Residential Energy Consumption across Different Population Groups: Comparative Analysis for Latino and Non-Latino Households in U.S.A.

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Residential Energy Consumption across Different Population Groups: Comparative Analysis for Latino and Non-Latino Households in U.S.A.

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PREFACE

This Argonne National Laboratory report is a product of extensive analytical and data base capabilities developed while conducting research sponsored by the U.S. Department of Energy's Office of Economic Impact and Diversity for over 10 years. These capabilities were used in estimating the dynamic energy demand models for black, non-black, Latino, and non-Latino households described in this report. This report is, for the most part, a reprint of research published in Energy Economics (19 [1997] 445-463).

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NOTATION

CDD	cooling degree days
DOE	U.S. Department of Energy
EIA	Energy Information Administration
HDD	heating degree days
LIHEAP	Low-Income Household Energy Assistance Program
LPG	liquefied petroleum gas
RECS	Residential Energy Consumption Survey

RESIDENTIAL ENERGY CONSUMPTION ACROSS DIFFERENT POPULATION GROUPS: COMPARATIVE ANALYSIS FOR LATINO AND NON-LATINO HOUSEHOLDS IN U.S.A.

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ABSTRACT

Residential energy cost, an important part of the household budget, varies significantly across different population groups. In the United States, researchers have conducted many studies of household fuel consumption by fuel type — electricity, natural gas, fuel oil, and liquefied petroleum gas (LPG) — and by geographic areas. The results of past research have also demonstrated significant variation in residential energy use across various population groups, including white, black, and Latino. However, our research shows that residential energy demand by fuel type for Latinos, the fastest-growing population group in the United States, has not been explained by economic and noneconomic factors in any available statistical model. This paper presents a discussion of energy demand and expenditure patterns for Latino and non-Latino households in the United States. The statistical model developed to explain fuel consumption and expenditures for Latino households is based on Stone and Geary's linear expenditure system model. For comparison, we also developed models for energy consumption in non-Latino, black, and nonblack households. These models estimate consumption of and expenditures for electricity, natural gas, fuel oil, and LPG by various households at the national level. The study revealed significant variations in the patterns of fuel consumption for Latinos and non-Latinos. The model methodology and results of this research should be useful to energy policymakers in government and industry, researchers, and academicians who are concerned with economic and energy issues related to various population groups.

1 INTRODUCTION

Residential energy cost, an important part of the household budget, varies significantly across different population groups in many countries. Energy consumption varies because of differences in such causal factors as fuel prices, climate, housing characteristics (type and age of home), and household characteristics (income, education of the head of the household, and ethnicity/race). In the United States, researchers have conducted many studies to analyze energy consumption by fuel type — including electricity, natural gas, fuel oil, and liquefied petroleum gas (LPG) — and by geographic areas, such as the census regions (DOE 1989b, 1993c). Through its eight Residential Energy Consumption Surveys (RECSs), conducted between 1978 and 1990,

the U.S. Department of Energy (DOE) Energy Information Administration (EIA) has collected extensive data on energy use by household and related characteristics (DOE 1993c). Each RECS contains data for several thousand households.

Past research has also demonstrated significant variations in residential energy use across various population groups, including white, black, and Latino. For example, the DOE-EIA estimated that the average household energy consumption at the national level in 1987 was 105.7×10^9 J (100.2×10^6 Btu) for whites, 116.4×10^9 J for blacks, and 92.1×10^9 J for Latinos (DOE 1989b). However, our research revealed that residential energy demand by fuel type for Latinos, the fastest-growing population group in the United States, has not been explained by economic and noneconomic factors in any available statistical model.

The purpose of this report is to discuss energy demand and expenditure patterns for Latino and non-Latino households in the United States as a case study of residential energy consumption across different population groups in a country. The statistical model developed to explain fuel consumption and expenditures for Latino households is based on the linear expenditure system model developed by Stone and Geary. For comparison, we also developed models for non-Latino, black, and nonblack households; these models estimate energy consumption of and expenditures for electricity, natural gas, fuel oil, and LPG by various households at the national level. Our study revealed significant variations in the patterns of consumption of these fuels by Latinos and non-Latinos. The model methodology and results of this research should be useful to energy policymakers in government and industry, researchers, and academicians who are concerned with economic and energy issues related to various population groups.

2 EFFECTS OF SOCIOECONOMIC AND CULTURAL/BEHAVIORAL FACTORS ON ENERGY CONSUMPTION

As discussed, past research has revealed significant variation in household energy use across various population groups, including white, black, and Latino. This variation could be attributed to engineering factors (e.g., thermal integrity of home, energy efficiency of appliances), energy factors (e.g., availability and prices of supplied fuels), economic factors (e.g., cost of home and appliances), and household characteristics (e.g., family income, number of household members, race/ethnicity).

