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HOUSEHOLD FUEL DEMAND ANALYSIS*

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Abstract

This study develops econometric models of residential demands for electricity, natural gas, and petroleum products. Fuel demands per household are estimated as functions of fuel prices, per capita income, heating degree days, and mean July temperature. Cross-sectional models are developed using a large data base containing observations for each state and year from 1951 through 1974.

Long-run own-price elasticities for all three fuels are greater than unity with natural gas showing the greatest sensitivity to own-price changes. Cross-price elasticities are all less than unity except for the elasticity of demand for oil with respect to the price of gas (which is even larger than the own-price elasticity of demand for oil). The models show considerable stability with respect to own-price elasticities but much instability with respect to the cross-price and income elasticities.

1. Introduction

This study analyzes residential demands for fuels — electricity, gas, oil — as functions of fuel prices, incomes and climatic variables. The cross-sectional econometric models constructed use a large data base containing variables for each state and each year from 1951 through 1974.[1]

Results of this study are being used in the development and improvement of a detailed engineering-economic model to simulate residential energy uses from 1970 through 2000.[2] The original version of the residential simulation model used fuel price and income elasticities from econometric analyses of the combined household/commercial sector using only a few years of data.[3,4,5] The present study was conducted primarily to provide improved estimates of these elasticities for the residential simulation model.

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The key features of this study are:

1. The models deal explicitly with residential energy demands (not the combined residential/commercial sector).
2. Improved definitions of residential fuel uses are developed to account for some residential fuel use that is generally allocated to the commercial sector.
3. Three different fuel oil price series are constructed. Models are estimated with each one to evaluate their relative strengths and weaknesses.
4. Models developed here are based on a large data base that contains variables for 47 states* and 24 years, a total of 1128 observations.
5. Cross-section models for 1951, 1955, 1960, 1965, 1970, 1971, 1972, 1973, and 1974 are estimated to evaluate the stability of coefficients over time.
6. Fuel use per household (rather than fuel use per capita) is chosen as the dependent variable because residential energy uses are related more closely to number of households than to number of people.
7. Models are developed for the three major household fuels — electricity, gas, and oil. During the past ten years, these fuels accounted for more than 90% of total residential energy use. Coal and liquefied natural gases account for only a small and declining portion of the total (5% during the 1970's).

A review of historical fuel use data reveals some interesting trends. The overall annual growth rate in energy use during the period of 1950 through 1975 was 3.4%, nearly double the growth rate in household formation (2.0%).[1] However, during recent years, growth in fuel use has been negative: -0.8% per year between 1972 and 1975.

The distribution of fuels among the total changed sharply during these 25 years. In 1950, coal accounted for more than one-third of household fuel use, while in 1975 coal accounted for only 2% of the total. Petroleum's share of the total also declined, from 26 to 18%. Electricity, on the other hand, increased its share from 18 to 43%. The share accounted for by gas increased from 22 to 24% during this period.

Several recent studies attempt to quantify the behavioral decisions underlying the fuel use trends described above. Baughman-Joskow[3] and Chern[4] developed fuel split and market share models respectively estimating shares of total energy use consumed by three major fuels. Since the data in both of these studies is from the combined residential/commercial sector it is difficult to apply these results directly to our residential simulation model.

Anderson[5] developed cross-section models (using data for 1960 and 1970) of residential demands for electricity and gas. Although Anderson dealt explicitly with the residential sector, he did not develop an

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*The states of North Carolina and South Carolina are combined, as are Washington, D.C. and Maryland.

equation for residential petroleum, presumably because of difficulties in separating residential and commercial uses of petroleum products. Thus, Anderson's results cannot be directly used in our simulation model.

2. Cross-Sectional Model Structure

A constant elasticity model* of the form:

$$Q_{ij} = A_j P_{elec_i}^{\beta_{j1}} P_{gas_i}^{\beta_{j2}} P_{oil_i}^{\beta_{j3}} Y_i^{\beta_{j4}} C_{1i}^{\beta_{j5}} C_{2i}^{\beta_{j6}} \varepsilon_{ij}$$

was used as the demand function for the three fuels. Taking the natural log of both sides of the equation yields a log-linear formulation:

$$\ln Q_{ij} = \beta_{j0} + \beta_{j1} \ln P_{elec_i} + \beta_{j2} \ln P_{gas_i} + \beta_{j3} \ln P_{oil_i} + \beta_{j4} \ln Y_i + \beta_{j5} \ln C_{1i} + \beta_{j6} \ln C_{2i} + \ln \varepsilon_{ij} .$$

where

- Q_{ij} is the average consumption per household of fuel j in state i
- P_{ki} is the average price of fuel k in state i
- Y_i is the per capita income in state i
- C_{1i} is the number of heating degree days in state i
- C_{2i} is the mean July temperature in state i
- β_{jm} is an unknown parameter
- ε_{ij} is a random disturbance term.

