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Electricity Demand in the United States: an ECONOMETRIC ANALYSIS

T. D. Mount · L. D. Chapman · T. J. Tyrrell

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T. D. Mount† L. D. Chapman† T. J. Tyrrell

ABSTRACT

The growth of demand for electricity since 1945 is attributed to five factors: population, income, and the prices of electricity, substitute fuels (natural gas), and complementary products such as household appliances. The data are annual observations for 48 contiguous states from 1946 to 1970. Single-equation models are fitted for three consumer classes (residential, commercial, and industrial) with the quantity of electricity as the dependent variable. Both constant and variable elasticity models are estimated. In all cases, a lagged dependent variable is used as a regressor, implying that demand adjusts through time to changes of the explanatory variables (geometric lag distribution). With a lagged dependent variable present, ordinary least-squares (OLS) estimators are inconsistent if the residuals are serially correlated. For this reason, a consistent instrumental variable (IV) estimator is used to check the OLS estimates. The estimated adjustment rates are higher with IV than with OLS. However, the long-run elasticities have similar magnitudes using both methods.

1. INTRODUCTION

The quantity of electricity demanded in the U.S. has grown consistently since the end of World War II. If past trends are extrapolated to the year 2000, the quantity demanded will increase to at least six times the 1970 level. It is questionable, however, whether these trends will remain unchanged in the future. In economic theory, demand is related to various causal factors, and, if the direction of change of one or more of these factors is reversed, demand will be affected. For example, the relative price of electricity has decreased in the past but will almost certainly increase during the next decade. This change would be expected to reduce the growth of demand for electricity. On the other hand, if price is not an important explanatory factor, the influence on demand will be negligible. Hence, determining whether or not price is important is essential if projections of future demand are to be accurate. The main objective of our analysis is to measure the relationships between the demand for electricity and causal factors such as price.

Electricity demand is assumed to be determined by five explanatory factors: population, income, and the prices of electricity, substitute fuels such as gas, and complementary products such as household appliances. Demand elasticities are estimated for each of the five factors,[1] and the magnitudes of these elasticities determine the relative importance of each factor. Hence, our specific objective is to obtain reliable estimates of the elasticities.

Annual values of the explanatory factors, particularly population, income, and the relative price of electricity,[2] exhibit very strong trend components between 1946 and 1970, and slightly less since 1970. Consequently, the correlation between all the factors is high, which makes estimation of the elasticities difficult. Even though most of the variation of demand can be explained by a variety of simple models, individual elasticity estimates may still be very inefficient. The fact that a model provides a close fit to available data need not imply that projections of future demand using this model are reliable. This is

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1. The demand elasticity is defined as the percentage change in the quantity demanded associated with a 1% increase in a particular factor.

2. In these three cases, the direction of trend is logically consistent with an increase in the demand for electricity.

particularly true in the case of electricity demand, as current levels of the explanatory factors are no longer following established trends.

Results from some of our preliminary analyses suggest that accurate estimators of the elasticities cannot be obtained from a single time series of observations. In fact, with these types of data, it is not always possible to show that any factor other than autonomous growth is statistically significant. On the other hand, it is doubtful that estimates derived from a single cross section of observations are satisfactory for making projections over time. Consequently, we rely on pooling both cross-section (states) and time-series (years) observations to provide a suitable data base for estimation. The resulting elasticity estimators are reasonably efficient.

The use of cross-section data from different states introduces an additional problem into the analysis. Standard estimation procedures are statistically sound only if the elasticity for each factor is the same in each state.[3] Under the more realistic specification that differences exist between states, standard estimators are inconsistent due to bias. For this reason, variable elasticity models are used to permit some degree of heterogeneity between states. In addition, models for three user classes (residential, commercial, and industrial) are estimated separately.

Another specification problem is that the quantity of electricity may follow some adjustment path through time in response to changes in the causal factors. This lag in response reflects the relationship between the use of electricity and existing stocks of electrical equipment and appliances. The size of these stocks depends on past as well as current decisions, and, consequently, on past and current levels of the explanatory factors. If the lag in demand is ignored, standard estimators of the elasticities are inconsistent.

A geometric lag structure is specified in our model, and two alternative estimation procedures are used. In both cases, short-run elasticity estimates (percentage change of demand in the current time period) and long-run elasticity estimates (percentage change of demand after the response is completed) are computed. However, the long-run elasticities have the most direct bearing on the future growth of the demand for electricity. In the following section, specific demand models and expressions for the corresponding elasticities are presented.

2. ALTERNATIVE DEMAND MODELS

In many empirical studies of the demand for electricity, a constant elasticity model is specified. Although a variable elasticity model is preferable with our type of pooled data, the constant elasticity model provides a convenient starting point for the discussion. This model, with a geometric lag structure included, may be written for a particular state and year as follows:

Constant Elasticity Model (CEM):

$$Q_{it} = AQ_{it-1}{}^{\lambda} V_{1it}{}^{\beta_1} \ldots V_{Nit}{}^{\beta_N}, \tag{1}$$

where

i is the ith state,
t is the tth year,
Q is the quantity of electricity demanded,

3. The same argument applies to different years as well. If each elasticity is different for every year and state, estimation is impossible, as the elasticities are underidentified. In this situation, some additional restrictions on the model are required.

V_n is the level of the nth causal factor, and

$A, \lambda, \beta_1, \ldots, \beta_N$ are unknown parameters.

The short-run elasticity for the nth factor is β_n, and the long-run elasticity is $\beta_n/(1 - \lambda)$. The value of λ must lie between 0 and 1, and $1 - \lambda$ is the proportion of the demand response that is completed in the first year. Hence, if λ is close to 0, demand adjusts quickly to changes in the causal factors; if λ is close to 1, demand adjusts slowly.

A simple generalization of this model is to specify that each elasticity varies as the level of the corresponding factor varies. Different forms of the relationship between the elasticity and the factor can be proposed, and it is difficult to choose between the most commonly used alternatives on purely empirical grounds. Our choice of the particular form is based on the suitability of the model for projecting future levels of demand. Specifically, the economic logic of the model is maintained when factors such as population and income increase above the levels observed in the data. The first modification of Eq. (1) is as follows:

Variable Elasticity Model A (VEMA):

$$Q_{it} = AQ_{it-1}{}^{\lambda} \, V_{1it}{}^{\beta_1} \ldots V_{Nit}{}^{\beta_N} \, e^{\gamma_1/V_{1it}} \ldots e^{\gamma_N/V_{Nit}}, \tag{2}$$

where e is a mathematical constant (the base of natural logarithms, $e = 2.7183$) and $\gamma_1, \ldots, \gamma_N$ are additional unknown parameters. The interpretation of λ is the same as in Eq. (1), but the short-run elasticity for the nth factor is now $[\beta_n - (\gamma_n/V_n)]$, and the long-run elasticity is $[\beta_n - (\gamma_n/V_n)]/(1 - \lambda)$. Hence, a particular level of V_n must be specified when evaluating both the short- and long-run elasticities. Both elasticities change if γ_n/V_n changes. When the value of V_n increases, the short-run elasticity approaches β_n asymptotically, and the long-run elasticity approaches $\beta_n/(1 - \lambda)$. In contrast, if V_n decreases towards 0, the elasticities change rapidly and approach infinity. The levels of all factors are expected to increase in the future; consequently, the relatively stable behavior of the elasticities in these circumstances is a desirable property.

The implication of Eq. (2) is that the different values of a particular elasticity between states can be explained exclusively by the level of the corresponding factor in each state. This is still a restrictive model. A further generalization is to specify that each elasticity is also related to various measurable demographic and geographic factors. With a single additional shift variable specified, one possible version of this generalized model is as follows:

Variable Elasticity Model B (VEMB):

$$Q_{it} = Ae^{\delta_0/D_{it}} \, Q_{it-1}{}^{\lambda} \, V_{1it}{}^{\beta_1 + \delta_1/D_{it}} \ldots V_{Nit}{}^{\beta_N + \delta_N/D_{it}} \, e^{\gamma_1/V_{1it}} \ldots e^{\gamma_N/V_{Nit}}, \tag{3}$$

where D is the level of the shift variable and $\delta_0, \delta_1, \ldots, \delta_N$ are additional unknown parameters. Under this specification, the short-run elasticity for the nth factor is $[\beta_n - (\gamma_n/V_n) + (\delta_n/D)]$, and the long-run elasticity is $[\beta_n - (\gamma_n/V_n) + (\delta_n/D)]/(1 - \lambda)$. Examples of shift variables that have been used in other studies are the mean January temperature and the degree of urbanization. However, it should be noted that it has generally been implicitly assumed that only the constant term A is influenced by these shift variables (i.e., that $\delta_0 \neq 0$ and $\delta_1 = \ldots = \delta_N = 0$).

3. ESTIMATION PROCEDURES

The main statistical objective of the analysis is to estimate the unknown parameters in the demand models, as the elasticities may be evaluated directly from these estimates. All three models may be written as a linear function of the parameters. Both the Constant Elasticity Model [CEM, Eq. (1)] and the Variable Elasticity Model A [VEMA, Eq. (2)] are restricted versions of the Variable Elasticity Model B [VEMB, Eq. (3)]; consequently, only the estimation of this latter model needs to be discussed. With the addition of a residual term, the linear form of Eq. (3) may be written as follows:

$$\log Q_{it} = \alpha + \delta_0 \frac{1}{D_{it}} + \lambda \log Q_{it-1} + \sum_{n=1}^{N} \beta_n \log V_{nit} + \sum_{n=1}^{N} \delta_n \frac{\log V_{nit}}{D_{it}} + \sum_{n=1}^{N} \gamma_n \frac{1}{V_{nit}} + \epsilon_{it}, \quad (4)$$

where $\alpha = \log A$ and ϵ is an unobserved stochastic residual. If the terms related to $\delta_0, \delta_1, \ldots, \delta_N$ are omitted, Eq. (4) is equivalent to the linear form of VEMA, and if in addition the terms for $\gamma_1, \ldots, \gamma_N$ are omitted, to the linear form of CEM.

Alternative regression procedures may be used to estimate the parameters in Eq. (4), and the properties of the residuals determine which procedure has the best statistical properties. Following Balestra and Nerlove (1966), econometricians have become increasingly interested in estimating models from pooled cross-section and time-series data. Most of these procedures use variance components techniques and imply that the residual in Eq. (4) contains components that are specific to each state and to each year. However, the increased efficiency of variance components estimation is noticeable only if the residual variance is relatively large. As our models fit the data extremely well, little advantage would result from using these more cumbersome techniques. On the other hand, if the more traditional procedure of identifying each state and year by a separate variable is followed, the effective variation of the explanatory factors is reduced. Estimation of the elasticity parameters is correspondingly less efficient. Nevertheless, omitting these variables could, in certain situations, lead to inconsistent estimators due to bias. A compromise solution is adopted in our analysis, and nine regions in the U.S. are identified. This implies that the constant term α is different in each of these nine regions.

Estimates in most regression analyses are derived using ordinary least-squares (OLS) techniques. The presence of a lagged dependent variable $\log Q_{it-1}$ in Eq. (4) makes the reliability of OLS very sensitive to the residual specifications. The consistency of OLS estimators holds only if the residuals are not serially correlated. For this reason, a more robust procedure, instrumental variables (IV), is used as well as OLS. The details of both OLS and IV estimation are outlined in Appendix A.

It is convenient at this point to summarize other empirical analyses of electricity demand. In Table 1, seven recent studies are cited, and information on the source of data, the factors considered, the type of model, and the estimation procedure used is provided. However, no attempt to appraise the specific empirical results in these studies is made until the final section.

4. THE EMPIRICAL RESULTS

Alternative demand models are estimated for the three dominant consumer classes which can be readily identified in the data sources: residential (R), commercial (C), and industrial (I). Annual observations of all variables in the models were obtained for 47 contiguous states[4] in the U.S. from 1947 to 1970, and the

4. North and South Carolina are combined together in some data sources, and so are Maryland and the District of Columbia.

