	.24089E-01	1.7300	2.9930
DEMAND(-1)	.81063	.38609E-01	.85077	20.996	440.82

Table E-29

Regional Time Series Model Using Average Price

GRAND RAPIDS

EQUATION

$$DEMAND = 8.604*AVG\ ELECTRICITY^{-0.49562}*INCOME^{0.045807}*AVG\ GAS^{0.26112}*DEMAND(-1)^{0.75755}$$

R-SQUARED = .99868

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .9984
STANDARD ERROR = .012883
DEPENDENT MEAN = 8.3191
STANDARD ERROR AS % MEAN DEMAND = .15486

RESIDUAL SUM SQUARE = .0031534
F-RATIO = 3,594.3
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.49562	.74343E-01	-.27475	-6.6667	44.445
INCOME	.45807E-01	.52866E-01	.22301E-01	.86647	.75078
AVG GAS	.26112	.57547E-01	.98733E-01	4.5375	20.589
DEMAND(-1)	.75755	.31357E-01	.79507	24.159	583.65

Table E-30

Regional Time Series Model Using Average Price

JACKSON

EQUATION

$$DEMAND = 6.1172*AVG\ ELECTRICITY^{-0.27553}*INCOME^{0.011146}*FUEL\ OIL^{-0.0145}*AVG\ GAS^{0.032118}*DEMAND(-1)^{0.81276}$$

R-SQUARED = .99906

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .9988
STANDARD ERROR = .010171
DEPENDENT MEAN = 8.5282
STANDARD ERROR AS % MEAN DEMAND = .11926

RESIDUAL SUM SQUARE = .0018621
F-RATIO = 3,823.6
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.27553	.74659E-01	-.15895	-3.6905	13.620
INCOME	.11146E-01	.33217E-01	.79818E-02	.33554	.11259
FUEL OIL	-.14500E-01	.32515E-01	-.72510E-02	-.44594	.19887
AVG GAS	.32118E-01	.61688E-01	.12196E-01	.52066	.27109
DEMAND(-1)	.81276	.25600E-01	.84370	31.749	1008.0

Table E-31

Regional Time Series Model Using Average Price

KALAMAZOO

EQUATION

$$DEMAND = 8.556*AVG\ ELECTRICITY^{-0.23377}*INCOME^{-0.042684}*AVG\ GAS^{-0.055209}*DEMAND(-1)^{0.81589}$$

R-SQUARED = .99807

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99766
STANDARD ERROR = .012857
DEPENDENT MEAN = 8.4837
STANDARD ERROR AS % MEAN DEMAND = .15155

RESIDUAL SUM SQUARE = .0031407
F-RATIO = 2,455.1
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.23377	.85778E-01	-.14914	-2.7257	7.4293
INCOME	-.42694E-01	.46014E-01	-.28517E-01	-.92762	.86048
AVG GAS	-.55209E-01	.70063E-01	-.24775E-01	-.78799	.62093
DEMAND(-1)	.81589	.29575E-01	.86009	27.587	761.05

Table E-32

Regional Time Series Model Using Average Price

LANSING

EQUATION

$$DEMAND = 5.9174*AVG\ ELECTRICITY^{-0.2414}*INCOME^{0.019957}*FUEL\ OIL^{0.0027935}*AVG\ GAS^{-0.034605}*DEMAND(-1)^{0.80328}$$

R-SQUARED = .99868

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99832
STANDARD ERROR = .012745
DEPENDENT MEAN = 8.6161
STANDARD ERROR AS % MEAN DEMAND = .14792

RESIDUAL SUM SQUARE = .0029238
F-RATIO = 2,729.7
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL F
AVG ELEC	-.24140	.85148E-01	-.13452	-2.8351	8.0379
INCOME	.19957E-01	.42603E-01	.12990E-01	.46845	.21944
FUEL OIL	.27935E-02	.42094E-01	.13192E-02	.6636E-01	.44041E-02
AVG GAS	-.34605E-01	.78274E-01	-.13091E-01	-.44209	.19545
DEMAND(-1)	.80328	.25916E-01	.84890	30.995	960.70

Table E-33

Regional Time Series Model Using Average Price

MUSKEGON

EQUATION

$$DEMAND = 4.583*AVG\ ELECTRICITY^{-0.3548}*INCOME^{0.077037}*AVG\ GAS^{0.19506}*DEMAND(-1)^{0.78797}$$

R-SQUARED = .99911

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99892
STANDARD ERROR = .010113
DEPENDENT MEAN = 8.3119
STANDARD ERROR AS % MEAN DEMAND = .12167

RESIDUAL SUM SQUARE = .0019432
F-RATIO = 5,327.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL F
AVG. ELEC	-.35480	.53725E-01	-.21088	-6.6041	43.614
INCOME	.77037E-01	.38065E-01	.39400E-01	2.0238	4.0959
AVG GAS	.19506	.40330E-01	.77189E-01	4.8365	23.391
DEMAND(-1)	.78797	.25718E-01	.82267	30.639	938.75

Table E-34

Regional Time Series Model Using Average Price

SAGINAW

EQUATION

$$DEMAND = 2.5816*AVG\ ELECTRICITY^{-0.32856}*INCOME^{0.0012536}*AVG\ GAS^{0.04807}*DEGREE\ DAYS^{0.11777}*DEMAND(-1)^{0.80122}$$

R-SQUARED = .99844

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .998
STANDARD ERROR = .015303
DEPENDENT MEAN = 8.38
STANDARD ERROR AS % MEAN DEMAND = .18261

RESIDUAL SUM SQUARE = .0042154
F-RATIO = 2,301.4
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.32856	.10747	-.18074	-3.0571	9.3457
INCOME	.12536E-02	.52969E-01	.72926E-03	.23667E-01	.56011E-03
AVG GAS	.48074E-01	.85105E-01	.16505E-01	.56488	.31909
DEGREE DAYS	.11777	.84608E-01	.14409E-01	1.3919	1.9375
DEMAND(-1)	.80122	.35633E-01	.83780	22.486	505.60

Table E-35

Regional Time Series Model Using Average Price

NORTHWEST

EQUATION

$$DEMAND = 3.8489*AVG\ ELECTRICITY^{-0.32956}*INCOME^{0.05777}*FUEL\ OIL^{0.10041}*AVG\ GAS^{0.0056132}*DEMAND(-1)^{0.79269}$$

R-SQUARED = .99827

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99779
STANDARD ERROR = .015468
DEPENDENT MEAN = 8.2558
STANDARD ERROR AS % MEAN DEMAND = .18737

RESIDUAL SUM SQUARE = .0043069
F-RATIO = 2,074.9
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.32956	.69567E-01	-.19681	-4.7373	22.442
INCOME	.57770E-01	.57453E-01	.36064E-01	1.0055	1.0111
FUEL OIL	.10014	.44534E-01	.44680E-01	2.2486	5.0562
AVG GAS	.56132E-02	.67001E-01	.20804E-02	.83778E-01	.70187E-02
DEMAND(-1)	.79269	.38047E-01	.81506	20.935	434.08

Table E-36

Regional Time Series Model Using Average Price

HURON

EQUATION

$$DEMAND = 6.9386*AVG\ ELECTRICITY^{-0.20935}*INCOME^{-0.0055151}*FUEL\ OIL^{-0.0042475}*DEMAND(-1)^{0.80317}$$

R-SQUARED = .99667

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99596
STANDARD ERROR = .017806
DEPENDENT MEAN = 8.5354
STANDARD ERROR AS % MEAN DEMAND = .20862

RESIDUAL SUM SQUARE = .0060241
F-RATIO = 1,419.7
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.20935	.86658E-01	-.15304	-2.4158	5.8361
INCOME	-.55151E-02	.36649E-01	-.55942E-02	-.15048	.22645E-01
FUEL OIL	-.42475E-02	.66440E-01	-.22235E-02	-.63930E-01	.40870E-02
DEMAND(-1)	.80317	.49163E-01	.85377	16.337	266.89