The electricity demand equation includes both C_{1i} and C_{2i} as explanatory variables that influence demands for electric space heating and electric air conditioning, respectively. Only C_{1i} is included in the gas and oil equations because almost all residential air conditioning systems use electricity as an energy source.

3. Data

We used several new data sources in our efforts to estimate accurate household fuel demand equations. Adjustments were made to several existing data sets to more precisely reflect household fuel uses. This section describes these data sources and adjustments.

3.1. Fuel use

The Edison Electric Institute[6] reports annual sales of electricity to residential customers. These figures include sales to individually-

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*Demand elasticity is defined as the percentage change in the quantity demanded associated with a 1% increase in a particular independent variable, i.e., $(\partial Q_i/\partial P_j)(P_j/Q_i)$.

metered dwellings and to gang-metered buildings with less than five households. Electricity sales to gang-metered buildings with five or more apartments are classified as commercial. To correct for this definitional problem, we increased the EEI figures for residential electricity sales by 4% for each state and each year.[7]

In a similar fashion, the American Gas Association[8] reports annual sales of gas to residential customers. To correct for the consumption of gas in gang-metered apartment units assigned by gas utilities to the commercial sector, we increased the AGA residential gas figure for each year and each state by 22% of the AGA commercial gas figure.[7]

The Bureau of Mines and American Petroleum Institute[9] report annual consumption of petroleum products (kerosene, Nos. 1-6 heating oils) for heating purposes. However, they do not estimate the fractions of these fuels consumed in the residential and commercial sectors. Based on conversations with staff in the Bureau of Economic Analysis (U.S. Department of Commerce) and ref. 7, we assumed that 100% of the kerosene and Nos. 1, 2, and 4 distillate heating oils classified by the Bureau of Mines as household/commercial were consumed in the residential sector. (This implies that 100% of the Nos. 5 and 6 residual heating oils were used in the commercial sector.)

3.2 Fuel prices

All prices used are state average prices. Prices for electricity and gas are obtained from EEI[6] and AGA,[8] respectively. The reported residential fuel prices are weighted with the reported commercial fuel prices to account for the adjustments in fuel use described above. Thus, state average fuel price is defined as total residential revenues divided by total residential consumption.

Developing appropriate price measures for residential petroleum use is much more difficult. Electricity and gas prices are based on complete records provided by electric and gas utilities to EEI, AGA, and the Federal Power Commission. Retail petroleum prices, however, can only be inferred from limited sample data.

Because of differences among fuel oil price series, we developed three different sets and estimated fuel demand equations with each one. The three prices series are: Platt's,[10] USDA,[11] and a combination of the two. As discussed later, we ultimately used the combined series because it gave the best (or the least bad, depending on one's outlook) results in terms of correct signs and t-statistics for the elasticity estimates.

The Platt's price series is available for cities in 23 states for each year from 1951 through 1974. States for which Platt's did not report prices were given the price from the geographically nearest state that did contain a Platt's price.

The USDA price series is available for each state for the years 1959 through 1974. To "create" fuel oil prices for the years 1951 through 1958, we developed regression equations to relate USDA kerosene prices for each year and state to corresponding fuel oil prices for the 1959-1974 period. These equations were then used with the USDA kerosene prices for 1951-1958 to estimate state fuel oil prices for these years. Finally, we adjusted the USDA prices each year by the national fuel oil price estimated by the Bureau of Labor Statistics.[12]

The third residential fuel oil price series was based on a combination of Platt's and USDA prices. Platt's prices were first multiplied by the ratio of BLS national fuel oil price to Platt's U.S. average price; this adjustment was made to correct Platt's wholesale prices to a retail level. States that had no Platt's price were then assigned a price based on the following formula:

$$P_{i,t} = P(\text{Platts})_{j,t} \cdot \left[\frac{P(\text{USDA})_{i,t}}{P(\text{USDA})_{j,t}}\right] \cdot \left[\frac{P(\text{BLS})_t}{P(\text{Platts})_t}\right]$$

where i represents a state without Platt's data and j represents a state adjacent to the ith state having a Platt's price. Thus, the USDA prices are used to provide greater cross-sectional variation to the Platt's series.