Table 1. Summary of Recent Studies of Electricity Demand

Authors Date of Publication Class of Consumer	Type of Data	Variables Included 1/ P_E	Y	N	P_F	T	Others	Type of Elasticity Models	Type of Distributed Lag	Estimation Procedure
1. Fisher and Kaysen (1962) R and I	Annual time series for each of 47 US states. (1946-1957)	X	X	2/		X		CEM for each state and industry	None	OLS on first differences of variables
2. Baxter and Rees (1968) I	Quarterly time series for industries in UK. (1954-1964)	X			X	X	Industrial output, Temperature, Wage rate	CEM and a linear function for each industry	Geometric	OLS
3. MacAvoy (1969) Combined	Pooled quadrennial time series for 9 regions in US. (1958-1972)	X	X	X				CEM	None	OLS
4. Wilson (1971) R	Cross section of 77 cities in US. (1967)	X	X	2/	X		Housing unit size, Temperature	CEM and a linear function	None	OLS
5. Halvorsen (1972) R	Pooled annual time series for 47 states in US. (1961-1969)	X	X	2/	X		Temperature, Urbanization	CEM, hyperbolic and linear functions	None	Simultaneous model using two stage least squares
6. Anderson (1972) R	Cross section of 47 states in US. (1969)	X	X	2/	X		Housing unit size, Temperature, Urbanization	CEM	None	OLS
7. Griffin (1972) R and (C + I)	Annual national totals for the US. (1950- 1970)	X	X	2/	X		Stock of air conditioners	CEM	Almon	OLS

1/ P_E = Price of Electricity, Y = Income, N = Population, P_F = Price of Alternative Fuel, T = Trend, Price of Appliances not included in any study.

2/ Quantity variables specified on a per capita or per household basis.

exact specifications of these variables are summarized in Table 2. The demand models discussed in Sect. 2 are all single-equation models. Hence, an implicit assumption is made that all five causal factors (population, income, and the prices of electricity, gas, and electrical appliances or machinery) are exogenous. In other words, the quantity of electricity demanded is determined for given values of these variables for every state and year. It is debatable, however, whether this assumption is strictly correct for the price of electricity. A typical rate schedule implies that large-scale users pay lower prices (decreasing block rates), and, consequently, that price is not independent of quantity for an individual consumer. Incorporating the concept of decreasing block rates into a demand model introduces two interrelated problems: simultaneity between quantity and price, and determining whether average or marginal prices are appropriate for the analysis.

The choice between average and marginal prices has been discussed by Wilson (1969) and Halvorsen (1972). In economic theory, consumer decisions are based on marginal prices, and Wilson favors this approach. On the other hand, average prices are of more practical importance to utility companies. Maintaining stability between average prices and average costs is a well-established practice of the regulatory agencies, which is achieved by modifying existing rate schedules. In both Halvorsen's and our models, average prices are preferred. In fact, the empirical evidence provided by Wilson suggests that results derived using marginal prices, based on typical billing, and using average prices are effectively identical. The similarity between these two alternatives may be partly due to the use of aggregated data. No unique marginal or average price exists for any city or state; consequently, the distinction between the two pricing systems may be obscured. We interpret the average price as a measure of the effective level of the rate schedule for a particular consumer class.

With regard to the simultaneity problem, single-equation models could lead to biased estimates of the parameters. Only Halvorsen has incorporated simultaneity into a demand model. Interestingly enough, the estimated demand parameters in his simultaneous model are very similar to the estimates that he obtains using a single-equation estimation technique (OLS). Even if a simultaneous model is preferred, the exact model specification of the pricing procedures used by utility companies is not straightforward. These procedures involve a synthesis of past experiences with established rate schedules, anticipation of future demand, and an evaluation of generating costs. Differences between rate schedules will bear a closer relationship to these types of considerations than to purely quantity effects.[5]

In summary, there is no empirical evidence that either the use of marginal prices or the consideration of simultaneity gives results that conflict with those obtained with average prices and single-equation models. In addition, rate adjustments tend to stabilize average prices to maintain a balance with average costs; consequently, it is not unreasonable to consider that consumers are aware of average prices and consider supply to be elastic in the short run.

Three demand models [Eqs. (1), (2), and (3)] and two alternative estimation procedures (OLS and IV) are discussed in Sects. 2 and 3, but only three of the six possible estimated models for each consumer class are presented here. Although the variable elasticity models (VEMA and VEMB) are more suited to our data, the constant elasticity model (CEM) has been widely used in other econometric studies of electricity demand (see Table 1). Consequently, the OLS estimate of CEM is given for comparative purposes. Estimates of VEMB, using the mean January temperature as the shift variable, showed no improvement over VEMA estimates, and only the OLS and IV estimates of VEMA are given.

5. This does not imply that further analysis of pricing procedures is unwarranted, as this is obviously an important area of study.

Table 2. The Specifications and Sources of Variables Used in the Demand Models

	Variable	Type of Variable 1/	Consumer Class 2/	Units of Measurement	Source
1.	Quantity Demanded	Q	R, C, I	Million kilowatt hours (KWH)	Edison Electric Institute Yearbook
2.	Population	V	Same	Thousands	Statistical Abstract of the U.S.
3.	Income	V	Same	Thousands of 1970 dollars per capita (deflated by Consumer Price Index)	Survey of Current Business
4.	Price of Electricity	V	R, C, I	Average mills/KWH received in 1970 dollars 3/	Edison Electric Institute Yearbook
5.	Price of Gas 4/	V	R, C, I	Average 1970 dollars/ thousand therms 3/ (lagged one year)	Gas Facts
6.	Price of Appliances or Machinery	V	R, C and I are the same	Index of appliance prices corrected to 1970 dollars 3/ (lagged one year)	Survey of Current Business
7.	Mean January Temperature (same for each year)	D	Same	Degrees Fahrenheit for largest town in state	Statistical Abstract of the U.S.

1/ These letters refer to the variables identified in equations 1, 2 and 3.

2/ "R, C, I" implies the variable is different for each of the three consumer classes. "Same" implies that no distinction is made between classes.

3/ Residential prices are deflated by the consumer price index. Commercial and industrial prices are deflated by the wholesale price index. Both these price indices are listed in the Survey of Current Business.

4/ **Includes natural, liquid petroleum, manufactured and mixed gas. However, natural gas is by far the largest source.**

The regression results for three estimated models and all three classes of consumers are summarized in Table B-1. In these nine cases, the fit of the model is good, and the multiple correlation coefficient (R^2) is over 0.99 for each of the models estimated by OLS.[6] Certain restrictions were imposed on the initial estimates that account for the zero coefficients for some variables. These restrictions were chosen on statistical grounds and also to maintain the economic logic of the estimated elasticity values.[7] For example, the coefficients for the log of income (β) were slightly negative in two of the models estimated by IV and are constrained to 0 in the final models. This procedure ensures that the income elasticities are nonnegative at high income levels.

In general, the major conclusion of the analysis is that the price of electricity is more important than income in terms of the long-run elasticities (LRE). Demand for all three consumer classes is generally elastic with respect to price and inelastic with respect to income. The LRE of population is close to 1, as would be expected, and the LRE for the price of gas is consistently very small. The LRE for the price of appliances is inelastic for class R and was constrained to 0 for C and I due to the incorrect sign of the initial estimates.

The estimated LRE's for each of the three models are surprisingly consistent with each other. The major difference between the IV and OLS estimates of VEMA is that the implied rate of adjustment is faster using IV (λ is closer to 0).[8] This is particularly true with classes C and I. Hence, even though the LRE's are similar, the short-run elasticities are generally larger with IV. Attempts to determine which model is most appropriate by predicting the 1971 demand for each state (1971 data are not used for estimation) suggest that the OLS models are better, particularly for class I.

The LRE's for population, income, and the price of electricity depend on the level of the corresponding factor for both the OLS and IV estimates of VEMA. The LRE's for the prices of gas and appliances, on the other hand, are constant in all models. Estimates of the LRE's for all models are summarized for two contrasting states (New York and Tennessee) at 1971 factor levels in Table 3, and a complete summary of the estimated variable LRE's and their 95% confidence intervals is given in Table B-2 for all 47 states at 1971 factor levels.

The exact relationships between the variable LRE estimates and the factor levels are illustrated in Fig. 1 for all three consumer classes. The LRE of population is similar in all classes and is close to 1 in all but the smallest states. In contrast, the income and price LRE's vary considerably over the observed range of factor levels. The LRE of income increases (except for class C using OLS) as income decreases and, in fact, is elastic for class I at low income levels. However, income is expected to rise in the future; consequently, its LRE will become increasingly inelastic, approaching 0 in classes R and I, and remaining fairly stable at slightly less than unit elasticity in class C. On the other hand, the LRE of price is inelastic at low price levels and becomes increasingly elastic as price increases. The relative price of electricity is expected to rise in the future for all consumer classes; as a result, price will become a more important determinant of electricity demand. This effect is particularly important in class I, as the LRE of price is more elastic at high prices in this class than in R or C. In spite of this, the price is generally lower for class I than for R and C (e.g., the lowest price in 1971 is 3.10 mills/kWhr in Washington for class I); consequently, the industrial LRE of price may currently be more inelastic in some regions relative to the other consumer classes. If all prices increase,

6. R^2 is an inappropriate measure of fit for the IV models, as the estimated residuals are not orthogonal to the explanatory variables.

7. Only one of the ten constraints imposed in the three OLS estimates of VEMA is clearly significant on the basis of standard F tests ($\gamma = 0$ for the price of appliances in class R). Imposing this constraint, however, has little effect on the economic implications of the other elasticities. No similar test exists for the constraints in the IV estimates of VEMA, but the constraints are similar to those imposed on the corresponding OLS models.

8. This is consistent with the direction of bias of the OLS estimate of λ if there is positive serial correlation [see the footnote under (A5) in Appendix A. The corresponding element of Σ^{-1} is on the diagonal and must be positive].

Table 3. Estimated Long-Run Elasticities for the Demand of Electricity

(Evaluated at 1971 Factor Levels)

Class of Demand	Factor	Elasticity Model	Estimation Procedures	New York	Tennessee	Mean Level for All States
Residential	Population	Constant	OLS	.94	.94	.94
		Variable	OLS	1.00	.99	.99
			IV	.96	.95	.95
	Income	Constant	OLS	.30	.30	.30
		Variable	OLS	.19	.21	.20
			IV	.17	.25	.21
	Price of Electricity	Constant	OLS	-1.21	-1.21	-1.21
		Variable	OLS	-1.24	-1.10	-1.20
			IV	-1.34	- .96	-1.24
	Price of Gas	Constant	OLS	.21	.21	.21
		Variable	OLS	.19	.19	.19
			IV	.13	.13	.13
	Price of Appliances	Constant	OLS	- .36	- .36	- .36
		Variable	OLS	- .42	- .42	- .42
			IV	- .74	- .74	- .74
Commercial	Population	Constant	OLS	.98	.98	.98
		Variable	OLS	1.04	1.02	1.03
			IV	.99	.98	.98
	Income	Constant	OLS	.80	.80	.80
		Variable	OLS	.93	.81	.86
			IV	.87	.89	.88
	Price of Electricity	Constant	OLS	-1.60	-1.60	-1.60
		Variable	OLS	-1.65	-1.12	-1.36
			IV	-1.50	-1.40	-1.45
	Price of Gas	Constant	OLS	.05	.05	.05
		Variable	OLS	.06	.06	.06
			IV	.04	.04	.04
Industrial	Population	Constant	OLS	1.09	1.09	1.09
		Variable	OLS	.99	1.01	1.01
			IV	1.02	1.05	1.05
	Income	Constant	OLS	.72	.72	.72
		Variable	OLS	.40	.60	.51
			IV	.50	.76	.65
	Price of Electricity	Constant	OLS	-1.79	-1.79	-1.79
		Variable	OLS	-1.89	-1.53	-1.82
			IV	-1.81	-1.46	-1.74
	Price of Gas	Constant	OLS	.00	.00	.00
		Variable	OLS	.00	.00	.00
			IV	.06	.06	.06