Table E-37

Regional Time Series Model Using Average Price

LAPEER

EQUATION

$$DEMAND = 1.4585*AVG\ ELECTRICITY^{-0.24244}*INCOME^{0.050368}*FUEL\ OIL^{0.058071}*DEGREE\ DAYS^{0.10421}*DEMAND(-1)^{0.81716}$$

R-SQUARED = .99928

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99908
STANDARD ERROR = .010813
DEPENDENT MEAN = 8.6306
STANDARD ERROR AS % MEAN DEMAND = .12529

RESIDUAL SUM SQUARE = .0021047
F-RATIO = 5,023.1
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.24244	.66677E-01	-.15002	-3.6361	13.221
INCOME	.50368E-01	.42492E-01	.25462E-01	1.1854	1.4051
FUEL OIL	.58071E-01	.37654E-01	.23834E-01	1.5422	2.3784
DEGREE DAYS	.10421	.52847E-01	.14221E-01	1.9682	3.8738
DEMAND(-1)	.81716	.28605E-01	.84875	28.567	816.10

Table E-38

Regional Time Series Model Using Average Price

SANILAC

EQUATION

$$DEMAND = 7.6248*AVG\ ELECTRICITY^{-0.25972}*INCOME^{-0.085164}*FUEL\ OIL^{0.05821}*DEMAND(-1)^{0.85297}$$

R-SQUARED = .99734

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99678
STANDARD ERROR = .017877
DEPENDENT MEAN = 8.6155
STANDARD ERROR AS % MEAN DEMAND = .20750

RESIDUAL SUM SQUARE = .0060723
F-RATIO = 1,779.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.25972	.10013	-.17594	-2.5938	6.7280
INCOME	-.85164E-01	.56268E-01	-.57621E-01	-1.5136	2.2908
FUEL OIL	.58210E-01	.67632E-01	.27119E-01	.86069	.74078
DEMAND(-1)	.85297	.41621E-01	.90517	20.494	420.00

Table E-39

Regional Time Series Model Using Average Price

ST. CLAIR

EQUATION

$$DEMAND = 11.974 * AVG\ ELECTRICITY^{-0.33304} * INCOME^{0.020112} * FUEL\ OIL^{0.013172} * DEMAND(-1)^{0.72371}$$

R-SQUARED = .9982

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99782
STANDARD ERROR = .013692
DEPENDENT MEAN = 8.4783
STANDARD ERROR AS % MEAN DEMAND = .16149

RESIDUAL SUM SQUARE = .0035618
F-RATIO = 2,627.9
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.33304	.95501E-01	-.22879	-3.4873	12.161
INCOME	.20112E-01	.44308E-01	.144131E-01	.45391	.20603
FUEL OIL	.13172E-01	.45344E-01	.65960E-02	.29048	.84381E-01
DEMAND(-1)	.72371	.40552E-01	.76772	17.846	318.49

Table E-40

Regional Time Series Model Using Average Price

TUSCOLA

EQUATION

$$DEMAND = 6.0587*AVG\ ELECTRICITY^{-0.25143}*INCOME^{-0.043383}*FUEL\ OIL^{0.039753}*DEMAND(-1)^{0.84833}$$

R-SQUARED = .99875

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99849
STANDARD ERROR = .014107
DEPENDENT MEAN = 8.5995
STANDARD ERROR AS % MEAN DEMAND = .16404

RESIDUAL SUM SQUARE = .0037811
F-RATIO = 3,796
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.25143	.76045E-01	-.15263	-3.3064	10.932
INCOME	-.43383E-01	.35086E-01	-.31236E-01	-1.2365	1.5289
FUEL OIL	.39753E-01	.50148E-01	.16080E-01	.79271	.62839
DEMAND(-1)	.84833	.35041E-01	.89358	24.209	586.10

Table E-41

Regional Time Series Model Using Average Price

OAKLAND

EQUATION

$$DEMAND = 5.148*AVG\ ELECTRICITY^{-0.142}*INCOME^{0.021055}*AVG\ GAS^{-0.12329}*DEMAND(-1)^{0.80928}$$

R-SQUARED = .99761

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99711
STANDARD ERROR = .017774
DEPENDENT MEAN = 8.5311
STANDARD ERROR AS % MEAN DEMAND = .20835

RESIDUAL SUM SQUARE = .0060027
F-RATIO = 1,983.6
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.14200	.11202	-.88450E-01	-1.2676	1.6068
INCOME	.21055E-01	.59725E-01	.10680E-01	.35253	.12428
AVG GAS	-.12329	.93956E-01	-.48872E-01	-1.3122	1.7218
DEMAND(-1)	.80928	.45917E-01	.85861	17.625	310.64

Table E-42

Regional Time Series Model Using Average Price

MACOMB

EQUATION

$$DEMAND = 26.86 * AVG\ ELECTRICITY^{-0.29004} * INCOME^{-0.031296} * FUEL\ OIL^{-0.19724} * DEMAND(-1)^{0.73214}$$

R-SQUARED = .99789

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99744
STANDARD ERROR = .016148
DEPENDENT MEAN = 8.3508
STANDARD ERROR AS % MEAN DEMAND = .19337

RESIDUAL SUM SQUARE = .0049543
F-RATIO = 2,243.9
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELECTRICITY	-.29004	.83895E-01	-.18270	-3.4572	11.953
INCOME	-.31296E-01	.73543E-01	-.15197E-01	-.42555	.18109
FUEL OIL	-.19724	.55048E-01	-.85185E-01	-3.5831	12.838
DEMAND(-1)	.73214	.49595E-01	.75762	14.762	217.92

Table E-43

Regional Time Series Model Using Average Price

WASHTENAW

EQUATION

$$DEMAND = 44.984*AVG\ ELECTRICITY^{-0.56434}*INCOME^{-0.01252}*AVG\ GAS^{0.20333}*DEMAND(-1)^{0.63014}$$

R-SQUARED = .99833

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99798
STANDARD ERROR = .010973
DEPENDENT MEAN = 8.5051
STANDARD ERROR AS % MEAN DEMAND = .12901

RESIDUAL SUM SQUARE = .0022876
F-RATIO = 2,839.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.56434	.75330E-01	-.45081	-7.4915	56.123
INCOME	-.12520E-01	.42480E-01	-.90591E-02	-.29474	.86869E-01
AVG GAS	.20333	.48291E-01	.11240	4.2106	17.729
DEMAND(-1)	.63014	.43071E-01	.66343	14.630	214.04

Table E-44

Regional Time Series Model Using Average Price

LENAWEE

EQUATION

$$DEMAND = 16.371 * AVG\ ELECTRICITY^{-0.37572} * INCOME^{0.03983} * AVG\ GAS^{0.085461} * DEMAND(-1)^{0.6889}$$

R-SQUARED = .99705

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99643
STANDARD ERROR = .017789
DEPENDENT MEAN = 8.9506
STANDARD ERROR AS % MEAN DEMAND = .19875

RESIDUAL SUM SQUARE = .0060126
F-RATIO = 1,604.5
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.37572	.13246	-.26967	-2.8364	8.0453
INCOME	.39830E-01	.53362E-01	.28479E-01	.74642	.55714
AVG GAS	.85461E-01	.10883	.31991E-01	.78524	.61660
DEMAND(-1)	.68890	.51285E-01	.73740	13.440	180.63

Table E-45

Regional Time Series Model Using Average Price

LIVINGSTON

EQUATION

$$DEMAND = 16.478*AVG\ ELECTRICITY^{-0.45167}*INCOME^{-.012763}*FUEL\ OIL^{-0.012011}*AVG\ GAS^{0.089947}*DEMAND(-1)^{0.7362}$$

R-SQUARED = .99913

24 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99889
STANDARD ERROR = .012471
DEPENDENT MEAN = 8.4893
STANDARD ERROR AS % MEAN DEMAND = .14690