The development of the third fuel oil price series was necessary because neither the Platt's nor the USDA series alone gave satisfactory results. When models were developed for fuel oil consumption using the Platt's series, the own-price coefficient frequently gave incorrect (positive) signs. The USDA oil price series often gave negative signs for cross-price coefficients.

3.3 Other variables

Heating degree-days and mean July temperature are used as explanatory variables to account for the effects of weather on fuel consumption for space heating and air conditioning. State heating degree days, compiled on a monthly basis, were obtained from the U.S. Department of Commerce.[13] These data were converted to a calendar year basis for this study. Mean July temperatures were also obtained from the Department of Commerce.[14] Data from several cities in each state were weighted by population to develop state estimates for mean July temperature.

Values of per capita income for each state and year were obtained from various issues of *Survey of Current Business*.[15]

All fuel price and income variables were deflated by the Consumer Price Index[15] (to account for temporal changes in price levels) and by Anderson's metropolitan cost of living index[5] (to account for regional differences in price levels).

The number of households in each state was obtained from the Bureau of the Census for the years 1950, 1960, 1965-1968, 1970, and 1972-1974.[16] To create data for the missing years we used estimates of state population from the Bureau of the Census[16] (provided for each year) and a simple interpolation scheme.

The data series used in this study is defined for each year from 1951 through 1974 and for each of 47 states. North and South Carolina are combined because separate state electricity use figures were not reported before 1957. Maryland and Washington, D.C. are also combined for the same reason. Alaska and Hawaii are excluded because only recent data are available for these states (see ref. 1 (Table 2) for definitions and unit of measurements for variables used in the econometric models).

4. Empirical Results

The following tables present regression results obtained with the equations of Section 2 and the data of Section 3. Coefficient estimates and corresponding t-statistics for cross-sectional equations are given in Table 1 for electricity, Table 2 for gas, and Table 3 for oil. The combined Platt's-USDA fuel oil price series was used for all regressions reported here because it gave better results than either the Platt's or USDA prices alone; see Section 3.

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Table 1 Estimated Household Demand for Electricity; Cross-Sectional Model*

Estimation Method: Ordinary Least Squares

Dependent Variable: *ln* (Q_{elec}/Household)

Year	*ln* P_{elec}	*ln* P_{gas}	*ln* P_{oil}	*ln* PCI	*ln* HDD	*ln* COOL	Constant	R^2
1951	−1.039	0.120	0.347	0.282	0.105	0.021	2.028	0.853
	(−12.48)[a]	(3.30)[a]	(1.91)[c]	(2.24)[b]	(1.85)[c]	(0.09)	(1.48)[d]	
1955	−1.035	0.089	0.619	0.007	0.100	−0.057	2.062	0.826
	(−11.29)[a]	(2.02)[b]	(2.47)[b]	(0.05)	(2.07)[b]	(−0.26)	(1.58)[d]	
1960	−1.029	0.094	0.738	0.148	0.115	0.238	0.700	0.803
	(−11.40)[a]	(1.55)[d]	(2.77)[a]	(0.90)	(1.59)[d]	(0.93)	(0.37)	
1965	−1.073	0.007	0.053	−0.211	−0.025	−0.002	5.54	0.785
	(−11.21)[a]	(0.12)	(0.20)	(−1.18)	(−0.35)	(−0.01)	(2.85)[a]	
1969	−1.082	0.107	0.029	−0.280	−0.063	0.233	4.911	0.781
	(−10.66)[a]	(1.35)[d]	(0.11)	(−1.31)[d]	(−0.85)	(1.02)	(2.66)[b]	
1970	−1.077	0.092	0.114	−0.376	−0.052	0.467	4.164	0.801
	(−10.53)[a]	(1.27)	(0.48)	(−1.82)[c]	(−0.99)	(1.89)[c]	(2.48)[b]	
1971	−0.867	0.121	0.127	−0.397	−0.115	0.186	4.735	0.759
	(−9.33)[a]	(1.62)[d]	(0.52)	(−1.80)[c]	(−1.77)[c]	(0.80)	(2.97)[a]	
1972	−1.069	0.146	0.037	−0.227	−0.112	0.156	5.36	0.793
	(−10.32)[a]	(2.15)[b]	(0.16)	(−1.07)	(−1.98)[c]	(0.72)	(3.63)[a]	
1973	−1.11	0.162	0.416	0.199	−0.085	0.504	2.511	0.834
	(−12.68)[a]	(2.68)[b]	(2.08)[b]	(1.07)	(−1.60)[d]	(2.49)[b]	(1.96)[c]	
1974	−1.032	0.403	0.555	0.007	−0.105	0.552	0.838	0.866
	(−14.70)[a]	(6.30)[a]	(3.24)[a]	(0.04)	(−2.82)[a]	(3.05)[a]	(0.78)	