Factor (Units given in Table 2)		Level of factor		
Population		18391	3990	4365
Income		4.81	3.19	3.72
Price of Electricity	Residential	29.39	12.13	21.39
	Commercial	29.29	16.01	20.26
	Industrial	12.20	7.70	10.89
Price of Gas	Residential	137.70	89.12	117.89
	Commercial	127.07	72.35	90.84
	Industrial	74.56	36.50	47.22

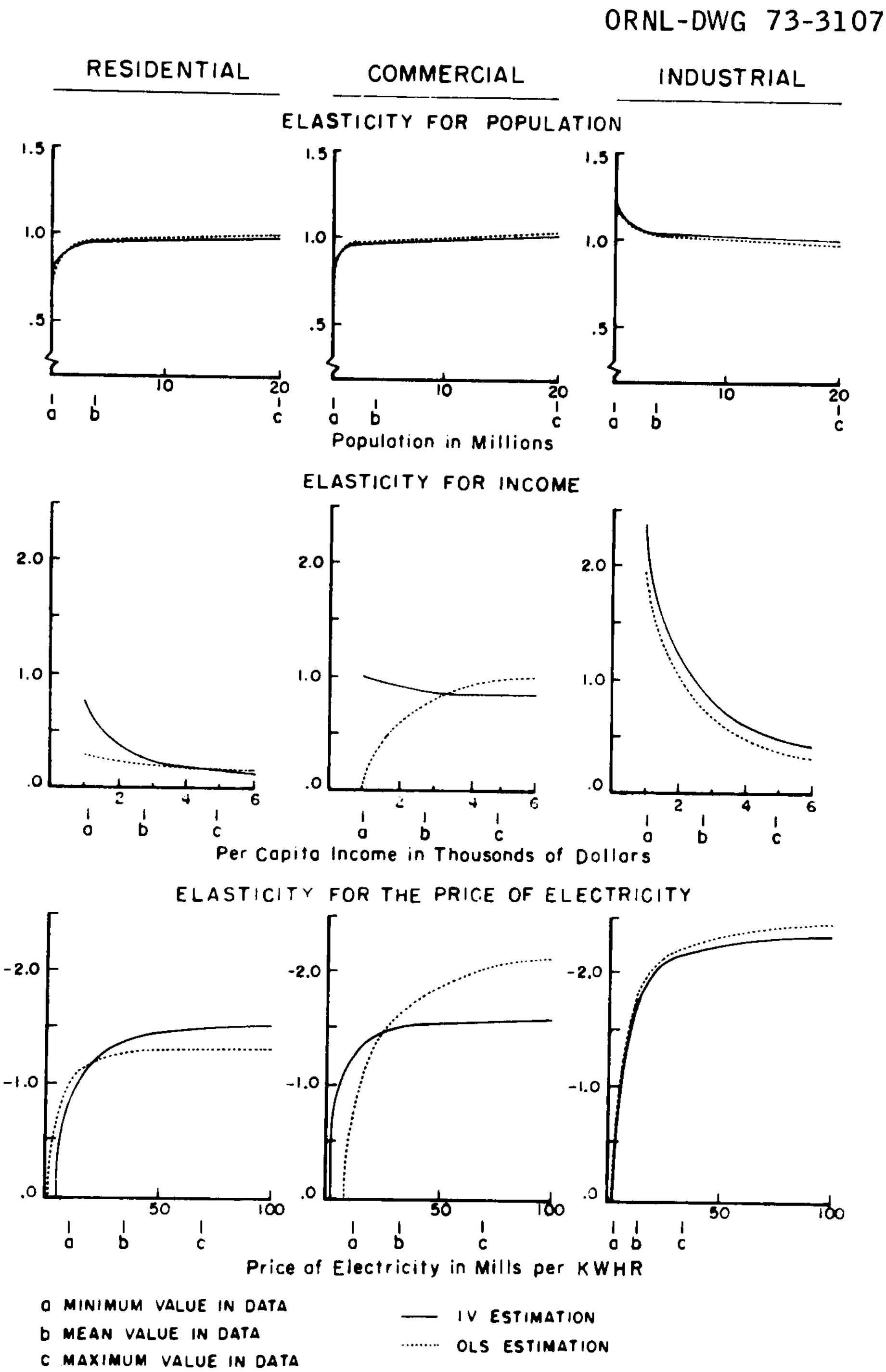

Fig. 1. Demand elasticity for population, income, and the price of electricity.

however, this situation will change, and eventually class I may exhibit the highest LRE for price in all regions.

5. CONCLUSIONS

The estimated long-run elasticities summarized in Table 3 demonstrate that electricity demand is generally price elastic for all three consumer classes, and becomes increasingly elastic as prices rise. In contrast, demand is generally inelastic with respect to income and, for residential and industrial classes, approaches 0 as income increases. The income elasticity for commerical demand is, however, only slightly inelastic over a wide range of income levels. Population exhibits approximately unit elasticity for all classes,[9] and the elasticities for both the prices of gas and appliances are consistently found to be inelastic.

Generally, demand is found to be income inelastic in other studies, but the nature of the price elasticity is more controversial. In particular, Fisher and Kaysen (1962) and Griffin (1972) conclude that the long-run price relationship is clearly inelastic. On the other hand, Wilson (1969), MacAvoy (1969), and Halvorsen (1972) find the relationship elastic. The results of Baxter and Rees (1968) and Anderson (1972) are less clear-cut. While it is difficult to make any direct comparison between these analyses due to the wide variety of models and data sources, one general comment is appropriate. Does the stock of electrical appliances and machinery respond to changes in the price of electricity? Fisher and Kaysen conclude that it does not, and Griffin implicitly assumes that price does not influence the stock as the number of air conditioners is identified as a separate exogenous variable in his demand model. Hence, price influences the intensity of use of existing stocks but not the size of the stock itself. In contrast, our results and those of Wilson, MacAvoy, and Halvorsen suggest that price also plays a role in determining the life style of residential consumers (e.g., whether or not to install air conditioning), and the types of facilities and production methods employed by commerical and industrial consumers. However, it should be remembered that demand responds relatively slowly to changes in the causal factors; consequently, any adaptation of present life styles or of existing facilities and production methods will also be very gradual.

The relative importance of price as a determinant of demand has implications for the future need of generating capacity. If prices increase over the next few years in response to increased fuel costs, etc., the growth of electricity demand will gradually decrease from the present rate. No accelerated growth of population or income is expected to offset this price effect. We have discussed the broad implications of this conclusion in an earlier article [Chapman et al. (1972)]. In summary, we consider that planning new generating capacity by extrapolating past trends significantly overestimates the future need for additional capacity.

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9. This implies that the common practice of estimating demand models on a per capita basis is reasonable.

Appendix A

ESTIMATION OF THE DEMAND ELASTICITIES

It is shown in Sect. 3 that all three demand models can be linearized and that the unknown parameters can be estimated using linear regression procedures. Before discussing the statistical properties of the estimators, it is convenient to express the linear form of Eq. (4) in matrix notation as follows:

$$Y = L\lambda + X\theta + \epsilon, \tag{A1}$$

where

$Y = [\log Q_{it}]$ is a $T \times 1$ vector of the dependent variable,
$L = [\log Q_{it-1}]$ is a $T \times 1$ vector of the lagged dependent variable,
$X = [1\ (1/D_{it}) \log V_{1it} \ldots \log V_{Nit}\ (\log V_{1it}/D_{it}) \ldots (\log V_{Nit}/D_{it})\ (1/V_{1it}) \ldots (1/V_{Nit})]$ is a $T \times K$ matrix of explanatory variables $[K = 2 + 3N$ in Eq. (4)$]$,
$\epsilon = [\epsilon_{it}]$ is a $T \times 1$ vector of unknown residuals,
λ is an unknown scalar,
$\theta = [\alpha_0\ \delta_0 \beta_1 \ldots \beta_N \delta_1 \ldots \delta_N\ \gamma_1 \ldots \gamma_N]$ is a $K \times 1$ vector of unknown parameters, and
T is the total number of observations for all states and years.

The variables in X are assumed to be nonstochastic, but ϵ is stochastic; consequently, Y and L are also stochastic. The number of variables included in X, and hence the size of K, depends on which demand model is being considered. Specifying that a particular parameter is 0 is equivalent to omitting the corresponding variable from (A1).

The statistical properties of the residual term determine which estimation procedure is appropriate. For example, the consistency of ordinary least-squares (OLS) estimation is critically dependent on whether the lagged dependent variable L is statistically independent of the residual term ϵ. If the residuals exhibit any interdependence through time, such as first-order serial correlation, the OLS estimator is inconsistent due to bias. One set of specifications under which the OLS estimator of (A1) is consistent [see Goldberger (1964), p. 269] is the following:[10]

(i) X is nonstochastic,
(ii) $E[\epsilon] = 0$,
(iii) $E[\epsilon\epsilon'] = \sigma_\epsilon^2 I$,
(iv) $\text{Plim } T^{-1}\ \epsilon'\epsilon = \sigma_\epsilon^2$,
(v) $\text{Plim } T^{-1} \begin{bmatrix} L'L & L'X \\ X'L & X'X \end{bmatrix} = \mathbf{\Sigma}$ ($\mathbf{\Sigma}$ is nonsingular), (A2)
(vi) $\text{Plim } T^{-1} L'\epsilon = 0$,

where

E denotes the expected value,
Plim denotes the probability limit,

10. No allowance for trend components is made explicitly in condition (v) of (A2). Conceptually, however, observations can be increased by adding more cross-section units as well as by adding more time periods.

I is an identity matrix of order T,
σ_ϵ^2 is the unknown variance of the residuals, and
$\mathbf{\Sigma}$ is a $(K+1) \times (K+1)$ matrix of unknown finite scalars.

The OLS estimator of λ and θ is:

$$\begin{bmatrix} \hat{\lambda} \\ \hat{\theta} \end{bmatrix} = \begin{bmatrix} L'L & L'X \\ X'L & X'X \end{bmatrix}^{-1} \begin{bmatrix} L'Y \\ X'Y \end{bmatrix}. \tag{A3}$$

A consistent estimator of the asymptotic variance covariance matrix of (A3) is

$$\hat{\sigma}_\epsilon^2 \begin{bmatrix} L'L & L'X \\ X'L & X'X \end{bmatrix}^{-1}, \tag{A4}$$

where $\hat{\sigma}_\epsilon^2 = (T-K-1)^{-1}\, \hat{\epsilon}'\hat{\epsilon}$ and $\hat{\epsilon} = Y - L\hat{\lambda} - X\hat{\theta}$. The values of (A3) and (A4) may be computed with any standard OLS regression program. However, it should be remembered that the stochastic nature of L implies that all the familiar statistical tests used in regression analyses are only valid asymptotically.

If condition (vi) of (A2) does not hold, as is the case when the residuals are serially correlated, the OLS estimator is inconsistent as

$$\text{Plim} \begin{bmatrix} \hat{\lambda} \\ \hat{\theta} \end{bmatrix} = \begin{bmatrix} \lambda \\ \theta \end{bmatrix} + \text{Plim}\, T^{-1} \begin{bmatrix} L'L & L'X \\ X'L & X'X \end{bmatrix}^{-1} \begin{bmatrix} \text{Plim}\, T^{-1}L'\epsilon \\ \text{Plim}\, T^{-1}X'\epsilon \end{bmatrix} = \begin{bmatrix} \lambda \\ \theta \end{bmatrix} + \mathbf{\Sigma}^{-1} \begin{bmatrix} \text{Plim}\, T^{-1}L'\epsilon \\ 0 \end{bmatrix}. \tag{A5}$$

It is only when $\text{Plim}\, T^{-1}L'\epsilon = 0$ that the second term on the right hand side of (A5) is 0, and this term represents the asymptotic bias of (A3).[11] Whenever $\text{Plim}\, T^{-1}L'\epsilon \neq 0$, all the estimated parameters are biased using OLS.

In situations where the bias in (A5) is not 0, an alternative estimator, instrumental variables (IV), is consistent [see Goldberger (1964), p. 284]. Although other procedures, such as maximum likelihood estimation, may give more efficient estimators than IV, these procedures imply solving a system of nonlinear equations, and suitable iterative programs are generally unavailable for our type of pooled data. Hence, IV is a convenient method to use, and it provides alternative estimates that can be compared with the OLS results.