RESIDUAL SUM SQUARE = .0027994
F-RATIO = 4,149.8
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.45167	.89029E-01	-.27084	-5.0733	25.738
INCOME	-.12763E-01	.38160E-01	-.62054E-02	-.33447	.11187
FUEL OIL	-.12011E-01	.47030E-01	-.47024E-02	-.25539	.65225E-01
AVG GAS	.89947E-01	.50488E-01	.31359E-01	1.7815	3.1739
DEMAND(-1)	.73620	.35834E-01	.76169	20.545	422.08

Table E-46

Regional Time Series Model Using Average Price

INGHAM

EQUATION

$$DEMAND = 19.131*AVG\ ELECTRICITY^{-0.35744}*INCOME^{-0.048193}*FUEL\ OIL^{-0.02203}*DEMAND(-1)^{0.75323}$$

R-SQUARED = .99834

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99799
STANDARD ERROR = .015842
DEPENDENT MEAN = 8.8058
STANDARD ERROR AS % MEAN DEMAND = .17990

RESIDUAL SUM SQUARE = .0047685
F-RATIO = 2,859.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.35744	.80671E-01	-.22386	-4.4309	19.633
INCOME	-.48193E-01	.51690E-01	-.24549E-01	-.93235	.86927
FUEL OIL	-.22030E-01	.57445E-01	-.91413E-02	-.38351	.14708
DEMAND(-1)	.75323	.34779E-01	.79565	21.658	469.05

Table E-47

Regional Time Series Model Using Average Price

MONROE

EQUATION

$$DEMAND = 13.472*AVG\ ELECTRICITY^{-0.28076}*INCOME^{0.030111}*FUEL\ OIL^{-0.12447}*DEMAND(-1)^{0.7344}$$

R-SQUARED = .99876

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .9985
STANDARD ERROR = .012585
DEPENDENT MEAN = 8.4222
STANDARD ERROR AS % MEAN DEMAND = .14943

RESIDUAL SUM SQUARE = .0030094
F-RATIO = 3,834.8
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.28076	.66883E-01	-.18267	-4.1978	17.622
INCOME	.30111E-01	.48687E-01	.20493E-01	.61846	.38249
FUEL OIL	-.12447	.42989E-01	-.52787E-01	-2.8955	8.3837
DEMAND(-1)	.73440	.40520E-01	.75327	18.124	328.49

Table E-48

Regional Time Series Model Using Average Price

WAYNE

EQUATION

$$DEMAND = 4.7899*AVG\ ELECTRICITY^{-0.35675}*INCOME^{0.14481}*AVG\ GAS^{0.095807}*DEMAND(-1)^{0.71409}$$

R-SQUARED = .99686

24 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .9962		RESIDUAL SUM SQUARE	= .0083734
STANDARD ERROR = .020993		F-RATIO	= 1,510
DEPENDENT MEAN = 8.0718		DEGREES OF FREEDOM	= 19

STANDARD ERROR AS % MEAN DEMAND = .26008

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.35675	.12330	-.22998	-2.8933	8.3711
INCOME	.14481	.81504E-01	.78498E-01	1.7767	3.1568
AVG GAS	.95807E-01	.87230E-01	.35201E-01	1.0983	1.2063
DEMAND(-1)	.71409	.64643E-01	.72807	11.047	122.03

Table E-49

Regional Time Series Model Excluding a Lagged Dependent Variable

CENTRAL

EQUATION

$$DEMAND = 0.0001*ELECTRICITY^{-0.49788}*INCOME^{-0.022385}*FUEL\ OIL^{0.52938}*URBAN^{4.8327}$$

R-SQUARED = .9902

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .98824
STANDARD ERROR = .033957
DEPENDENT MEAN = 8.2988
STANDARD ERROR AS % MEAN DEMAND = .40917

RESIDUAL SUM SQUARE = .023061
F-RATIO = 505.33
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.49788	.18587	-.25165	-2.6787	7.1754
INCOME	-.22385E-01	.11832	-.13090E-01	-.18920	.35795E-01
FUEL OIL	.52938	.12323	.25385	4.2961	18.456
URBAN	4.8327	.34003	.99315	14.213	202.00

Table E-50

Regional Time Series Model Excluding a Lagged Dependent Variable

BATTLE CREEK

EQUATION

$$DEMAND - 1.72E11*ELECTRICITY^{-0.41115}*INCOME^{-0.10398}*FUEL\ OIL^{0.33908}*URBAN^{-4.0238}*MULTIUNIT^{-0.46093}$$

R-SQUARED = .99412

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99257
STANDARD ERROR = .024884
DEPENDENT MEAN = 8.4501
STANDARD ERROR AS % MEAN DEMAND = .29448

RESIDUAL SUM SQUARE = .011765
F-RATIO = 642.33
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.41115	.13650	-.22542	-3.0121	9.0725
INCOME	-.10398	.13657	-.66483E-01	-.76138	.57970
FUEL OIL	.33908	.909695E-01	.17637	3.7386	13.977
URBAN	-4.0238	.39025	-.93827	-10.311	106.32
MULTIUNIT	-.46093	.66720E-01	-.17378	-6.9084	47.726

Table E-51

Regional Time Series Model Excluding a Lagged Dependent Variable

NORTHEAST

EQUATION

$$\text{DEMAND} = 0.00001 * \text{ELECTRICITY}^{-0.64494} * \text{INCOME}^{0.21263} * \text{FUEL OIL}^{0.39731} * \text{URBAN}^{4.544}$$

R-SQUARED = .98794

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .98553
STANDARD ERROR = .040834
DEPENDENT MEAN = 8.1992
STANDARD ERROR AS % MEAN DEMAND = .49802

RESIDUAL SUM SQUARE = .033348
F-RATIO = 409.6
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.64494	.24138	-.30076	-2.6719	7.1392
INCOME	.21263	.14058	.12260	1.5125	2.2876
FUEL OIL	.39731	.14849	.17577	2.6757	7.1593
URBAN	4.5440	.37464	.75763	12.129	147.11

Table E-52

Regional Time Series Model Excluding a Lagged Dependent Variable

FLINT

EQUATION

$$DEMAND = 0.00001*ELECTRICITY^{-1.1074}*INCOME^{0.90137}*FUEL\ OIL^{0.26663}*URBAN^{7.2535}$$

R-SQUARED = .96723

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .96068
STANDARD ERROR = .065009
DEPENDENT MEAN = 8.4515
STANDARD ERROR AS % MEAN DEMAND = .76920

RESIDUAL SUM SQUARE = .084524
F-RATIO = 147.59
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-1.1074	.31739	-.53467	-3.4889	12.173
INCOME	.90137	.23240	.43899	3.8784	15.042
FUEL OIL	.26663	.23385	.12213	1.1402	1.3000
URBAN	7.2535	1.1514	.30278	6.2999	39.689

Table E-53

Regional Time Series Model Excluding a Lagged Dependent Variable

GRAND RAPIDS

EQUATION

$$DEMAND = 12.604*ELECTRICITY^{-0.48937}*INCOME^{0.4492}*GAS^{-0.4982}*URBAN^{0.64165}$$

R-SQUARED = .99302

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99162
STANDARD ERROR = .031369
DEPENDENT MEAN = 8.2923
STANDARD ERROR AS % MEAN DEMAND = .37829

RESIDUAL SUM SQUARE = .01968
F-RATIO = 711.01
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.48937	.13441	-.22605	-3.6410	13.257
INCOME	.44920	.13839	.20757	3.2458	10.535
GAS	-.49820	.12096	-.22083	-4.1187	16.964
URBAN	.64165	.44731E-01	.43754	14.345	205.77

Table E-54

Regional Time Series Model Excluding a Lagged Dependent Variable

JACKSON

EQUATION

$$DEMAND = 0.00001*ELECTRICITY^{-0.82301}*INCOME^{0.9658}*FUEL\ OIL^{0.22858}*URBAN^{12.741}$$

R-SQUARED = .96541

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .95849
STANDARD ERROR = .063669
DEPENDENT MEAN = 8.5036
STANDARD ERROR AS % MEAN DEMAND = .74873