*The figures in parentheses are t-statistics, R^2 is the multiple coefficient of determination. There are 47 observations in each equation.

[a] Statistically significant at the 1% level.
[b] Statistically significant at the 5% level.
[c] Statistically significant at the 10% level.
[d] Statistically significant at the 20% level.

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Table 2 Estimated Household Demand for Natural Gas: Cross-Sectional Model*

Estimation Method: Ordinary Least Squares
Dependent Variable: *ln* (Q_{gas}/Household)

Year	*ln* P_{elec}	*ln* P_{gas}	*ln* P_{oil}	*ln* PCI	*ln* HDD	Constant	R^2
1951	1.309 (3.64)[a]	−1.744 (−11.95)[a]	−0.548 (−0.75)	1.966 (3.84)[a]	−0.129 (−0.74)	3.21 (1.16)	0.821
1955	1.167 (2.99)[a]	−2.039 (−10.20)[a]	−0.449 (−0.39)	2.18 (3.56)[a]	−0.076 (−0.37)	4.57 (1.08)	0.762
1960	0.530 (2.22)[c]	−2.026 (−13.72)[a]	−0.329 (−0.46)	1.332 (3.10)[a]	0.036 (0.25)	6.58 (2.04)[b]	0.835
1965	0.381 (1.21)	−1.539 (−9.47)[a]	0.348 (0.41)	1.590 (2.71)[a]	0.116 (0.71)	1.895 (0.48)	0.725
1969	0.197 (0.86)	−2.368 (−14.62)[a]	−0.656 (−1.14)	1.684 (3.52)[a]	0.144 (1.19)	8.269 (3.00)[a]	0.848
1970	0.193 (0.75)	−2.42 (−13.39)[a]	−0.521 (−0.88)	1.876 (3.58)[a]	0.174 (1.37)	7.626 (2.56)[b]	0.825
1971	0.225 (1.07)	−2.256 (−13.33)[a]	−0.346 (−0.63)	2.175 (4.36)[a]	0.201 (1.80)[c]	5.706 (2.22)[b]	0.826
1972	0.204 (0.75)	−2.091 (−11.67)[a]	−0.569 (−0.93)	1.929 (3.43)[a]	0.254 (2.15)[b]	5.318 (1.89)[c]	0.792
1973	0.520 (1.87)[c]	−2.047 (−10.62)[a]	−1.060 (−1.66)[d]	1.195 (2.01)[c]	0.141 (1.09)	7.323 (2.93)[a]	0.771
1974	0.654 (2.72)[a]	−2.227 (−11.22)[a]	−0.100 (−1.66)[d]	1.771 (2.94)[a]	0.231 (2.12)[b]	6.547 (2.73)[a]	0.781

*The figures in parentheses are t-statistics, R^2 is the multiple coefficient of determination. There are 47 observations in each equation.

[a]Statistically significant at the 1% level.
[b]Statistically significant at the 5% level.
[c]Statistically significant at the 10% level.
[d]Statistically significant at the 20% level.

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Table 3 Estimated Household Demand for Fuel Oil; Cross-Sectional Model*