The instrumental variable estimator of λ and θ may be written as follows:

$$\begin{bmatrix} \tilde{\lambda} \\ \tilde{\theta} \end{bmatrix} = \begin{bmatrix} L^{*\prime}L & L^{*\prime}X \\ X'L & X'X \end{bmatrix}^{-1} \begin{bmatrix} L^{*\prime}Y \\ X'Y \end{bmatrix}, \tag{A6}$$

where L^* is a $T \times 1$ vector of the instrument for L and is chosen so that $\text{Plim}\, T^{-1}L^{*\prime}\epsilon = 0$. A consistent estimator of the asymptotic variance covariance matrix of (A6) is[12]

$$\tilde{\sigma}_\epsilon^2 \begin{bmatrix} L^{*\prime}L & L^{*\prime}X \\ X'L & X'X \end{bmatrix}^{-1} \begin{bmatrix} L^{*\prime}L^* & L^{*\prime}X \\ X'L^* & X'X \end{bmatrix} \begin{bmatrix} L'L^* & L'X \\ X'L^* & X'X \end{bmatrix}^{-1}, \tag{A7}$$

---

11. If the residuals exhibit first-order serial correlation and $\epsilon_{it} = \rho\epsilon_{it-1} + \omega_{it}$ where all ω_{it} are uncorrelated and have the same variance σ_ω^2, then $\text{Plim}\, T^{-1}L'\epsilon = \rho\sigma_\omega^2$ and $\text{Plim}\, T^{-1}\, \epsilon'\epsilon = \sigma_\omega^2/(1-\rho^2)$.

12. No attempt is made to introduce serial correlation or any other type of residual interdependence explicitly into the model, and (A7) is evaluated as though $E[\epsilon\epsilon'] = \sigma_\epsilon^2 I$. Although this implies that (A7) is only an approximation of the true matrix, the consistency of (A6) is not affected by this. Improvements to (A7) can only be made if the form of $E[\epsilon\epsilon']$ is known together with the values (estimates) of any additional parameters.

where $\tilde{\sigma}_{\epsilon}^2 = (T - K - 1)^{-1} \tilde{\epsilon}'\tilde{\epsilon}$ and $\tilde{\epsilon} = Y - L\tilde{\lambda} - X\tilde{\theta}$. One possible instrument for L is to use a linear combination of the lagged variables in X, and we adopt the following definition of L^*:

$$L^* = X_{-1}\hat{\Phi},$$

where X_{-1} is the matrix X lagged by one time period and $\hat{\Phi} = (X'_{-1}X_{-1})^{-1}X'_{-1}L$ is a $K \times 1$ vector of OLS estimates.

Appendix B

ESTIMATION OF THE SHORT- AND LONG-RUN DEMAND ELASTICITIES

Estimates of the parameters for any of the three demand models and the variance covariance matrix of these estimates may be computed using (A3) and (A4) for OLS and (A6) and (A7) for IV. Although the following expressions are presented only for the OLS estimates, the IV expressions are equivalent.

The estimated short-run elasticity (S_n) for factor V_n is

$$\hat{S}_n = \hat{\beta}_n - \hat{\gamma}_n/V_n + \hat{\delta}_n/D, \tag{A8}$$

with variance

$$\hat{\sigma}_{\hat{S}_n}^2 = \text{Var}(\hat{\beta}_n) + \text{Var}(\hat{\gamma}_n)/V_n^2 + \text{Var}(\hat{\delta}_n)/D^2 - 2\,\text{Cov}(\hat{\beta}_n, \hat{\gamma}_n)/V_n + 2\,\text{Cov}(\hat{\beta}_n, \hat{\delta}_n)/D - 2\,\text{Cov}(\hat{\gamma}_n, \hat{\delta}_n)/(V_nD), \tag{A9}$$

where $\hat{\beta}_n$, $\hat{\gamma}_n$, and $\hat{\delta}_n$ are estimates in (A3) and the individual variances and covariances on the right hand side are estimates in (A4). Both (A8) and (A9) are computed for specified levels of the factor V_n and the shift variable D. Assuming that ϵ is normally distributed and that the sample size is large, the 95% confidence interval for S_n is $\hat{S}_n \pm 1.96\,\hat{\sigma}_{\hat{S}_n}$.

The long-run elasticity (L_n) of factor V_n is derived by dividing S_n by $1 - \lambda$, and the estimated value is

$$\hat{L}_n = \hat{S}_n/(1 - \hat{\lambda}), \tag{A10}$$

where $\hat{\lambda}$ is the estimated lag coefficient in (A3).

Assuming that ϵ is normally distributed, the distribution of $\hat{L}_n$ may be approximated by a normal distribution if $1 - \hat{\lambda}$ is significantly different from 0 [e.g., see Griliches (1967), p. 32]. With a large sample, the 95% confidence interval for L_n is determined by solving the following quadratic equation for Z, and the two solution values are the end points of the 95% confidence interval.

$$[(1 - \hat{\lambda})^2 - 1.96^2\,\text{Var}(\hat{\lambda})]Z^2 - 2[\hat{S}_n(1 - \hat{\lambda}) + 1.96^2\,\text{Cov}(\hat{\lambda}, \hat{S}_n)]Z + [\hat{S}_n^2 - 1.96^2\,\hat{\sigma}_{\hat{S}_n}^2] = 0, \tag{A11}$$

where $\hat{S}_n$ and $\hat{\sigma}_{\hat{S}_n}^2$ are defined in (A8) and (A9), respectively, $\text{Var}(\hat{\lambda})$ is an estimate in (A4), $\text{Cov}(\hat{\lambda}, \hat{S}_n) = -\text{Cov}(\hat{\lambda}, \hat{\beta}_n) + \text{Cov}(\hat{\lambda}, \hat{\gamma}_n)/V_n - \text{Cov}(\hat{\lambda}, \hat{\delta}_n)/D$, and these last three covariances are estimates in (A4).

Equivalent expressions may be derived from (A8), (A9), (A10), and (A11) for the other two demand models. If all terms related to $\hat{\delta}_n$ and D are omitted, the expressions may be used for the Variable Elasticity

Model A [VEMA, Eq. (2)]. If, in addition, all terms related to γ_n and V_n are omitted, the expressions may be used for the Constant Elasticity Model [CEM, Eq. (1)].

The estimated regression coefficients for the three consumer classes and for the three alternative models are summarized in Table B-1. In addition, short- and long-run elasticity estimates are given for the OLS and IV estimates of VEMA for each state and for each consumer class in Table B-2. For population, income, and the price of electricity (factors for which the estimate of γ is not 0), the elasticity estimates are evaluated at 1971 levels of the factors. The parameter estimates required for calculating these elasticities and the corresponding confidence intervals are summarized in Table B-3.

Table B-1. Parameter Estimates for the Constant and Variable Elasticity Models

Explanatory Factor	Units of Measurement	Parameter Estimated	RESIDENTIAL Constant Elasticity OLS	RESIDENTIAL Variable Elasticity (Model A) OLS	RESIDENTIAL Variable Elasticity (Model A) IV	COMMERCIAL Constant Elasticity OLS	COMMERCIAL Variable Elasticity (Model A) OLS	COMMERCIAL Variable Elasticity (Model A) IV	INDUSTRIAL Constant Elasticity OLS	INDUSTRIAL Variable Elasticity (Model A) OLS	INDUSTRIAL Variable Elasticity (Model A) IV
1. Lagged demand	Million kilowatt hours	λ	.8859 (136.5)	.8837 (119.2)	.7177 (33.0)	.8735 (75.7)	.8724 (75.7)	.1843 (2.4)	.8869 (79.9)	.8765 (76.5)	.2167 (2.7)
2. Population	Thousands	β	.1075 (17.0)	.1172 (15.3)	.2703 (13.3)	.1244 (10.6)	.1333 (10.2)	.8105 (10.4)	.1237 (8.5)	.1220 (7.5)	.7970 (9.1)
		γ	.0000 ---	9.7821 (3.3)	8.3737 (2.3)	.0000 ---	10.5007 (1.6)	32.9935 (2.4)	.0000 ---	-11.7364 (1.0)	-97.7104 (3.5)
3. Income	Thousand dollars per capita (deflated)	β	.0343 (4.2)	.0195 (0.6)	.0000 ---	.1011 (5.3)	.1486 (2.5)	.6825 (4.9)	.0817 (3.3)	.0000 ---	.0000 ---
		γ	.0000 ---	-.0139 (0.2)	-.2246 (6.8)	.0000 ---	.1432 (1.0)	-.1387 (0.5)	.0000 ---	-.2358 (3.6)	-1.8921 (8.0)
4. Price of Electricity	Mills per kilowatt hour (deflated)	β	-.1385 (12.5)	-.1552 (7.7)	-.4524 (10.4)	-.2030 (9.6)	-.2925 (6.2)	-1.3242 (8.9)	-.2021 (8.1)	-.3097 (8.9)	-1.8867 (9.1)
		γ	.0000 ---	-.3304 (0.9)	-2.1965 (4.2)	.0000 ---	-2.4014 (2.0)	-2.8931 (1.2)	.0000 ---	-.9290* (8.9)	-5.7016 (5.4)
5. Price of Gas	Dollars per thousand therms (deflated)	β	.0238 (6.7)	.0225 (6.2)	.0370 (7.7)	.0068 (1.0)	.0082 (1.1)	.0305 (2.0)	.0000 ---	.0000 ---	.0475 (2.4)
6. Price of Appliances	Price index (deflated)	β	-.0408 (2.4)	-.0486 (2.5)	-.2094 (7.5)	.0000 ---	.0000 ---	.0000 ---	.0000 ---	.0000 ---	.0000 ---
7. Region	North East	α	.4620	.4986	1.7699	.5960	.8115	3.4981	.4897	1.1280	6.4089
	Mid Atlantic	α	.4612	.4917	1.7564	.5897	.7958	3.5180	.4363	1.0766	6.0087
	East North Central	α	.4802	.5117	1.7818	.5930	.8021	3.5006	.4814	1.1190	6.2585
	West North Central	α	.5056	.5404	1.8319	.6180	.8340	3.6629	.4374	1.0640	5.8895
	South Atlantic	α	.4858	.5181	1.7669	.6088	.8178	3.5222	.4764	1.1052	6.1519
	East South Central	α	.4844	.5150	1.7443	.5619	.7692	3.3090	.4995	1.1335	6.3657
	West South Central	α	.5175	.5492	1.8190	.6381	.8484	3.6860	.4639	1.0876	6.0289
	Mountain	α	.4837	.5151	1.7641	.6392	.8493	3.6691	.4635	1.0875	6.0307
	Pacific	α	.4679	.5020	1.7445	.5688	.7862	3.3586	.3586	1.0050	5.5643
Estimated Residual Variance			.001335	.001324	.002042	.006834	.006795	.029547	.022271	.022034	.090169
Sum of Squared Residuals			1.4229	1.4071	2.1725	7.2917	7.2295	31.4384	23.7852	23.5100	96.0305

* The constraint $\gamma = 3\beta$ is imposed for the industrial price of electricity in this model **to ensure that the estimated price elasticity is negative for all observed price levels.**