RESIDUAL SUM SQUARE = .081074
F-RATIO = 139.54
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.82301	.34614	-.41689	-2.3777	5.6535
INCOME	.96580	.21197	.65460	4.5564	20.760
FUEL OIL	.22858	.22847	.10984	1.0005	1.0010
URBAN	12.741	2.3180	.28620	5.4966	30.213

Table E-55

Regional Time Series Model Excluding a Lagged Dependent Variable

KALAMAZOO

EQUATION

$$DEMAND = 0.00001*ELECTRICITY^{-0.54373}*INCOME^{-0.26484}*FUEL\ OIL^{0.31672}*GAS^{0.20733}*URBAN^{6.2692}$$

R-SQUARED = .99466

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99325
STANDARD ERROR = .023386
DEPENDENT MEAN = 8.4606
STANDARD ERROR AS % MEAN DEMAND = .27641

RESIDUAL SUM SQUARE = .010391
F-RATIO = 707.46
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.54373	.13619	-.30233	-3.9923	15.939
INCOME	-.26484	.91666E-01	-.16965	-2.8891	8.3472
FUEL OIL	.31672	.85471E-01	.16707	3.7056	13.731
GAS	.20733	.10045	.71582E-01	2.0640	4.2599
URBAN	6.2692	.34699	1.0728	18.068	326.44

Table E-56

Regional Time Series Model Excluding a Lagged Dependent Variable

LANSING

EQUATION

$$DEMAND = 0.00001*ELECTRICITY^{-0.50937}*INCOME^{0.096626}*FUEL\ OIL^{0.42873}*URBAN^{14.857}*MULTIUNIT^{-0.37688}$$

R-SQUARED = .99306

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99123
STANDARD ERROR = .031385
DEPENDENT MEAN = 8.588
STANDARD ERROR AS % MEAN DEMAND = .36546

RESIDUAL SUM SQUARE = .018716
F-RATIO = 543.44
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.50937	.18021	-.24060	-2.8266	7.9894
INCOME	.96626E-01	.11602	.62842E-01	.83283	.69361
FUEL OIL	.42873	.11379	.19212	3.7677	14.196
URBAN	14.857	1.1878	.99858	12.507	156.44
MULTIUNIT	-.37688	.51707E-01	-.20727	-7.2887	53.125

Table E-57

Regional Time Series Model Excluding a Lagged Dependent

MUSKEGON

EQUATION

$$DEMAND = 3.20E09*ELECTRICITY^{-0.19956}*INCOME^{0.65727}*GAS^{-0.9405}*URBAN^{-0.41442}*DEGREE\ DAYS^{0.4368}$$

R-SQUARED = .99222

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99018
STANDARD ERROR = .032418
DEPENDENT MEAN = 8.2865
STANDARD ERROR AS % MEAN DEMAND = .39121

RESIDUAL SUM SQUARE = .019967
F-RATIO = 484.88
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.19956	.15789	-.96570E-01	-1.2639	1.5974
INCOME	.65727	.14734	.32407	4.4608	19.898
GAS	-.94050	.11736	-.43675	-8.0138	64.221
URBAN	-.41442	.30569E-01	-.35271	-13.557	183.79
DEGREE DAYS	.43680	.13643	.84871E-01	3.2016	10.250

Table E-58

Regional Time Series Model Excluding a Lagged Dependent Variable

SAGINAW

EQUATION

$$DEMAND = 3.615*ELECTRICITY^{-0.97986}*INCOME^{1.211}*FUEL\ OIL^{0.303}*MULTIUNIT^{-0.88201}$$

R-SQUARED = .97728

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .97274
STANDARD ERROR = .060329
DEPENDENT MEAN = 8.351
STANDARD ERROR AS % MEAN DEMAND = .72241

RESIDUAL SUM SQUARE = .072792
F-RATIO = 215.07
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.97986	.30207	-.42451	-3.2438	10.523
INCOME	1.2110	.19153	.66634	6.3227	39.976
FUEL OIL	.30300	.21877	.12453	1.3850	1.9183
MULTIUNIT	-.88201	.11799	-.31088	-7.4753	55.880

Table E-59

Regional Time Series Model Excluding a Lagged Dependent Variable

NORTHWEST

EQUATION

$$DEMAND = 2.98E26*ELECTRICITY^{-0.65295}*INCOME^{0.48032}*GAS^{0.81593}*FUEL\ OIL^{-0.29561}*MULTIUNIT^{-3.7537}*DEGREE\ DAYS^{0.50851}*URBAN^{-15.131}$$

R-SQUARED = .98478

25 OBSERVATIONS, 7 VARIABLES

CORRECTED R-SQUARED = .97852
STANDARD ERROR = .050972
DEPENDENT MEAN = 8.2294
STANDARD ERROR AS % MEAN DEMAND = .61939

RESIDUAL SUM SQUARE = .044169
F-RATIO = 157.18
DEGREES OF FREEDOM = 17

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.65295	.36946	-.29719	-1.7673	3.1233
INCOME	.48032	.22818	.30059	2.1050	4.4311
GAS	.81593	.56916	.35637	1.4336	2.0551
FUEL OIL	-.29561	.22223	-.12764	-1.3302	1.7695
MULTIUNIT	-3.7537	.56313	-2.5239	-6.6658	44.433
DEGREE DAYS	.50851	.26367	.62376E-01	1.9286	3.7195
URBAN	-15.131	2.8835	-3.0507	-5.2474	27.535

Table E-60

Regional Time Series Model Excluding a Lagged Dependent Variable

HURON

EQUATION

$$DEMAND = 2999.2*ELECTRICITY^{-0.97495}*INCOME^{0.48679}*FUEL\ OIL^{0.18953}*MULTIUNIT^{-0.60403}*DEGREE\ DAYS^{-0.17472}$$

R-SQUARED = .99377

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99213
STANDARD ERROR = .026822
DEPENDENT MEAN = 8.5099
STANDARD ERROR AS % MEAN DEMAND = .31518

RESIDUAL SUM SQUARE = .013669
F-RATIO = 606.45
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.97475	.11184	-.84091	-8.7172	75.989
INCOME	.48679	.63882E-01	.49615	7.6201	58.066
FUEL OIL	.18953	.11376	.94107E-01	1.6660	2.7755
MULTIUNIT	-.60403	.39095E-01	-.43776	-15.450	238.71
DEGREE DAYS	-.17472	.11589	-.38070E-01	-1.5075	2.2727

Table E-61

Regional Time Series Model Excluding a Lagged Dependent Variable

LAPEER

EQUATION

$$DEMAND = 3.89E06*ELECTRICITY^{-0.45044}*INCOME^{0.13373}*FUEL\ OIL^{0.15052}*URBAN^{-2.4442}*MULTIUNIT^{-0.438}$$

R-SQUARED = .99811

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99762
STANDARD ERROR = .01862
DEPENDENT MEAN = 8.6002
STANDARD ERROR AS % MEAN DEMAND = .21650

RESIDUAL SUM SQUARE = .0065871
F-RATIO = 2,010.9
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.45044	.10529	-.30802	-4.2782	18.303
INCOME	.13373	.46832E-01	.75898E-01	2.8555	8.1539
FUEL OIL	.15052	.76857E-01	.59253E-01	1.9584	3.8354
URBAN	-2.4442	.13033	-.88669	-18.754	351.72
MULTIUNIT	-.43800	.30947E-01	-.29475	-14.153	200.31

Table E-62

Regional Time Series Model Excluding a Lagged Dependent Variable

SANILAC

EQUATION

$$DEMAND = 393.00*ELECTRICITY^{-1.3875}*INCOME^{0.64146}*GAS^{0.15846}*MULTIUNIT^{-0.52652}$$

R-SQUARED = .96623

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .95948
STANDARD ERROR = .068359
DEPENDENT MEAN = 8.587
STANDARD ERROR AS % MEAN DEMAND = .79607

RESIDUAL SUM SQUARE = .093458
F-RATIO = 143.08
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-1.3875	.38309	-1.0658	-3.6220	13.119
INCOME	.64146	.21671	.43505	2.9600	8.7614
GAS	.15846	.47349	.66542E-01	.33467	.11200
MULTIUNIT	-.52652	.75831E-01	-.56483	-6.9434	48.211