Estimation Method: Ordinary Least Squares

Dependent Variable: $ln\ (Q_{oil}/\text{Household})$

Year	$ln\ P_{elec}$	$ln\ P_{gas}$	$ln\ P_{oil}$	ln PCI	ln HDD	Constant	R^2
1951	0.605	1.106	−0.229	0.854	0.885	−13.71	0.880
	(2.94)[a]	(13.23)[a]	(−0.55)	(2.92)[a]	(8.83)[a]	(−8.62)[a]	
1955	0.594	1.303	−0.159	0.596	1.148	−16.74	0.846
	(2.46)[b]	(10.53)[a]	(0.22)	(1.57)[d]	(9.16)[a]	(−6.40)[a]	
1960	0.100	1.799	−1.780	1.008	1.535	−17.06	0.797
	(0.28)	(8.18)[a]	(−1.68)[c]	(1.58)[d]	(7.04)[a]	(−3.55)[a]	
1965	0.067	1.329	−2.446	0.355	1.405	−11.12	0.747
	(0.159)	(6.08)[a]	(−2.13)[b]	(0.45)	(6.40)[a]	(−2.08)[b]	
1969	−0.012	2.250	−1.855	−0.557	1.611	−17.27	0.813
	(−0.033)	(8.47)[a]	(−1.96)[c]	(−0.71)	(8.08)[a]	(−3.82)[a]	
1970	−0.248	2.298	−1.762	−0.369	1.450	−15.86	0.798
	(−0.61)	(8.01)[a]	(−1.87)[c]	(−0.44)	(7.20)[a]	(−3.35)[a]	
1971	−0.057	2.376	−1.477	0.094	1.269	−16.57	0.798
	(−0.19)	(8.75)[a]	(−1.68)[c]	(0.12)	(7.06)[a]	(−4.02)[a]	
1972	0.164	2.128	−1.148	0.240	1.234	−16.83	0.831
	(0.48)	(9.48)[a]	(−1.50)[d]	(0.34)	(8.34)[a]	(−4.77)[a]	
1973	0.497	2.005	−1.244	−0.483	1.273	−16.05	0.817
	(1.65)[d]	(9.57)[a]	(−1.79)[c]	(−0.75)	(9.06)[a]	(−5.90)[a]	
1974	0.560	1.742	−0.650	−0.801	1.221	−15.44	0.784
	(1.90)[c]	(7.17)[a]	(0.88)	(−1.09)	(9.13)[a]	(−5.27)[a]	

*The figures in parentheses are t-statistics, R^2 is the multiple coefficient of determination. There are 47 observations in each equation.

[a]Statistically significant at the 1% level.

[b]Statistically significant at the 5% level.

[c]Statistically significant at the 10% level.

[d]Statistically significant at the 20% level.

The models show considerable stability over time for the own-price coefficients for electricity and natural gas; long-run elasticities average -1.0 and -2.1, respectively. The own-price elasticity of demand for oil shows more variation, with values ranging from -0.2 in 1955 to -2.5 in 1965. From 1965 to 1973 this elasticity declined steadily in absolute magnitude from -2.5 to -1.2. This covers a period during which oil consumption per household declined 28%, signifying a possible structural change in the demand for oil.

Cross-price elasticities for both electricity and gas generally increased in magnitude and statistical significance over time, especially during the last six years of the data series. This suggests that households have become more aware of relative fuel costs and have acted accordingly in their fuel choice decisions.

The absolute magnitude of the own-price elasticity for oil, averaging -1.3, is considerably less (44%) than the cross-price elasticity of oil with respect to the price of gas, averaging 1.8. The implication that the quantity of oil demanded by households is more responsive to changes in gas price than to changes in oil price is counter-intuitive. This result appears to stem from gas availability problems in the Northeast. Although the price of natural gas is high in large oil-consuming states (Maine, New Hampshire, Vermont), oil consumption is also influenced by the unavailability of gas. Thus the elasticity of oil demand with respect to gas price reflects both a price effect and an availability effect.

The per capita income elasticity of demand for natural gas was considerably higher and more stable over time than corresponding values for electricity and oil. Since 1951, the income elasticity of demand for gas averaged 1.8. For electricity and oil these elasticities averaged -0.1 and + 0.1, respectively, indicating a clear preference for natural gas in high income states.

Fuel oil consumption shows a greater response to cold weather than either natural gas or electricity. The average elasticity of oil use with respect to HDD is 1.3. For natural gas and electricity the values averaged 0.11 and -0.02, respectively. The negative value for electricity reflects the fact that electric heating is widely used only in mild climates, such as the Southeast. For example, in 1970 only 0.3% of single-family homes in the 14 state New England, Middle Atlantic and East North Central regions were heated by electricity, whereas in the 14 state South Atlantic and East South Central regions, electric space heating was used in 15% of single-family homes.[5]

The percentage of households with air conditioning in the U.S. increased from 1% in 1950 to 36% in 1970 and 49% in 1974.[2] The variable, mean July temperature, is included in our equations to capture the influence of air conditioning on electricity demand. For all years before 1969 the coefficient of this variable is statistically insignificant (Table 1), probably because only a small fraction of households in each state owned air conditioning equipment. From 1969 on, both the magnitude and statistical significance of this variable increased. The average value of the coefficient for mean July temperature was +0.34 for the 1970 to 1974 period.