Table B-2. Elasticity Estimate for Population, Income, and Price of Electricity

State	Class Demand	Est. Procedure	Population: Level of Factor (thous.)	Population: SR Elasticity	Population: Long Run Elasticity Estimate	Population: Long Run Elasticity 95% C.I.	Income: Level of Factor (thous.)	Income: SR Elasticity	Income: Long Run Elasticity Estimate	Income: Long Run Elasticity 95% C.I.	Price of Electricity: Level of Factor (mills/KWH)	Price of Electricity: SR Elasticity	Price of Electricity: Long Run Elasticity Estimate	Price of Electricity: Long Run Elasticity 95% C.I.
Me	R	OLS	1003	.11	.92	.89 - .95	3.28	.02	.20	.02 - .40	25.04	- .14	-1.22	-1.33 - -1.11
		IV		.26	.93	.91 - .94		.07	.24	.19 - .29		- .36	-1.29	-1.35 - -1.23
	C	OLS		.12	.96	.90 - 1.03		.10	.82	.49 - 1.15	24.60	- .19	-1.53	-1.75 - -1.31
		IV		.78	.95	.93 - .97		.72	.89	.78 - 1.00		-1.21	-1.48	-1.55 - -1.41
	I	OLS		.13	1.08	.97 - 1.19		.07	.58	.28 - .87	11.29	- .23	-1.84	-2.10 - -1.59
		IV		.89	1.14	1.10 - 1.18		.58	.74	.64 - .83		-1.38	-1.76	-1.85 - -1.68
N. H.	R	OLS	762	.10	.90	.86 - .94	3.56	.02	.20	-.00 - .42	25.05	- .14	-1.22	-1.33 - -1.11
		IV		.26	.92	.90 - .94		.06	.22	.17 - .27		- .36	-1.29	-1.35 - -1.23
	C	OLS		.12	.94	.86 - 1.02		.11	.85	.48 - 1.21	26.58	- .20	-1.58	-1.79 - -1.39
		IV		.77	.94	.91 - .97		.72	.88	.77 - 1.00		-1.22	-1.49	-1.56 - -1.42
	I	OLS		.14	1.11	.97 - 1.25		.07	.54	.26 - .80	12.81	- .24	-1.92	-2.19 - -1.65
		IV		.93	1.18	1.13 - 1.23		.53	.68	.59 - .77		-1.44	-1.84	-1.93 - -1.75
Vt.	R	OLS	458	.10	.82	.75 - .90	3.46	.02	.20	-.00 - .42	21.25	- .14	-1.20	-1.33 - -1.08
		IV		.25	.89	.85 - .93		.06	.23	.18 - .28		- .35	-1.24	-1.30 - -1.17
	C	OLS		.11	.87	.71 - 1.02		.11	.84	.49 - 1.19	22.09	- .18	-1.44	-1.71 - -1.17
		IV		.74	.91	.85 - .96		.72	.89	.77 - 1.00		-1.19	-1.46	-1.55 - -1.38
	I	OLS		.15	1.20	.91 - 1.47		.07	.55	.27 - .83	14.48	- .25	-1.99	-2.27 - -1.71
		IV		1.01	1.29	1.20 - 1.38		.55	.70	.61 - .79		-1.49	-1.91	-2.01 - -1.80
Mass.	R	OLS	5758	.12	.99	.95 - 1.04	4.40	.02	.19	-.06 - .47	28.37	- .14	-1.24	-1.35 - -1.12
		IV		.27	.95	.93 - .98		.05	.18	.14 - .22		- .37	-1.33	-1.39 - -1.27
	C	OLS		.13	1.03	.94 - 1.12		.12	.91	.45 - 1.37	26.16	- .20	-1.57	-1.78 - -1.37
		IV		.80	.99	.96 - 1.02		.71	.88	.73 - 1.03		-1.21	-1.49	-1.55 - -1.42
	I	OLS		.12	1.00	.84 - 1.17		.05	.43	.21 - .65	16.85	- .25	-2.06	-2.35 - -1.78
		IV		.81	1.04	.98 - 1.10		.43	.55	.48 - .62		-1.55	-1.98	-2.10 - -1.86
R. I.	R	OLS	960	.11	.92	.89 - .95	3.91	.02	.20	-.03 - .44	26.59	- .14	-1.23	-1.34 - -1.11
		IV		.26	.93	.91 - .94		.06	.20	.16 - .25		- .37	-1.31	-1.37 - -1.25
	C	OLS		.12	.96	.89 - 1.02		.11	.88	.47 - 1.29	21.92	- .18	-1.43	-1.70 - -1.16
		IV		.78	.95	.93 - .97		.72	.88	.75 - 1.01		-1.19	-1.46	-1.55 - -1.37
	I	OLS		.13	1.09	.97 - 1.20		.06	.49	.23 - .73	16.39	- .25	-2.05	-2.34 - -1.77
		IV		.90	1.15	1.11 - 1.18		.48	.62	.54 - .70		-1.54	-1.96	-2.08 - -1.85
Conn.	R	OLS	3081	.11	.98	.94 - 1.02	4.82	.02	.19	-.08 - .49	24.16	- .14	-1.22	-1.33 - -1.10
		IV		.27	.95	.93 - .97		.05	.16	.13 - .20		- .36	-1.28	-1.34 - -1.22
	C	OLS		.13	1.02	.94 - 1.10		.12	.93	.44 - 1.43	22.54	- .19	-1.46	-1.71 - -1.20
		IV		.80	.98	.95 - 1.01		.71	.87	.71 - 1.04		-1.20	-1.47	-1.55 - -1.38
	I	OLS		.13	1.02	.87 - 1.16		.05	.40	.19 - .59	14.73	- .25	-2.00	-2.28 - -1.72
		IV		.83	1.06	1.01 - 1.11		.39	.50	.44 - .56		-1.50	-1.91	-2.02 - -1.81

Table B-2 (continued)

State	Class Demand	Est. Procedure	Population: Level of Factor (thous.)	Population: SR Elasticity	Population: Long Run Elasticity Estimate	Population: Long Run Elasticity 95% C.I.	Income: Level of Factor (thous.)	Income: SR Elasticity	Income: Long Run Elasticity Estimate	Income: Long Run Elasticity 95% C.I.	Price of Electricity: Level of Factor (mills/KWH)	Price of Electricity: SR Elasticity	Price of Electricity: Long Run Elasticity Estimate	Price of Electricity: Long Run Elasticity 95% C.I.
N. Y.	R	OLS	18391	.12	1.00	.96 - 1.05	4.81	.02	.19	-.08 - .49	29.39	- .14	-1.24	-1.35 - -1.12
		IV		.27	.96	.93 - .98		.05	.17	.13 - .20		- .38	-1.34	-1.40 - -1.28
	C	OLS		.13	1.04	.94 - 1.14		.12	.93	.44 - 1.43	29.29	- .21	-1.65	-1.86 - -1.45
		IV		.81	.99	.96 - 1.02		.71	.87	.71 - 1.03		-1.23	-1.50	-1.57 - -1.44
	I	OLS		.12	.99	.81 - 1.17		.05	.40	.19 - .59	12.20	- .23	-1.89	-2.16 - -1.63
		IV		.80	1.02	.96 - 1.09		.39	.50	.44 - .57		-1.42	-1.81	-1.90 - -1.73
N. J.	R	OLS	7300	.12	1.00	.95 - 1.04	4.63	.02	.19	-.07 - .48	27.61	- .14	-1.23	-1.35 - -1.12
		IV		.27	.95	.93 - .98		.05	.17	.13 - .21		- .37	-1.32	-1.38 - -1.26
	C	OLS		.13	1.03	.94 - 1.13		.12	.92	.44 - 1.41	25.79	- .20	-1.56	-1.77 - -1.36
		IV		.81	.99	.96 - 1.02		.71	.87	.72 - 1.03		-1.21	-1.49	-1.55 - -1.42
	I	OLS		.12	1.00	.83 - 1.17		.05	.41	.20 - .62	14.56	- .25	-1.99	-2.27 - -1.72
		IV		.81	1.03	.97 - 1.09		.41	.52	.45 - .59		-1.50	-1.91	-2.01 - -1.81
Pa.	R	OLS	11879	.12	1.00	.95 - 1.05	3.96	.02	.20	-.03 - .45	25.06	- .14	-1.22	-1.33 - -1.11
		IV		.27	.95	.93 - .98		.06	.20	.16 - .24		- .36	-1.29	-1.35 - -1.23
	C	OLS		.13	1.04	.94 - 1.14		.11	.88	.47 - 1.29	22.71	- .19	-1.46	-1.72 - -1.21
		IV		.81	.99	.96 - 1.02		.72	.88	.74 - 1.01		-1.20	-1.47	-1.55 - -1.39
	I	OLS		.12	1.00	.82 - 1.17		.06	.48	.23 - .72	12.99	- .24	-1.93	-2.20 - -1.66
		IV		.81	1.03	.96 - 1.09		.48	.61	.53 - .69		-1.45	-1.85	-1.94 - -1.76
Ohio	R	OLS	10778	.12	1.00	.95 - 1.05	3.98	.02	.20	-.03 - .45	22.34	- .14	-1.21	-1.33 - -1.09
		IV		.27	.95	.93 - .98		.06	.20	.15 - .24		- .35	-1.25	-1.31 - -1.19
	C	OLS		.13	1.04	.94 - 1.14		.11	.88	.47 - 1.30	21.00	- .18	-1.40	-1.69 - -1.10
		IV		.81	.99	.96 - 1.02		.72	.88	.74 - 1.02		-1.19	-1.45	-1.55 - -1.36
	I	OLS		.12	1.00	.82 - 1.17		.06	.48	.23 - .72	9.69	- .21	-1.73	-1.98 - -1.49
		IV		.81	1.03	.97 - 1.09		.48	.61	.53 - .68		-1.30	-1.66	-1.74 - -1.57
Ind.	R	OLS	5274	.12	.99	.95 - 1.04	3.81	.02	.20	-.02 - .44	20.37	- .14	-1.20	-1.33 - -1.06
		IV		.27	.95	.93 - .97		.06	.21	.16 - .25		- .34	-1.22	-1.29 - -1.15
	C	OLS		.13	1.03	.94 - 1.12		.11	.87	.47 - 1.27	20.13	- .17	-1.36	-1.68 - -1.03
		IV		.80	.99	.96 - 1.02		.72	.88	.75 - 1.01		-1.18	-1.45	-1.55 - -1.34
	I	OLS		.12	1.01	.84 - 1.17		.06	.50	.24 - .75	11.26	- .23	-1.84	-2.10 - -1.59
		IV		.82	1.04	.98 - 1.10		.50	.63	.55 - .71		-1.38	-1.76	-1.85 - -1.68
Ill.	R	OLS	11196	.12	1.00	.95 - 1.05	4.58	.02	.19	-.07 - .48	25.70	- .14	-1.22	-1.34 - -1.11
		IV		.27	.95	.93 - .98		.05	.17	.13 - .21		- .37	-1.30	-1.36 - -1.24
	C	OLS		.13	1.04	.94 - 1.14		.12	.92	.45 - 1.40	23.21	- .19	-1.48	-1.72 - -1.24
		IV		.81	.99	.96 - 1.02		.71	.87	.72 - 1.03		-1.20	-1.47	-1.55 - -1.39
	I	OLS		.12	1.00	.82 - 1.17		.05	.42	.20 - .62	11.80	- .23	-1.87	-2.13 - -1.61
		IV		.81	1.03	.96 - 1.09		.41	.53	.46 - .59		-1.40	-1.79	-1.88 - -1.71

Table B-2 (continued)