Table E-63

Regional Time Series Model Excluding a Dependent Variable

ST. CLAIR

EQUATION

$$DEMAND = 2.66E14*ELECTRICITY^{0.094923}*INCOME^{-0.060781}*FUEL\ OIL^{0.077182}*URBAN^{-6.316}$$

R-SQUARED = .98236

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .97883
STANDARD ERROR = .04632
DEPENDENT MEAN = 8.4506
STANDARD ERROR AS % MEAN DEMAND = .54812

RESIDUAL SUM SQUARE = .04291
F-RATIO = 278.49
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	.94923E-01	.19966	.77769E-01	.47542	.22602
INCOME	-.60781E-01	.17567	-.41408E-01	-.34600	.11972
FUEL OIL	.77182E-01	.16678	.36403E-01	.46277	.21415
URBAN	-6.3160	.64606	-1.1369	-9.7762	95.574

Table E-64

Regional Time Series Model Excluding a Lagged Dependent Variable

TUSCOLA

EQUATION

$$DEMAND = 1.29E09*ELECTRICITY^{-0.46646}*INCOME^{0.19889}*FUEL\ OIL^{0.11509}*MULTIUNIT^{-0.25008}*URBAN^{-4.9735}$$

R-SQUARED = .99672

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99586
STANDARD ERROR = .025015
DEPENDENT MEAN = 8.5679
STANDARD ERROR AS % MEAN DEMAND = .29197

RESIDUAL SUM SQUARE = .01189
F-RATIO = 1,154.8
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.46646	.13610	-.31307	-3.4273	11.747
INCOME	.19889	.10968	.13797	1.8133	3.2882
FUEL OIL	.11509	.10195	.44469E-01	1.1289	1.2743
MULTIUNIT	-.25008	.49016E-01	-.20128	-5.1020	26.031
URBAN	-4.9735	.58079	-.72645	-8.5633	73.329

Table E-65

Regional Time Series Model Excluding a Lagged Dependent Variable

OAKLAND

EQUATION

$$DEMAND = 0.0131*ELECTRICITY^{-0.83317}*INCOME^{0.066059}*FUEL\ OIL^{0.33103}*URBAN^{2.7636}$$

R-SQUARED = .9948

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99376
STANDARD ERROR = .028008
DEPENDENT MEAN = 8.502
STANDARD ERROR AS % MEAN DEMAND = .32942

RESIDUAL SUM SQUARE = .015698
F-RATIO = 957.08
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.83317	.71883E-01	-.60247	-11.591	134.34
INCOME	.66059E-01	.84088E-01	.36092E-01	.78559	.61716
FUEL OIL	.33103	.11414	.13204	2.9003	8.4116
URBAN	2.7636	.16000	.54757	17.272	298.31

Table E-66

Regional Time Series Model Excluding a Lagged Dependent Variable

MACOMB

EQUATION

$$DEMAND = 1.23*ELECTRICITY^{-0.57673}*INCOME^{0.15641}*GAS^{-0.29945}*URBAN^{1.6825}$$

R-SQUARED = .99368

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99242
STANDARD ERROR = .029362
DEPENDENT MEAN = 8.3256
STANDARD ERROR AS % MEAN DEMAND = .35267

RESIDUAL SUM SQUARE = .017242
F-RATIO = 786.05
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.57673	.98603E-01	-.43870	-5.8489	34.210
INCOME	.15641	.14753	.72380E-01	1.0602	1.1239
GAS	-.29945	.12293	-.85241E-01	-2.4359	5.9336
URBAN	1.6825	.12669	.45778	13.280	176.35

Table E-67

Regional Time Series Model Excluding a Lagged Dependent Variable

WASHTENAW

EQUATION

$$DEMAND = 0.0141*ELECTRICITY^{-0.44528}*INCOME^{0.29255}*FUEL\ OIL^{0.14583}*URBAN^{3.2465}MULTIUNIT^{-0.97656}$$

R-SQUARED = .99367

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .992
STANDARD ERROR = .023236
DEPENDENT MEAN = 8.4847
STANDARD ERROR AS % MEAN DEMAND = .27386

RESIDUAL SUM SQUARE = .010259
F-RATIO = 596.24
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.44528	.12787	-.44708	-3.4824	12.127
INCOME	.29255	.10453	.20747	2.7986	7.8324
FUEL OIL	.14583	.94298E-01	.84292E-01	1.5465	2.3917
URBAN	3.2465	.31021	.90154	10.466	109.53
MULTIUNIT	-.97656	.15478	-.50381	-6.3095	39.810

Table E-68

Regional Time Series Model Excluding a Lagged Dependent Variable

LENAWEE

EQUATION

$$\text{DEMAND} = 3.78E04 * \text{ELECTRICITY}^{-1.0807} * \text{INCOME}^{-0.0040176} * \text{GAS}^{0.051198} * \text{FUEL OIL}^{-0.22433}$$

R-SQUARED = .89677

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .87613
STANDARD ERROR = .1144
DEPENDENT MEAN = 8.9218
STANDARD ERROR AS % MEAN DEMAND = 1.2822

RESIDUAL SUM SQUARE = .26173
F-RATIO = 43.437
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-1.0807	.47761	-.86727	-2.2627	5.1196
INCOME	-.40176E-02	.41967	-.26245E-02	-.95733E-02	.91647E-04
GAS	.51198E-01	.48492	.15482E-01	.10558	.11147E-01
FUEL OIL	-.22433	.42009	-.10364	-.53400	.28516

Table E-69

Regional Time Series Model Excluding a Lagged Dependent Variable

LIVINGSTON

EQUATION

$$DEMAND = 4.23E05*ELECTRICITY^{-0.36593}*INCOME^{0.12844}*FUEL\ OIL^{0.31879}*URBAN^{-2.3406}$$

R-SQUARED = .99593

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99512
STANDARD ERROR = .027808
DEPENDENT MEAN = 8.4584
STANDARD ERROR AS % MEAN DEMAND = .32877

RESIDUAL SUM SQUARE = .015466
F-RATIO = 1,224.5
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.36593	.84484E-01	-.23979	-4.3314	18.761
INCOME	.12844	.64326E-01	.67781E-01	1.9966	3.9866
FUEL OIL	.31879	.96286E-01	.12026	3.3109	10.962
URBAN	-2.3406	.12502	-.81766	-18.722	350.51

Table E-70

Regional Time Series Model Excluding a Lagged Dependent Variable

INGHAM

EQUATION

$$DEMAND - 0.00001*ELECTRICITY^{-0.27387}*INCOME^{0.17653}*GAS^{0.14175}*URBAN^{9.889}*MULTIUNIT^{-0.36788}$$

R-SQUARED = .99494

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99361
STANDARD ERROR = .030306
DEPENDENT MEAN = 8.7748
STANDARD ERROR AS % MEAN DEMAND = .34537

RESIDUAL SUM SQUARE = .01745
F-RATIO = 747.93
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.27387	.12729	-.18836	-2.1515	4.6288
INCOME	.17653	.16120	.85549E-01	1.0951	1.1992
GAS	.14175	.15837	.36735E-01	.89502	.80106
URBAN	9.8890	1.2516	.85257	7.0914	62.432
MULTIUNIT	-.36788	.10829	-.15397	-3.3972	11.541

Table E-71

Regional Time Series Model Excluding a Lagged Dependent Variable

MONROE

EQUATION

$$DEMAND = 25.574*ELECTRICITY^{-0.51433}*INCOME^{0.12584}*GAS^{0.19338}*MULTIUNIT^{-1.0226}*URBAN^{2.1324}$$

R-SQUARED = .98909

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .98622
STANDARD ERROR = .040374
DEPENDENT MEAN = 8.3962
STANDARD ERROR AS % MEAN DEMAND = .48086