In general, the own-price elasticities of electricity and natural gas show good stability over time and are highly significant statistically. This is not the case with the oil own-price elasticity which has an average t-statistic of -1.4 over the sample period. (The average t-statistics for electricity and natural gas are -11.5 and -12.0, respectively). Oil consumption shows the greatest response to cold weather with natural gas use showing the greatest response to per capita income changes.

5. Model Assumptions and Limitations

All analytical efforts involve assumptions and limitations related both to the data used to construct the model and to the structure of the model itself. Our work is not different: we "adjusted" and "created" data series where an existing one did not match our needs or where none existed. In defining our models, we made simplifying assumptions because of data unavailability, computational simplicity, or lack of adequate theory.

Our models assume implicitly that all fuels are always available at stated prices and that consumption is a function only of prices, incomes, and weather. No information is included in the model concerning availability of fuels; this is quite important for gas.

During the early years covered by our models, gas was unavailable in many states because pipelines had not yet been constructed in these regions. During later years, gas shortages occurred; utilities in many regions were unable to provide gas to new customers. Thus the usual supply-demand balance was influenced by both prices and availability. If we had been able to obtain quantitative information on gas availability in each state and year, we would have constructed models that included this variable. However, such information does not exist.

In our study, average prices of electricity and natural gas were used instead of marginal prices because suitable data series on state marginal prices were not available. A recent study by Taylor et al.,[17] concerning residential energy demands, developed an electricity price series that includes not only changes in marginal prices, but also customer charges and intramarginal prices as well.

Specification of our models may not be complete. Excluded variables that may play a statistically significant role in the regressions include household size, fraction of households living in rural areas, fraction of households living in single-family units, and fraction of households with income below $3,000. Unfortunately, such data are available from the Bureau of the Census only for Census years (1960 and 1970).

Interpretation of the cross-sectional results assumes that the system is in long-run equilibrium. This may not be true for 1951 when the shift in fuel choice from coal to other fuels was still in progress, and in 1973 and 1974 when the effects of the Arab oil embargo were very much in evidence.

6. Summary

This study developed econometric models of household demands for electricity, gas, and oil using a large data base containing observations for 47 states and 24 years. The cross-sectional equations assume that fuel demands are functions of fuel prices, incomes, and weather variables.

In the long-run, own-price elasticities for all three fuels are greater than unity. Gas shows the greatest sensitivity to own-price changes and electricity shows the smallest response. The cross-price elasticities are all less than unity with one exception. The elasticity of demand for oil with respect to the price of gas is about 1.8, considerably larger than the own-price elasticity of demand for oil (-1.3). The coefficients of per capita income (cross-sectional models) show considerable variation in both signs and magnitudes across different time periods. It appears that the income elasticity of demand for gas is greater than +1, that demand for oil is almost independent of income, and that demand for electricity may decline with increases in incomes.

Two key deficiencies with respect to the data used in constructing these models are the price series for fuel oil and the use of *ex post* average prices for electricity and natural gas. Biased coefficients due to problems of simultaneity are a possibility when average rather than marginal prices are used. Another data problem concerns disaggregation of combined household/commercial petroleum use for the two sectors. We feel that improved data series on residential consumption of petroleum products would substantially improve the reliability and stability of the coefficients.

The major problem with the assumed model structures is simplicity. We ignore problems of gas availability, changes in equipment ownership, and other factors that may cause structural changes over time.

Despite these problems in both data and equations, the results obtained here are quite useful. Table 4 presents a synthesis of our long-run elasticities.

Table 4. Price and income elasticity estimates

Fuel	P_{elec}	P_{gas}	P_{oil}	Income
Electricity	-1.04	0.13	0.30	-0.11
Natural gas	0.54	-2.08	-0.42	1.77
Fuel oil	0.23	1.83	-1.28	0.09

The key features of the models developed here include:

1. Explicit consideration of only the residential sector using improved definitions of residential fuel uses.
2. Use of a large data base containing 1128 observations.
3. Development of 9 different cross-section equations for each fuel.

While these improvements over previous econometric models of household fuel demands do not always lead to more consistent coefficient estimates, the large data base and large number of equations estimated show clearly which coefficients are stable and reliable and which are not.

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