State	Class Demand	Est. Procedure	Population: Level of Factor (thous.)	Population: SR Elasticity	Population: Long Run Elasticity Estimate	Population: Long Run Elasticity 95% C.I.	Income: Level of Factor (thous.)	Income: SR Elasticity	Income: Long Run Elasticity Estimate	Income: Long Run Elasticity 95% C.I.	Price of Electricity: Level of Factor (mills/KWH)	Price of Electricity: SR Elasticity	Price of Electricity: Long Run Elasticity Estimate	Price of Electricity: Long Run Elasticity 95% C.I.
Mich.	R	OLS	8997	.12	1.00	.95 - 1.05	4.14	.02	.20	-.04 - .46	22.27	- .14	-1.21	-1.33 - -1.09
		IV		.27	.95	.93 - .98		.05	.19	.15 - .23		- .35	-1.25	-1.31 - -1.19
	C	OLS		.13	1.04	.94 - 1.13		.11	.89	.46 - 1.33	23.01	- .19	-1.47	-1.72 - -1.23
		IV		.81	.99	.96 - 1.02		.72	.88	.74 - 1.02		-1.20	-1.47	-1.55 - -1.39
	I	OLS		.12	1.00	.83 - 1.17		.06	.46	.22 - .69	12.48	- .24	-1.90	-2.17 - -1.64
		IV		.81	1.03	.97 - 1.09		.46	.58	.51 - .66		-1.43	-1.83	-1.92 - -1.74
Wisc.	R	OLS	4476	.12	.99	.95 - 1.03	3.72	.02	.20	-.02 - .43	21.37	- .14	-1.20	-1.33 - -1.08
		IV		.27	.95	.93 - .97		.06	.21	.17 - .26		- .35	-1.24	-1.30 - -1.17
	C	OLS		.13	1.03	.94 - 1.11		.11	.86	.48 - 1.25	23.56	- .19	-1.49	-1.73 - -1.26
		IV		.80	.98	.96 - 1.01		.72	.88	.76 - 1.01		-1.20	-1.47	-1.55 - -1.40
	I	OLS		.12	1.01	.85 - 1.17		.06	.51	.25 - .77	13.78	- .24	-1.96	-2.24 - -1.69
		IV		.82	1.05	.99 - 1.10		.51	.65	.57 - .73		-1.47	-1.88	-1.98 - -1.78
Minn.	R	OLS	3881	.11	.99	.95 - 1.03	3.81	.02	.20	-.02 - .44	23.33	- .14	-1.21	-1.33 - -1.10
		IV		.27	.95	.93 - .97		.06	.21	.16 - .25		- .36	-1.27	-1.33 - -1.21
	C	OLS		.13	1.02	.94 - 1.11		.11	.87	.47 - 1.27	25.60	- .20	-1.56	-1.77 - -1.35
		IV		.80	.98	.96 - 1.01		.72	.88	.75 - 1.01		-1.21	-1.48	-1.55 - -1.42
	I	OLS		.13	1.01	.86 - 1.16		.06	.50	.24 - .75	13.59	- .24	-1.95	-2.23 - -1.68
		IV		.82	1.05	.99 - 1.10		.50	.63	.55 - .71		-1.47	-1.87	-1.97 - -1.78
Iowa	R	OLS	2852	.11	.98	.94 - 1.02	3.72	.02	.20	-.01 - .43	24.56	- .14	-1.22	-1.33 - -1.10
		IV		.27	.95	.93 - .97		.06	.21	.17 - .26		- .36	-1.29	-1.34 - -1.23
	C	OLS		.13	1.02	.94 - 1.09		.11	.86	.48 - 1.25	24.77	- .20	-1.53	-1.75 - -1.32
		IV		.80	.98	.95 - 1.00		.72	.88	.76 - 1.01		-1.21	-1.48	-1.55 - -1.41
	I	OLS		.13	1.02	.88 - 1.16		.06	.51	.25 - .77	12.61	- .24	-1.91	-2.18 - -1.65
		IV		.83	1.06	1.01 - 1.11		.51	.65	.57 - .73		-1.43	-1.83	-1.92 - -1.74
Mo.	R	OLS	4749	.12	.99	.95 - 1.03	3.72	.02	.20	-.02 - .43	24.32	- .14	-1.22	-1.33 - -1.10
		IV		.27	.95	.93 - .97		.06	.21	.17 - .26		- .36	-1.28	-1.34 - -1.22
	C	OLS		.13	1.03	.94 - 1.12		.11	.86	.48 - 1.25	23.08	- .19	-1.48	-1.72 - -1.23
		IV		.80	.99	.96 - 1.01		.72	.88	.76 - 1.01		-1.20	-1.47	-1.55 - -1.39
	I	OLS		.12	1.01	.85 - 1.17		.06	.51	.25 - .77	13.01	- .24	-1.93	-2.20 - -1.66
		IV		.82	1.04	.99 - 1.10		.51	.65	.57 - .73		-1.45	-1.85	-1.94 - -1.76
N. D.	R	OLS	625	.10	.87	.82 - .92	3.24	.02	.20	.02 - .40	24.21	- .14	-1.22	-1.33 - -1.10
		IV		.26	.91	.88 - .93		.07	.25	.19 - .30		- .36	-1.28	-1.34 - -1.22
	C	OLS		.12	.91	.81 - 1.01		.10	.82	.49 - 1.14	21.76	- .18	-1.43	-1.70 - -1.15
		IV		.76	.93	.90 - .96		.73	.89	.78 - .99		-1.19	-1.46	-1.55 - -1.37
	I	OLS		.14	1.14	.95 - 1.32		.07	.59	.28 - .88	18.71	- .26	-2.11	-2.40 - -1.81
		IV		.95	1.22	1.16 - 1.28		.58	.74	.65 - .84		-1.58	-2.02	-2.15 - -1.89

Table B-2 (continued)

State	Class Demand	Est. Procedure	Population: Level of Factor (thous.)	Population: SR Elasticity	Population: Long Run Elasticity Estimate	Population: Long Run Elasticity 95% C.I.	Income: Level of Factor (thous.)	Income: SR Elasticity	Income: Long Run Elasticity Estimate	Income: Long Run Elasticity 95% C.I.	Price of Electricity: Level of Factor (mills/KWH)	Price of Electricity: SR Elasticity	Price of Electricity: Long Run Elasticity Estimate	Price of Electricity: Long Run Elasticity 95% C.I.
S. D.	R	OLS	670	.10	.88	.84 - .93	3.30	.02	.20	.02 - .40	24.02	- .14	-1.22	-1.33 - -1.10
		IV		.26	.91	.89 - .94		.07	.24	.19 - .29		- .36	-1.28	-1.34 - -1.22
	C	OLS		.12	.92	.83 - 1.01		.11	.83	.49 - 1.15	25.71	- .20	-1.56	-1.77 - -1.36
		IV		.76	.93	.90 - .96		.72	.89	.78 - 1.00		-1.21	-1.49	-1.55 - -1.42
	I	OLS		.14	1.13	.96 - 1.29		.07	.58	.28 - .87	15.42	- .25	-2.02	-2.30 - -1.74
		IV		.94	1.20	1.15 - 1.26		.57	.73	.64 - .82		-1.52	-1.94	-2.05 - -1.83
Neb.	R	OLS	1512	.11	.95	.92 - .98	3.83	.02	.20	-.02 - .44	20.20	- .14	-1.19	-1.33 - -1.06
		IV		.26	.94	.92 - .95		.06	.21	.16 - .25		- .34	-1.22	-1.28 - -1.15
	C	OLS		.13	.99	.93 - 1.05		.11	.87	.47 - 1.27	16.31	- .15	-1.14	-1.64 - - .61
		IV		.79	.97	.95 - .99		.72	.88	.75 - 1.01		-1.15	-1.41	-1.57 - -1.24
	I	OLS		.13	1.05	.94 - 1.16		.06	.50	.24 - .75	11.20	- .23	-1.84	-2.09 - -1.58
		IV		.86	1.10	1.06 - 1.14		.49	.63	.55 - .71		-1.38	-1.76	-1.84 - -1.68
Kan.	R	OLS	2258	.11	.97	.94 - 1.01	3.92	.02	.20	-.03 - .45	22.69	- .14	-1.21	-1.33 - -1.09
		IV		.27	.94	.93 - .96		.06	.20	.16 - .25		- .36	-1.26	-1.32 - -1.20
	C	OLS		.13	1.01	.94 - 1.08		.11	.88	.47 - 1.29	19.19	- .17	-1.31	-1.67 - - .94
		IV		.80	.98	.95 - 1.00		.72	.88	.75 - 1.01		-1.17	-1.44	-1.56 - -1.32
	I	OLS		.13	1.03	.90 - 1.16		.06	.49	.23 - .73	10.99	- .23	-1.82	-2.08 - -1.57
		IV		.84	1.07	1.03 - 1.12		.48	.62	.54 - .69		-1.37	-1.75	-1.83 - -1.67
Del.	R	OLS	558	.10	.86	.80 - .91	4.38	.02	.19	-.06 - .47	25.10	- .14	-1.22	-1.33 - -1.11
		IV		.26	.90	.87 - .93		.05	.18	.14 - .22		- .36	-1.29	-1.35 - -1.23
	C	OLS		.11	.90	.78 - 1.01		.12	.91	.45 - 1.37	21.60	- .18	-1.42	-1.70 - -1.14
		IV		.75	.92	.88 - .96		.71	.88	.73 - 1.03		-1.19	-1.46	-1.55 - -1.37
	I	OLS		.14	1.16	.94 - 1.37		.05	.44	.21 - .65	11.89	- .23	-1.87	-2.14 - -1.62
		IV		.97	1.24	1.17 - 1.31		.43	.55	.48 - .62		-1.41	-1.80	-1.88 - -1.71
M. & D.C.	R	OLS	4741	.12	.99	.95 - 1.03	4.55	.02	.19	-.07 - .48	23.88	- .14	-1.22	-1.33 - -1.10
		IV		.27	.95	.93 - .97		.05	.17	.14 - .21		- .36	-1.28	-1.33 - -1.22
	C	OLS		.13	1.03	.94 - 1.12		.12	.92	.45 - 1.39	22.52	- .19	-1.46	-1.71 - -1.20
		IV		.80	.99	.96 - 1.01		.71	.87	.72 - 1.03		-1.20	-1.47	-1.55 - -1.38
	I	OLS		.12	1.01	.85 - 1.17		.05	.42	.20 - .63	13.03	- .24	-1.93	-2.20 - -1.66
		IV		.82	1.04	.99 - 1.10		.42	.53	.46 - .60		-1.45	-1.85	-1.94 - -1.76
Va.	R	OLS	4714	.12	.99	.95 - 1.03	3.71	.02	.20	-.01 - .43	19.39	- .14	-1.19	-1.33 - -1.05
		IV		.27	.95	.93 - .97		.06	.21	.17 - .26		- .34	-1.20	-1.27 - -1.13
	C	OLS		.13	1.03	.94 - 1.12		.11	.86	.48 - 1.24	18.23	- .16	-1.26	-1.66 - - .85
		IV		.80	.99	.96 - 1.01		.72	.88	.76 - 1.01		-1.17	-1.43	-1.56 - -1.29
	I	OLS		.12	1.01	.85 - 1.17		.06	.52	.25 - .77	10.40	- .22	-1.78	-2.04 - -1.54
		IV		.82	1.04	.99 - 1.10		.51	.65	.57 - .73		-1.34	-1.71	-1.79 - -1.63

Table B-2 (continued)