RESIDUAL SUM SQUARE = .030971
F-RATIO = 344.54
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.54133	.18485	-.40363	-2.9286	8.5765
INCOME	.12584	.23645	.81433E-01	.53222	.28326
GAS	.19338	.13918	.11489	1.3894	1.9304
MULTIUNIT	-1.0226	.17467	-.39576	-5.8546	34.276
URBAN	2.1324	.70624	.63257	3.0194	9.1165

Table E-72

Regional Time Series Model Excluding a Lagged Dependent Variable

WAYNE

EQUATION

$$DEMAND = 0.00001*ELECTRICITY^{-0.46447}*INCOME^{0.31159}*GAS^{-0.63074}*URBAN^{22.07}*FUEL\ OIL^{0.20397}*MULTIUNIT^{-0.60422}$$

R-SQUARED = .99435

25 OBSERVATIONS, 6 VARIABLES

CORRECTED R-SQUARED = .99247
STANDARD ERROR = .031006
DEPENDENT MEAN = 8.0462
STANDARD ERROR AS % MEAN DEMAND = .38535

RESIDUAL SUM SQUARE = .017305
F-RATIO = 528.07
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
ELECTRICITY	-.46447	.18120	-.33340	-2.5633	6.5703
INCOME	.31159	.18499	.16061	1.6843	2.8370
GAS	-.63074	.20540	-.21970	-3.0708	9.4299
URBAN	22.070	11.445	.30764	1.9284	3.7187
FUEL OIL	.20397	.17130	.80765E-01	1.1907	1.4178
MULTIUNIT	-.60422	.15464	-.18224	-3.9073	15.267

Table E-73

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

CENTRAL

EQUATION

$$DEMAND = 0.0056*AVG\ ELECTRICITY^{-0.61932}*INCOME^{-0.069475}*FUEL\ OIL^{0.36567}*URBAN^{4.0162}$$

R-SQUARED = .99542

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .9945
STANDARD ERROR = .023225
DEPENDENT MEAN = 8.2988
STANDARD ERROR AS % MEAN DEMAND = .27985

RESIDUAL SUM SQUARE = .010788
F-RATIO = 1,085.9
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.61932	.10034	-.37542	-6.1720	38.093
INCOME	-.69475E-01	.74472E-01	-.40626E-01	-.93290	.87031
FUEL OIL	.36567	.71495E-01	.17534	5.1146	26.159
URBAN	4.0162	.28324	.82534	14.179	201.05

Table E-74

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

BATTLE CREEK

EQUATION

$$DEMAND = 2.64E10 * AVG\ ELECTRICITY^{-0.54913} * INCOME^{-0.12913} * FUEL\ OIL^{0.22631} * URBAN^{-3.3966} * MULTIUNIT^{-0.43694}$$

R-SQUARED = .99888

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99858
STANDARD ERROR = .010872
DEPENDENT MEAN = 8.4501
STANDARD ERROR AS % MEAN DEMAND = .12866

RESIDUAL SUM SQUARE = .0022458
F-RATIO = 3,381
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.54913	.48525E-01	-.34038	-11.316	128.06
INCOME	-.12913	.58566E-01	-.82558E-01	-2.2049	4.8611
FUEL OIL	.22631	.33834E-01	.11771	6.6887	44.739
URBAN	-3.3966	.18419	-.79202	-18.440	340.05
MULTIUNIT	-.43694	.29243E-01	-.16473	-14.942	223.25

Table E-75

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

NORTHEAST

EQUATION

$$DEMAND = 0.0009*AVG\ ELECTRICITY^{-0.69872}*INCOME^{0.13457}*FUEL\ OIL^{0.18144}*URBAN^{3.6924}$$

R-SQUARED = .99253

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99104
STANDARD ERROR = .032127
DEPENDENT MEAN = 8.1992
STANDARD ERROR AS % MEAN DEMAND = .39183

RESIDUAL SUM SQUARE = .020643
F-RATIO = 664.77
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.69872	.14310	-.39642	-4.8828	23.842
INCOME	.13457	.10322	.77590E-01	1.3037	1.6995
FUEL OIL	.18144	.98451E-01	.80271E-01	1.8430	3.3966
URBAN	3.6924	.36558	.61565	10.100	102.02

Table E-76

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

FLINT

EQUATION

$$DEMAND = 0.00001*AVG\ ELECTRICITY^{-1.1048}*INCOME^{0.53325}*FUEL\ OIL^{-0.034796}*URBAN^{5.2885}$$

R-SQUARED = .97917

CORRECTED R-SQUARED = .975
STANDARD ERROR = .051831
DEPENDENT MEAN = 8.4515
STANDARD ERROR AS % MEAN DEMAND = .61328

RESIDUAL SUM SQUARE = .05373
F-RATIO = 235.04
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-1.1048	.19968	-.62244	-5.5328	30.612
INCOME	.53325	.21484	.25971	2.4821	6.1609
FUEL OIL	-.34796E-01	.14888	-.15939E-01	-.23372	.54627E-01
URBAN	5.2885	1.0023	.22076	5.2765	27.841

Table E-77

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

GRAND RAPIDS

EQUATION

$$DEMAND = 6.025*AVG\ ELECTRICITY^{-0.41716}*INCOME^{0.50839}*AVG\ GAS^{-0.48974}*URBAN^{0.67783}$$

R-SQUARED = .9949

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99388
STANDARD ERROR = .026813
DEPENDENT MEAN = 8.2923
STANDARD ERROR AS % MEAN DEMAND = .32335

RESIDUAL SUM SQUARE = .014379
F-RATIO = 974.98
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.41716	.15541	-.23175	-2.6842	7.2050
INCOME	.50839	.10589	.23492	4.8009	23.048
AVG GAS	-.48974	.15308	-.17367	-3.1993	10.235
URBAN	.67783	.61808E-01	.46221	10.967	120.27

Table E-78

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

JACKSON

EQUATION

$$DEMAND = 0.00001*AVG\ ELECTRICITY^{-0.91028}*INCOME^{0.69401}*FUEL\ OIL^{0.03721}*URBAN^{9.9778}$$

R-SQUARED = .97694

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .97233
STANDARD ERROR = .051981
DEPENDENT MEAN = 8.5036
STANDARD ERROR AS % MEAN DEMAND = .61128

RESIDUAL SUM SQUARE = .05404
F-RATIO = 211.85
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.91028	.21171	-.52554	-4.2996	18.487
INCOME	.69401	.18853	.47039	3.6812	13.551
FUEL OIL	.37213E-01	.15482	.17883E-01	.24036	.57773E-01
URBAN	9.9778	2.0709	.22413	4.8180	23.213

Table E-79

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

KALAMAZOO

EQUATION

$$DEMAND = 0.00001*AVG\ ELECTRICITY^{-0.49724}*INCOME^{-0.33538}*FUEL\ OIL^{0.19099}*AVG\ GAS^{-0.056214}*URBAN^{5.6132}$$

R-SQUARED = .9972

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99646
STANDARD ERROR = .016943
DEPENDENT MEAN = 8.4606
STANDARD ERROR AS % MEAN DEMAND = .20026

RESIDUAL SUM SQUARE = .0054542
F-RATIO = 1,351.3
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.49724	.11223	-.31373	-4.4306	19.631
INCOME	-.33538	.63825E-01	-.21484	-5.2547	27.612
FUEL OIL	.19099	.60422E-01	.10075	3.1609	9.9913
AVG GAS	-.56214E-01	.10735	-.25193E-01	-.52366	.27422
URBAN	5.6132	.28334	.96055	19.811	392.47

Table E-80

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

LANSING

EQUATION

$$\text{DEMAND } 0.00001{*}\text{AVG ELECTRICITY}^{-0.63195}{*}\text{INCOME}^{-0.010049}{*}\text{FUEL OIL}^{0.29239}{*}\text{URBAN}^{13.308}{*}\text{MULTIUNIT}^{-0.3444}$$

R-SQUARED = .99769

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99708
STANDARD ERROR = .018107
DEPENDENT MEAN = 8.588
STANDARD ERROR AS % MEAN DEMAND = .21084