State	Class Demand	Est. Procedure	Population: Level of Factor (thous.)	Population: SR Elasticity	Population: Long Run Elasticity Estimate	Population: Long Run Elasticity 95% C.I.	Income: Level of Factor (thous.)	Income: SR Elasticity	Income: Long Run Elasticity Estimate	Income: Long Run Elasticity 95% C.I.	Price of Electricity: Level of Factor (mills/KWH)	Price of Electricity: SR Elasticity	Price of Electricity: Long Run Elasticity Estimate	Price of Electricity: Long Run Elasticity 95% C.I.
W. Va.	R	OLS	1752	.11	.96	.93 - .99	3.10	.02	.21	.03 - .39	20.93	- .14	-1.20	-1.33 - -1.07
		IV		.27	.94	.92 - .96		.07	.26	.20 - .31		- .35	-1.23	-1.30 - -1.17
	C	OLS		.13	1.00	.93 - 1.06		.10	.80	.50 - 1.10	19.24	- .17	-1.31	-1.67 - - .95
		IV		.79	.97	.95 - .99		.73	.89	.79 - .99		-1.17	-1.44	-1.56 - -1.32
	I	OLS		.13	1.04	.92 - 1.16		.08	.62	.30 - .92	9.27	- .21	-1.70	-1.94 - -1.46
		IV		.85	1.09	1.05 - 1.13		.61	.78	.68 - .88		-1.27	-1.62	-1.71 - -1.54
N.& S.C.	R	OLS	7773	.12	1.00	.95 - 1.04	3.32	.02	.20	.02 - .41	18.38	- .14	-1.18	-1.33 - -1.03
		IV		.27	.95	.93 - .98		.07	.24	.19 - .29		- .33	-1.18	-1.26 - -1.10
	C	OLS		.13	1.03	.94 - 1.13		.11	.63	.49 - 1.16	16.15	- .14	-1.13	-1.64 - - .59
		IV		.81	.99	.96 - 1.02		.72	.89	.78 - 1.00		-1.14	-1.40	-1.57 - -1.23
	I	OLS		.12	1.00	.83 - 1.17		.07	.57	.28 - .86	8.73	- .20	-1.65	-1.88 - -1.42
		IV		.81	1.03	.97 - 1.09		.57	.73	.63 - .82		-1.23	-1.58	-1.67 - -1.48
Ga.	R	OLS	4664	.12	.99	.95 - 1.03	3.40	.02	.20	.01 - .41	16.94	- .14	-1.17	-1.34 - -1.00
		IV		.27	.95	.93 - .97		.07	.23	.18 - .28		- .32	-1.14	-1.23 - -1.06
	C	OLS		.13	1.03	.94 - 1.12		.11	.84	.49 - 1.18	18.88	- .17	-1.30	-1.67 - - .91
		IV		.80	.98	.96 - 1.01		.72	.89	.77 - 1.00		-1.17	-1.44	-1.56 - -1.31
	I	OLS		.12	1.01	.85 - 1.17		.07	.56	.27 - .84	9.82	- .22	-1.74	-1.99 - -1.50
		IV		.82	1.04	.99 - 1.10		.56	.71	.62 - .80		-1.31	-1.67	-1.75 - -1.59
Fla.	R	OLS	7041	.12	1.00	.95 - 1.04	3.69	.02	.20	-.01 - .43	19.39	- .14	-1.19	-1.33 - -1.05
		IV		.27	.95	.93 - .98		.06	.22	.17 - .26		- .34	-1.20	-1.27 - -1.13
	C	OLS		.13	1.03	.94 - 1.13		.11	.86	.48 - 1.24	21.17	- .18	-1.40	-1.69 - -1.11
		IV		.81	.99	.96 - 1.02		.72	.88	.76 - 1.01		-1.19	-1.46	-1.55 - -1.36
	I	OLS		.12	1.00	.83 - 1.17		.06	.52	.25 - .77	11.32	- .23	-1.84	-2.10 - -1.59
		IV		.81	1.04	.97 - 1.09		.51	.65	.57 - .74		-1.38	-1.77	-1.85 - -1.68
Ky.	R	OLS	3282	.11	.98	.94 - 1.02	3.15	.02	.21	.03 - .39	16.65	- .14	-1.16	-1.34 - - .99
		IV		.27	.95	.93 - .97		.07	.25	.20 - .31		- .32	-1.14	-1.23 - -1.05
	C	OLS		.13	1.02	.94 - 1.10		.10	.81	.49 - 1.12	15.58	- .14	-1.08	-1.64 - - .51
		IV		.80	.98	.96 - 1.01		.73	.89	.79 - .99		-1.14	-1.40	-1.58 - -1.21
	I	OLS		.13	1.02	.87 - 1.16		.07	.61	.29 - .91	7.43	- .18	-1.50	-1.71 - -1.29
		IV		.83	1.06	1.00 - 1.11		.60	.77	.67 - .86		-1.12	-1.43	-1.55 - -1.30
Tenn.	R	OLS	3990	.11	.99	.95 - 1.03	3.19	.02	.21	.03 - .40	12.13	- .13	-1.10	-1.41 - - .80
		IV		.27	.95	.93 - .97		.07	.25	.19 - .30		- .27	- .96	-1.12 - - .81
	C	OLS		.13	1.02	.94 - 1.11		.10	.81	.49 - 1.13	16.01	- .14	-1.12	-1.64 - - .57
		IV		.80	.98	.96 - 1.01		.73	.89	.79 - .99		-1.14	-1.40	-1.57 - -1.23
	I	OLS		.12	1.01	.86 - 1.16		.07	.60	.29 - .90	7.70	- .19	-1.53	-1.75 - -1.32
		IV		.82	1.05	.99 - 1.10		.59	.76	.66 - .85		-1.15	-1.46	-1.58 - -1.35

Table B-2 (continued)

			Population				Income				Price of Electricity			
State	Class Demand	Est. Procedure	Level of Factor (thous.)	SR Elasticity	Long Run Elasticity Estimate	Long Run Elasticity 95% C.I.	Level of Factor (thous.)	SR Elasticity	Long Run Elasticity Estimate	Long Run Elasticity 95% C.I.	Level of Factor (mills/KWH)	SR Elasticity	Long Run Elasticity Estimate	Long Run Elasticity 95% C.I.
Alab.	R	OLS	3479	.11	.98	.95 - 1.02	2.92	.02	.21	.05 - .38	15.15	- .13	-1.15	-1.36 - - .94
		IV		.27	.95	.93 - .97		.08	.27	.21 - .33		- .31	-1.09	-1.20 - - .98
	C	OLS		.13	1.02	.94 - 1.10		.10	.78	.49 - 1.06	17.28	- .15	-1.20	-1.65 - - .74
		IV		.80	.98	.96 - 1.01		.73	.89	.80 - .99		-1.16	-1.42	-1.57 - -1.27
	I	OLS		.13	1.02	.87 - 1.16		.08	.65	.31 - .98	7.94	- .19	-1.56	-1.78 - -1.34
		IV		.83	1.05	1.00 - 1.11		.65	.83	.72 - .93		-1.17	-1.49	-1.60 - -1.38
Miss.	R	OLS	2226	.11	.97	.94 - 1.01	2.65	.02	.21	.07 - .36	17.08	- .14	-1.17	-1.34 - -1.00
		IV		.27	.94	.93 - .96		.08	.30	.23 - .36		- .32	-1.15	-1.23 - -1.06
	C	OLS		.13	1.01	.94 - 1.08		.09	.74	.48 - 1.00	18.55	- .16	-1.28	-1.66 - - .88
		IV		.80	.98	.95 - 1.00		.73	.90	.82 - .98		-1.17	-1.43	-1.56 - -1.30
	I	OLS		.13	1.03	.90 - 1.16		.09	.72	.35 - 1.08	9.90	- .22	-1.75	-1.99 - -1.51
		IV		.84	1.07	1.03 - 1.12		.71	.91	.79 - 1.03		-1.31	-1.67	-1.76 - -1.59
Ark.	R	OLS	1944	.11	.96	.93 - 1.00	2.91	.02	.21	.05 - .38	21.42	- .14	-1.20	-1.33 - -1.08
		IV		.27	.94	.93 - .96		.08	.27	.21 - .33		- .35	-1.24	-1.30 - -1.18
	C	OLS		.13	1.00	.94 - 1.07		.10	.78	.49 - 1.06	20.14	- .17	-1.36	-1.68 - -1.03
		IV		.79	.97	.95 - 1.00		.73	.90	.80 - .99		-1.18	-1.45	-1.55 - -1.34
	I	OLS		.13	1.04	.91 - 1.16		.08	.66	.32 - .98	9.14	- .21	-1.68	-1.92 - -1.45
		IV		.85	1.08	1.04 - 1.12		.65	.83	.72 - .93		-1.26	-1.61	-1.70 - -1.52
La.	R	OLS	3631	.11	.99	.95 - 1.03	3.11	.02	.21	.03 - .39	20.59	- .14	-1.20	-1.33 - -1.07
		IV		.27	.95	.93 - .97		.07	.26	.20 - .31		- .35	-1.22	-1.29 - -1.16
	C	OLS		.13	1.02	.94 - 1.11		.10	.80	.49 - 1.11	19.29	- .17	-1.32	-1.67 - - .95
		IV		.80	.98	.96 - 1.01		.73	.89	.79 - .99		-1.17	-1.44	-1.56 - -1.32
	I	OLS		.13	1.01	.86 - 1.16		.08	.61	.29 - .92	7.89	- .19	-1.55	-1.77 - -1.34
		IV		.82	1.05	1.00 - 1.10		.61	.78	.68 - .87		-1.16	-1.49	-1.59 - -1.37
Okla.	R	OLS	2610	.11	.98	.94 - 1.01	3.36	.02	.20	.01 - .41	23.07	- .14	-1.21	-1.33 - -1.09
		IV		.27	.95	.93 - .97		.07	.24	.18 - .29		- .36	-1.27	-1.32 - -1.20
	C	OLS		.13	1.01	.94 - 1.09		.11	.83	.49 - 1.17	18.85	- .17	-1.29	-1.67 - - .91
		IV		.80	.98	.95 - 1.00		.72	.89	.78 - 1.00		-1.17	-1.44	-1.56 - -1.31
	I	OLS		.13	1.02	.89 - 1.16		.07	.57	.27 - .85	9.68	- .21	-1.73	-1.97 - -1.49
		IV		.83	1.07	1.02 - 1.11		.56	.72	.63 - .81		-1.30	-1.66	-1.74 - -1.57
Tex.	R	OLS	11460	.12	1.00	.95 - 1.05	3.53	.02	.20	-.00 - .42	19.59	- .14	-1.19	-1.33 - -1.05
		IV		.27	.95	.93 - .98		.06	.23	.17 - .27		- .34	-1.21	-1.28 - -1.13
	C	OLS		.13	1.04	.94 - 1.14		.11	.85	.48 - 1.21	16.73	- .15	-1.17	-1.65 - - .67
		IV		.81	.99	.96 - 1.02		.72	.88	.77 - 1.00		-1.15	-1.41	-1.57 - -1.25
	I	OLS		.12	1.00	.82 - 1.17		.07	.54	.26 - .81	7.78	- .19	-1.54	-1.76 - -1.33
		IV		.81	1.03	.96 - 1.09		.54	.68	.60 - .77		-1.15	-1.47	-1.58 - -1.36

Table B-2 (continued)