RESIDUAL SUM SQUARE = .0062293
F-RATIO = 1,640.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.63195	.80200E-01	-.34850	-7.8797	62.089
INCOME	-.10049E-01	.68490E-01	-.65367E-02	-.14673	.21528E-01
FUEL OIL	.29239	.55949E-01	.13102	5.2260	27.312
URBAN	13.308	.72923	.89449	18.250	333.06
MULTIUNIT	-.34440	.29598E-01	-.18940	-11.636	135.39

Table E-81

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

MUSKEGON

EQUATION

$$DEMAND = 3.55E09*AVG\ ELECTRICITY^{-0.62361}*INCOME^{0.59961}*AVG\ GAS^{-0.61523}*URBAN^{-0.36429}*DEGREE\ DAYS^{0.19113}$$

R-SQUARED = .98614

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .98249
STANDARD ERROR = .043281
DEPENDENT MEAN = 8.2865
STANDARD ERROR AS % MEAN DEMAND = .52231

RESIDUAL SUM SQUARE = .035591
F-RATIO = 270.36
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.62361	.21899	-.37406	-2.8477	8.1092
INCOME	.59961	.18326	.29564	3.2719	10.705
AVG GAS	-.61523	.26826	-.22857	-2.2934	5.2598
URBAN	-.36429	.72716E-01	-.31005	-5.0098	25.098
DEGREE DAYS	.19113	.20324	.37136E-01	.94040	.88435

Table E-82

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

SAGINAW

EQUATION

$$DEMAND = 120.22*AVG\ ELECTRICITY^{-1.0132}*INCOME^{0.7979}*FUEL\ OIL^{0.037387}*MULTIUNIT^{-0.66208}$$

R-SQUARED = .98719

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .98463
STANDARD ERROR = .045299
DEPENDENT MEAN = 8.351
STANDARD ERROR AS % MEAN DEMAND = .54244

RESIDUAL SUM SQUARE = .041041
F-RATIO = 385.32
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-1.0132	.17342	-.55639	-5.8426	34.136
INCOME	.79790	.17797	.43904	4.4833	20.100
FUEL OIL	.37387E-01	.13428	.15366E-01	.27842	.77515E-01
MULTIUNIT	-.66208	.99974E-01	-.23336	-6.6225	43.858

Table E-83

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

NORTHWEST

EQUATION

$$DEMAND = 2.42E18*AVG\ ELECTRICITY^{-0.79413}*INCOME^{-0.0075592}*AVG\ GAS^{0.41818}*FUEL\ OIL^{-0.37788}$$
$$*MULTIUNIT^{-2.0343}*DEGREE\ DAYS^{0.34567}*URBAN^{-9.084}$$

R-SQUARED = .99205

25 OBSERVATIONS, 7 VARIABLES

CORRECTED R-SQUARED = .98878
STANDARD ERROR = .036835
DEPENDENT MEAN = 8.2294
STANDARD ERROR AS % MEAN DEMAND = .44760

RESIDUAL SUM SQUARE = .023065
F-RATIO = 303.21
DEGREES OF FREEDOM = 17

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.79413	.17573	-.48483	-4.5190	20.422
INCOME	-.75592E-02	.19313	-.47307E-02	-.39140E-01	.15320E-02
AVG GAS	.41818	.23802	.14612	1.7569	3.0868
FUEL OIL	-.37788	.11160	-.16317	-3.3860	11.465
MULTIUNIT	-2.0343	.32511	-1.3678	-6.2572	39.153
DEGREE DAYS	.34567	.20885	.42401E-01	1.6551	2.7395
URBAN	-9.0840	1.1783	-1.8315	-7.7094	59.436

Table E-84

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

HURON

EQUATION

$$DEMAND = 247.08*AVG\ ELECTRICITY^{-0.7196}*INCOME^{0.56595}*FUEL\ OIL^{-0.073508}*MULTIUNIT^{-0.36088}*DEGREE\ DAYS^{0.020589}$$

R-SQUARED = .98347

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .97911
STANDARD ERROR = .043707
DEPENDENT MEAN = 8.5099
STANDARD ERROR AS % MEAN DEMAND = .51360

RESIDUAL SUM SQUARE = .036296
F-RATIO = 226.02
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.71960	.17571	-.51895	-4.0953	16,772
INCOME	.56595	.10795	.57685	5.2429	27.488
FUEL OIL	-.73508E-01	.16933	-.36500E-01	-.43411	.18845
MULTIUNIT	-.36088	.64378E-01	-.26154	-5.6056	31.423
DEGREE DAYS	.20589E-01	.18744	.44862E-02	.10984	.12066E-01

Table E-85

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

LAPEER

EQUATION

$$DEMAND = 3.39E06*AVG\ ELECTRICITY^{-0.46506}*INCOME^{0.086488}*FUEL\ OIL^{0.075694}*URBAN^{-2.3175}*MULTIUNIT^{-0.30864}$$

R-SQUARED = .99824

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99777
STANDARD ERROR = .018003
DEPENDETN MEAN = 8.6002
STANDARD ERROR AS % MEAN DEMAND = .20933

RESIDUAL SUM SQUARE = .006158
F-RATIO = 2,151.2
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.46506	.10172	-.28682	-4.5718	20.902
INCOME	.86488E-01	.49058E-01	.49086E-01	1.7630	3.1080
FUEL OIL	.75694E-01	.62665E-01	.29798E-01	1.2079	1.4590
URBAN	-2.3175	.14468	-.84074	-16.018	256.59
MULTIUNIT	-.30864	.23590E-01	-.20770	-13.084	171.18

Table E-86

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

SANILAC

EQUATION

$$DEMAND = 4046.06 * AVG\ ELECTRICITY^{-0.39717} * INCOME^{0.10588} * AVG\ GAS^{-1.0292} * MULTIUNIT^{0.0052058}$$

R-SQUARED = .98118

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .97741
STANDARD ERROR = .051037
DEPENDENT MEAN = 8.587
STANDARD ERROR AS % MEAN DEMAND = .59436

RESIDUAL SUM SQUARE = .052096
F-RATIO = 260.64
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.39717	.25359	-.26629	-1.5662	2.4530
INCOME	.10588	.20077	.71814E-01	.52738	.27813
AVG GAS	-1.0292	.20924	-.66203	-4.9185	24.192
MULTIUNIT	.52058E-02	.66678E-01	.55845E-02	.78047E-01	.60955E-02

Table E-87

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

ST. CLAIR

EQUATION

$$DEMAND = 4.98E11*AVG\ ELECTRICITY^{-0.84969}*INCOME^{-0.30475}*FUEL\ OIL^{\ 0.27206}*URBAN^{-4.1092}$$

R-SQUARED = .99057

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .98869
STANDARD ERROR = .033865
DEPENDENT MEAN = 8.4506
STANDARD ERROR AS % MEAN DEMAND = .40073

RESIDUAL SUM SQUARE = .022936
F-RATIO = 525.36
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.84969	.20117	-.57114	-4.2237	17.840
INCOME	-.30475	.10568	-.20761	-2.8838	8.3164
FUEL OIL	.27206	.10881	.12832	2.5003	6.2516
URBAN	-4.1092	.65970	-.73965	-6.2290	38.800

Table E-88

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

TUSCOLA

EQUATION

$$DEMAND = 8.42E08 * AVG\ ELECTRICITY^{-0.55673} * INCOME^{0.12807} * FUEL\ OIL^{0.085039} * MULTIUNIT^{-0.14195} * URBAN^{-4.6584}$$

R-SQUARED = .99835

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99791
STANDARD ERROR = .017763
DEPENDENT MEAN = 8.5679
STANDARD ERROR AS % MEAN DEMAND = .20732

RESIDUAL SUM SQUARE = .0059949
F-RATIO = 2,294
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.55673	.85926E-01	-.33567	-6.4792	41.979
INCOME	.12807	.78930E-01	.88841E-01	1.6226	2.6327
FUEL OIL	.85039E-01	.63158E-01	.32858E-01	1.3465	1.8129
MULTIUNIT	-.14195	.25956E-01	-.11425	-5.4691	29.911
URBAN	-4.6584	.40803	-.68043	-11.417	130.34