State	Class Demand	Est. Procedure	Population: Level of Factor (thous.)	Population: SR Elasticity	Population: Long Run Elasticity Estimate	Population: Long Run Elasticity 95% C. I.	Income: Level of Factor (thous.)	Income: SR Elasticity	Income: Long Run Elasticity Estimate	Income: Long Run Elasticity 95% C.I.	Price of Electricity: Level of Factor (mills/KWH)	Price of Electricity: SR Elasticity	Price of Electricity: Long Run Elasticity Estimate	Price of Electricity: Long Run Elasticity 95% C.I.
Mont.	R	OLS	708	.10	.89	.85 - .93	3.34	.02	.20	.01 - .41	20.38	- .14	-1.20	-1.33 - -1.06
		IV		.26	.92	.89 - .94		.07	.24	.18 - .29		- .34	-1.22	-1.29 - -1.15
	C	OLS		.12	.93	.84 - 1.01		.11	.83	.49 - 1.16	18.80	- .16	-1.29	-1.67 - - .90
		IV		.76	.94	.91 - .96		.72	.89	.78 - 1.00		-1.17	-1.43	-1.56 - -1.31
	I	OLS		.14	1.12	.96 - 1.27		.07	.57	.28 - .86	4.14	- .09	- .69	- .79 - - .60
		IV		.93	1.19	1.14 - 1.24		.57	.72	.63 - .82		- .51	- .65	-1.00 - - .28
Ida.	R	OLS	732	.10	.89	.85 - .93	3.26	.02	.20	.02 - .40	15.26	- .13	-1.15	-1.36 - - .95
		IV		.26	.92	.90 - .94		.07	.24	.19 - .30		- .31	-1.09	-1.20 - - .99
	C	OLS		.12	.93	.85 - 1.02		.10	.82	.49 - 1.14	13.92	- .12	- .94	-1.63 - - .22
		IV		.77	.94	.91 - .97		.72	.89	.78 - .99		-1.12	-1.37	-1.59 - -1.14
	I	OLS		.14	1.12	.97 - 1.26		.07	.59	.28 - .88	5.87	- .15	-1.23	-1.40 - -1.06
		IV		.93	1.19	1.14 - 1.24		.58	.74	.64 - .83		- .91	-1.17	-1.36 - - .97
Wy.	R	OLS	340	.09	.76	.65 - .87	3.60	.02	.20	-.01 - .42	23.33	- .14	-1.21	-1.33 - -1.10
		IV		.25	.87	.81 - .93		.06	.22	.17 - .27		- .36	-1.27	-1.33 - -1.21
	C	OLS		.10	.80	.57 - 1.03		.11	.85	.48 - 1.22	16.87	- .15	-1.18	-1.65 - - .69
		IV		.71	.87	.80 - .95		.72	.88	.76 - 1.00		-1.15	-1.41	-1.57 - -1.25
	I	OLS		.16	1.27	.85 - 1.67		.07	.53	.26 - .79	10.06	- .22	-1.76	-2.01 - -1.52
		IV		1.08	1.38	1.24 - 1.53		.53	.67	.58 - .76		-1.32	-1.69	-1.77 - -1.60
Col.	R	OLS	2283	.11	.97	.94 - 1.01	3.89	.02	.20	-.03 - .44	24.08	- .14	-1.22	-1.33 - -1.10
		IV		.27	.94	.93 - .96		.06	.20	.16 - .25		- .36	-1.28	-1.34 - -1.22
	C	OLS		.13	1.01	.94 - 1.08		.11	.88	.47 - 1.28	19.42	- .17	-1.32	-1.67 - - .96
		IV		.80	.98	.95 - 1.00		.72	.88	.75 - 1.01		-1.18	-1.44	-1.56 - -1.32
	I	OLS		.13	1.03	.90 - 1.16		.06	.49	.24 - .74	10.87	- .22	-1.82	-2.07 - -1.56
		IV		.84	1.07	1.03 - 1.12		.49	.62	.54 - .70		-1.36	-1.74	-1.82 - -1.66
N. M.	R	OLS	1030	.11	.93	.90 - .96	3.25	.02	.20	.02 - .40	25.30	- .14	-1.22	-1.34 - -1.11
		IV		.26	.93	.91 - .94		.07	.24	.19 - .30		- .37	-1.29	-1.35 - -1.24
	C	OLS		.12	.97	.90 - 1.03		.10	.82	.49 - 1.14	19.43	- .17	-1.32	-1.67 - - .97
		IV		.78	.95	.93 - .97		.73	.89	.78 - .99		-1.18	-1.44	-1.56 - -1.32
	I	OLS		.13	1.08	.97 - 1.19		.07	.59	.28 - .88	10.68	- .22	-1.80	-2.06 - -1.55
		IV		.89	1.14	1.10 - 1.17		.58	.74	.65 - .84		-1.35	-1.73	-1.81 - -1.65
Az.	R	OLS	1849	.11	.96	.93 - 1.00	3.71	.02	.20	-.01 - .43	21.43	- .14	-1.20	-1.33 - -1.08
		IV		.27	.94	.93 - .96		.06	.21	.17 - .26		- .35	-1.24	-1.30 - -1.18
	C	OLS		.13	1.00	.93 - 1.07		.11	.86	.48 - 1.25	18.45	- .16	-1.27	-1.66 - - .87
		IV		.79	.97	.95 - .99		.72	.88	.76 - 1.01		-1.17	-1.43	-1.56 - -1.30
	I	OLS		.13	1.04	.92 - 1.16		.06	.51	.25 - .77	11.39	- .23	-1.85	-2.11 - -1.59
		IV		.85	1.08	1.04 - 1.13		.51	.65	.57 - .73		-1.39	-1.77	-1.85 - -1.69

Table B-2 (continued)

State	Class Demand	Est. Proce- dure	Population: Level of Factor (thous.)	Population: SR Elas- ticity	Population: Long Run Elasticity Estimate	Population: Long Run Elasticity 95% C.I.	Income: Level of Factor (thous.)	Income: SR Elas- ticity	Income: Long Run Elasticity Estimate	Income: Long Run Elasticity 95% C.I.	Price of Electricity: Level of Factor (mills/KWH)	Price of Electricity: SR Elas- ticity	Price of Electricity: Long Run Elasticity Estimate	Price of Electricity: Long Run Elasticity 95% C.I.
Utah	R	OLS	1099	.11	.93	.90 - .96	3.26	.02	.20	.02 - .40	21.37	- .14	-1.20	-1.33 - -1.08
		IV		.26	.93	.92 - .95		.07	.24	.19 - .30		- .35	-1.24	-1.30 - -1.17
	C	OLS		.12	.97	.91 - 1.03		.10	.82	.49 - 1.14	18.45	- .16	-1.27	-1.66 - - .87
		IV		.78	.96	.94 - .98		.73	.89	.78 - .99		-1.17	-1.43	-1.56 - -1.30
	I	OLS		.13	1.07	.96 - 1.18		.07	.59	.28 - .88	12.24	- .23	-1.89	-2.16 - -1.63
		IV		.89	1.13	1.09 - 1.17		.58	.74	.65 - .84		-1.42	-1.81	-1.90 - -1.73
Nev.	R	OLS	507	.10	.84	.77 - .91	4.69	.02	.19	-.07 - .49	13.92	- .13	-1.13	-1.37 - - .89
		IV		.25	.90	.86 - .93		.05	.17	.13 - .21		- .29	-1.04	-1.17 - - .92
	C	OLS		.11	.88	.75 - 1.02		.12	.93	.44 - 1.41	15.69	- .14	-1.09	-1.64 - - .52
		IV		.75	.91	.87 - .96		.71	.87	.71 - 1.03		-1.14	-1.40	-1.58 - -1.21
	I	OLS		.15	1.18	.93 - 1.41		.05	.41	.20 - .61	7.09	- .18	-1.45	-1.65 - -1.25
		IV		.99	1.26	1.18 - 1.34		.40	.51	.45 - .58		-1.08	-1.38	-1.52 - -1.25
Wash.	R	OLS	3449	.11	.98	.94 - 1.02	3.96	.02	.20	-.03 - .45	9.76	- .12	-1.04	-1.47 - - .63
		IV		.27	.95	.93 - .97		.06	.20	.16 - .24		- .23	- .81	-1.02 - - .59
	C	OLS		.13	1.02	.94 - 1.10		.11	.88	.47 - 1.30	11.33	- .08	- .63	-1.61 - .40
		IV		.80	.98	.96 - 1.01		.72	.88	.74 - 1.01		-1.07	-1.31	-1.63 - - .98
	I	OLS		.13	1.02	.87 - 1.16		.06	.48	.23 - .72	3.10	- .01	- .08	- .09 - - .07
		IV		.83	1.05	1.00 - 1.11		.48	.61	.53 - .69		- .05	- .06	- .60 - .50
Ore.	R	OLS	2158	.11	.97	.94 - 1.00	3.76	.02	.20	-.02 - .44	12.05	- .13	-1.10	-1.41 - - .80
		IV		.27	.94	.93 - .96		.06	.21	.16 - .26		- .27	- .96	-1.11 - - .80
	C	OLS		.13	1.01	.94 - 1.08		.11	.87	.48 - 1.26	12.74	- .10	- .82	-1.62 - .03
		IV		.80	.97	.95 - 1.01		.72	.88	.75 - 1.01		-1.10	-1.34	-1.61 - -1.07
	I	OLS		.13	1.03	.90 - 1.16		.06	.51	.24 - .76	4.22	- .09	- .72	- .83 - - .62
		IV		.84	1.08	1.03 - 1.12		.50	.64	.56 - .72		- .54	- .68	-1.03 - - .33
Cal.	R	OLS	20223	.12	1.00	.96 - 1.05	4.48	.02	.19	-.06 - .48	21.00	- .14	-1.20	-1.33 - -1.07
		IV		.27	.96	.93 - .98		.05	.18	.14 - .22		- .35	-1.23	-1.30 - -1.17
	C	OLS		.13	1.04	.94 - 1.14		.11	.91	.45 - 1.38	17.82	- .16	-1.24	-1.66 - - .80
		IV		.81	.99	.96 - 1.02		.71	.87	.72 - 1.03		-1.16	-1.42	-1.56 - -1.28
	I	OLS		.12	.99	.81 - 1.17		.05	.43	.20 - .64	9.49	- .21	-1.72	-1.96 - -1.48
		IV		.80	1.02	.96 - 1.09		.42	.54	.47 - .61		-1.29	-1.64	-1.73 - -1.56
			Price of Gas				**Price of Appliances**							
All States	**R**	**OLS**	**--**	**.02**	**.19**	**.13 - .26**	**--**	**-.05**	**-.42**	**-.71 - -.10**				
		IV		**.04**	**.13**	**.10 - .16**		**-.21**	**-.74**	**-.87 - -.60.**				
	C	**OLS**	**--**	**.01**	**.06**	**-.05 - .18**	**--**	**.00**	**.00**	**-- --**				
		IV		**.03**	**.04**	**.00 - .07**		**.00**	**.00**	**-- --**				
	I	**OLS**	**--**	**.00**	**.00**	**-- --**	**--**	**.00**	**.00**	**-- --**				
		IV		**.05**	**.06**	**.01 - .11**		**.00**	**.00**	**-- --**				

Table B-3. Estimated Parameters for Calculating Elasticities, (A8) and (A10), and Confidence Intervals, (A9) and (A11)[1]

Factor[2/]	Estimation Method	Parameter	RESIDENTIAL Estimated Value	RESIDENTIAL Estimated Variances and Covariances x 10^4 β	γ	λ	COMMERCIAL Estimated Value	COMMERCIAL Estimated Variances and Covariances x 10^4 β	γ	λ	INDUSTRIAL Estimated Value	INDUSTRIAL Estimated Variances and Covariances x 10^4 β	γ	λ
Population	OLS	β	.1172	.584792			.1333	1.72285			.1220	2.64325		
		γ	9.7821	86.5111	90295.6		10.5007	392.799	432334.		-11.7364	887.851	1377863.	
		λ	.8837	-.522742	-14.6336	.549730	.8724	-1.30779	-43.4399	1.32894	.8765	-1.29459	222.072	1.31247
	IV	β	.2703	4.13211			.8105	61.1500			.7970	76.3516		
		γ	8.3737	57.3548	132455.		32.9935	3490.46	1939276.		-97.7104	-2298.93	7619858.	
		λ	.7177	-4.35077	53.2810	4.73060	.1843	-60.2128	-2000.04	61.1865	.2167	-66.8825	7799.73	64.5286
Income	OLS	β	.0195	9.27793			.1486	36.4045			--	--		
		γ	-.0139	21.5070	54.1971		.1432	82.5843	209.161		-.2358	--	43.9935	
		λ	.8837	.878497	2.50684	.549730	.8724	-1.03095	.544286	1.32894	.8765	--	3.30650	1.31247
	IV	β	--	--			.6825	191.656			--	--		
		γ	-.2246	--	10.7754		-.1387	341.527	918.863		-1.8921	--	553.492	
		λ	.7177	--	4.76981	4.73060	.1843	-47.4664	25.0598	61.1865	.2167	--	162.142	64.5286
Price of Electricity	OLS	β	-.1552	4.05908			-.2925	22.1072			-.3097	12.1672		
		γ	-.3304	62.4275	1425.47		-2.4014	494.367	13868.8		-.9290	-36.3314	216.703	
		λ	.8837	.945407	6.04683	.549730	.8724	1.99246	.949629	1.32894	.8765	3.13240	-11.3821	1.31247
	IV	β	-.4524	18.9730			-1.3242	220.684			-1.8867	425.276		
		γ	-2.1965	175.773	2695.45		-2.8931	2209.20	60339.1		-5.7016	1720.43	11057.1	
		λ	.7177	8.49276	53.2576	4.73060	.1843	91.7359	43.7224	61.1865	.2167	147.223	389.687	64.5286
Price of Gas	OLS	β	.0225	.129441	--		.0082	.538120	--		--	--	--	
		λ	.8837	-.049234	--	.549730	.8724	-.043050	--	1.32894	--	--	--	1.31247
	IV	β	.0370	.229166	--		.0305	2.39824	--		.0475	4.01331	--	
		λ	.7177	-.414522	--	4.73060	.1843	-1.98207	--	61.1865	.2167	-5.14461	--	64.5286
Price of Appliances	OLS	β	-.0486	3.70353	--		--	--	--		--	--	--	
		λ	.8837	.717990	--	.549730	--	--	--	--	--	--	--	--
	IV	β	-.2094	7.83036	--		--	--	--		--	--	--	
		λ	.7177	4.45501	--	4.73060	--	--	--	--	--	--	--	--

1/ Estimates are for VEMA; Eq. 2.

2/ Units of measurement are given in Table 2 and Table B1.

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