Table E-89

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

OAKLAND

EQUATION

$$DEMAND = 1.7079 * AVG\ ELECTRICITY^{-1.0327} * INCOME^{0.099669} * FUEL\ OIL^{0.043233} * URBAN^{1.8031}$$

R-SQUARED = .9949

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99388
STANDARD ERROR = .027742
DEPENDENT MEAN = 8.502
STANDARD ERROR AS % MEAN DEMAND = .32630

RESIDUAL SUM SQUARE = .015393
F-RATIO = 975.56
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-1.0327	.88131E-01	-.63716	-11.718	137.31
INCOME	.99669E-01	.81521E-01	.55456E-01	1.2226	1.4948
FUEL OIL	.43233E-01	.99701E-01	.17244E-01	.43363	.18803
URBAN	1.8031	.16376	.35725	11.011	121.23

Table E-90

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

MACOMB

EQUATION

$$DEMAND = 2.80*AVG\ ELECTRICITY^{-0.86651}*INCOME^{0.3279}*AVG\ GAS^{-0.00066466}*URBAN^{1.2413}$$

R-SQUARED = .99806

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99767
STANDARD ERROR = .016264
DEPENDENT MEAN = 8.3256
STANDARD ERROR AS % MEAN DEMAND = .19535

RESIDUAL SUM SQUARE = .0052903
F-RATIO = 2,573.2
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELECTRICITY	-.86651	.78309E-01	-.54389	-11.065	122.44
INCOME	.32790	.65548E-01	.15174	5.0024	25.024
AVG GAS	-.66466E-03	.79710E-01	-.25921E-03	-.83385E-02	.69530E-04
URBAN	1.2413	.77357E-01	.33774	16.046	257.48

Table E-91

Regional Time Series Model Using Ave e Price and
Excluding a Lagged Dependent Va ble

WASHTENAW

EQUATION

$$DEMAND = 0.1967*AVG\ ELECTRICITY^{-0.61336}*INCOME^{0.13666}*FUEL\ OIL^{0.073119}*URBAN^{2.6928}*MULTIUNIT^{-0.60094}$$

R-SQUARED = .99637

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99542
STANDARD ERROR = .10759
DEPENDENT MEAN = 8.4847
STANDARD ERROR AS % MEAN DEMAND = .20731

RESIDUAL SUM SQUARE = .0058784
F-RATIO = 1,043.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.61336	.10321	-.48575	-5.9432	35.321
INCOME	.13666	.85523E-01	.96918E-01	1.5980	2.5536
FUEL OIL	.73119E-01	.59000E-01	.42264E-01	1.2393	1.5359
URBAN	2.6928	.27243	.74778	9.8843	97.699
MULTIUNIT	-.60094	.90339E-01	-.31002	-6.6521	44.250

Table E-92

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

LENAWEE

EQUATION

$$DEMAND = 1.32E05*AVG\ ELECTRICITY^{-2.1319}*INCOME^{-0.23093}*AVG\ GAS^{0.77166}*FUEL\ OIL^{0.23999}$$

R-SQUARED = .97331

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .96798
STANDARD ERROR = .058166
DEPENDENT MEAN = 8.9218
STANDARD ERROR AS % MEAN DEMAND = .65195

RESIDUAL SUM SQUARE = .067665
F-RATIO = 182.36
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-2.1319	.27686	-1.4880	-7.7002	59.293
INCOME	-.23093	.15490	-.15086	-1.4908	2.2225
AVG GAS	.77166	.31674	.28208	2.4363	5.9355
FUEL OIL	.23999	.19834	.11088	1.2100	1.4641

Table E-93

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

LIVINGSTON

EQUATION

$$DEMAND = 3.92E05*AVG\ ELECTRICITY^{-0.78412}*INCOME^{0.016269}*FUEL\ OIL^{0.30353}*URBAN^{-1.8055}$$

R-SQUARED = .99715

25 OBSERVATIONS, 4 VARIABLES

CORRECTED R-SQUARED = .99657
STANDARD ERROR = .023297
DEPENDENT MEAN = 8.4584
STANDARD ERROR AS % MEAN DEMAND = .27543

RESIDUAL SUM SQUARE = .010855
F-RATIO = 1,746.8
DEGREES OF FREEDOM = 20

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.78412	.13211	-.47034	-5.9352	35.226
INCOME	.16269E-01	.63244E-01	.85860E-02	.25725	.66177E-01
FUEL OIL	.30353	.78340E-01	.11450	3.8746	15.012
URBAN	-1.8055	.16543	-.63075	-10.914	119.12

Table E-94

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

INGHAM

EQUATION

$$DEMAND = 0.00001*AVG\ ELECTRICITY^{-0.59118}*INCOME^{0.15727}*AVG\ GAS^{0.21561}*URBAN^{8.2779}*MULTIUNIT^{-0.32914}$$

R-SQUARED = .99732

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99662
STANDARD ERROR = .022048
DEPENDENT MEAN = 8.7748
STANDARD ERROR AS % MEAN DEMAND = .25127

RESIDUAL SUM SQUARE = .0092366
F-RATIO = 1,416.4
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.59118	.11079	-.36556	-5.3359	28.471
INCOME	.15727	.11400	.76215E-01	1.3796	1.9032
AVG GAS	.21561	.8650E-01	.77663E-01	2.4903	6.2017
URBAN	8.2779	.75434	.71366	10.974	120.42
MULTIUNIT	-.32914	.55933E-01	-.13775	-5.8845	34.627

Table E-95

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

MONROE

EQUATION

$$DEMAND = 47.560 * AVG\ ELECTRICITY^{-0.54989} * INCOME^{0.11746} * AVG\ GAS^{-0.13856} * MULTIUNIT^{-0.7451} * URBAN^{1.7765}$$

R-SQUARED = .99594

25 OBSERVATIONS, 5 VARIABLES

CORRECTED R-SQUARED = .99487
STANDARD ERROR = .024629
DEPENDENT MEAN = 8.3962
STANDARD ERROR AS % MEAN DEMAND = .29333

RESIDUAL SUM SQUARE = .011525
F-RATIO = 932.29
DEGREES OF FREEDOM = 19

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.54989	.16659	-.35678	-3.3008	10.896
INCOME	.11749	.14551	.76011E-01	.80726	.65167
AVG GAS	-.13856	.90831E-01	-.64306E-01	-1.5254	2.3270
MULTIUNIT	-.74510	.10742	-.28836	-6.9363	48.113
URBAN	1.7765	.41756	.52698	4.2544	18.100

Table E-96

Regional Time Series Model Using Average Price and Excluding a Lagged Dependent Variable

WAYNE

EQUATION

$$DEMAND = 0.00001*AVG\ ELECTRICITY^{-0.70543}*INCOME^{0.24687}*AVG\ GAS^{-0.21544}*URBAN^{25.672}*FUEL\ OIL^{0.14312}*MULTIUNIT^{-0.39636}$$

R-SQUARED = .99582

25 OBSERVATIONS, 6 VARIABLES

CORRECTED R-SQUARED = .99443
STANDARD ERROR = .026658
DEPENDENT MEAN = 8.0462
STANDARD ERROR AS % MEAN DEMAND = .33131

RESIDUAL SUM SQUARE = .012792
F-RATIO = 715.44
DEGREES OF FREEDOM = 18

VARIABLE	COEFFICIENT	STANDARD ERROR	BETA	T-STATISTIC	PARTIAL-F
AVG ELEC	-.70543	.12969	-.45486	-5.4392	29.585
INCOME	.24687	.16204	.12725	1.5235	2.3211
AVG GAS	-.21544	.16984	-.75461E-01	-1.2685	1.6091
URBAN	25.672	9.5539	.35785	2.6870	7.2202
FUEL OIL	.14312	.96840E-01	.56669E-01	1.4779	2.1841
MULTIUNIT	-.39636	.14417	-.11955	-2.7492	7.5582