The household energy use across white, black, and Latino households in the United States varies because of significant variations in income (generally highest for white and lowest for black), type of homes (proportionately more blacks live in older, less energy-efficient homes and in rental dwellings), urban vs. rural location (blacks concentrate in large urban cities), climate (blacks and Latinos live in more moderate South and West census regions, respectively), and central city location (sometimes restricting availability of natural gas and LPG). Household energy use is also affected by the number of household members; the average black or Latino household is larger than the average white household. The proposed household energy demand model incorporates the effects of these socioeconomic, cultural, and behavioral factors through its explanatory variables. The specification of the model is discussed in the following sections.

3 LITERATURE SEARCH

By using the Social Studies Category Index database for 1992–1994, we conducted a literature search to identify publications on topics related to energy demand by Latino households. We did not identify any publication on energy demand that provided information about household energy consumption, expenditures, or prices by fuel type for Latinos. However, several publications on related topics were reviewed. These characteristics described in the articles (socioeconomic, behavioral) are of interest because of their potential effect on energy consumption patterns in Latino households; the information from these sources is summarized in the following paragraphs.

Chapa and Valencia (1993) discuss Latino population growth and demographic characteristics. Between 1980 and 1990, the Latino population in the United States increased by 53%, while the total population grew by 9% (U.S. Department of Commerce, Bureau of the Census 1991). About half of this growth was attributable to foreign immigration, and the other half to births in the United States. The Latino population reached more than 22 million in 1990. The authors document that the Latino population has lower income and educational levels, but higher family size, than the non-Latino population.

Perez and Salazar (1993) analyzed the economic implications of the fast-growing Latino population. They characterized the Latino population as undereducated, youthful, and growing. For example, the rate at which Latinos 25 years and older had completed high school in 1989 was only about 51%, compared with 65% for blacks and 78% for whites.

Lutzenhiser (1993) reviews literature concerning human factors in energy use, particularly household consumption. According to Lutzenhiser, "... residential-sector consumption seems to be characterized by variability and change, with human behavior playing a central role in both the short- and long-term initiation, maintenance, and alteration of energy flows" (p. 250).

In another article, Lutzenhiser (1992) discussed the value of an emerging cultural or lifestyle model of energy use. The impact of change in lifestyle on energy use is among the issues Lutzenhiser raises. The author states that "The prospects of movement toward a cultural model in energy research seem good." This methodology is exploratory and not directly usable for our research. Nevertheless, it substantiates our approach of estimating household energy consumption by population group, including the Latino population, separately because lifestyles may vary across different groups.

Lee and Singh (1994) analyzed household consumption of electricity and natural gas by using modified regression techniques. One of their objectives was to estimate energy conservation from the perspective of increasing gas availability. Hsing (1994) estimated residential demand for electricity by using the cross-sectionally correlated and time-wise

autoregressive model. Demand was estimated for five southern U.S. states from 1981-1990. After reviewing these and other commonly used methodologies, we have selected a reliable regression methodology that is more suitable for our objective of estimating energy consumption for Latino households. The lack of a methodology had not been a problem for analyzing energy consumption for Latino households; the lack of data is what has constrained the analysis.

Poyer and Williams (1993) compared total energy and electricity demand elasticities for non-Latino whites with the demand elasticities for Latinos and blacks. This analysis was at the national level, but it did not include other residential fuels (natural gas, fuel oil, and LPG).

Other very good research related to residential energy demand has been done over the past 20 years: see Bohi (1981), Electric Power Research Institute (1982), Blattenberger et al. (1983), Cowing and McFadden (1984), Dubin and McFadden (1984), DOE (1984a), Morrissey (1984), Dubin (1985), Hamblin et al. (1986), Khazzoom (1986), and Baxter et al. (1987).

4 DATA SOURCES

The household energy demand model was developed by using selected data from DOE-EIA RECSS conducted for 1980, 1982, 1984, 1987, and 1990 (DOE 1982b, 1985, 1987b, 1989a, 1993a). Several reports on each of these surveys are available (DOE 1982a, 1984b, 1987a, 1989b, 1993b,c). The total number of observations in the analyzed data set is 7,823, out of which 455 observations are for Latino households. The classification as a Latino household was based on self-identification as a Latino by the head of the household in the survey year. A comparison of energy expenditure data for 1981 and 1990 was derived from the 1981 and the 1990 RECSs. A report on the 1981 survey is also available (DOE 1983b).

5 PROPOSED HOUSEHOLD ENERGY DEMAND AND EXPENDITURE MODEL

Given the market, demographic, and policy contexts, we propose a theoretical framework based on the linear expenditure system model developed by Stone (1954) and Geary (1950-1951). To capture the dynamics of energy demand, Pollak's (1970) dynamic version of the Stone-Geary model is used in developing the model.

The Stone-Geary-Pollak utility function is additive and is therefore strongly separable, allowing us to split the utility function by commodity group. For the fuel and energy group, the associated subutility function for the Pollak-Stone-Geary model is as follows:

$$u_e = \prod_{i=1}^n [q_{it} - (\gamma_i + \theta_i q_{i(t-1)})]^{\beta_i} \quad (1)$$

where u_e is the utility index, q_{it} is the consumption of the i th fuel in period t , γ_i is the nondiscretionary demand for the i th fuel, θ_i is the dynamic adjustment parameter for the i th fuel, $q_{i(t-1)}$ is the consumption of the i th fuel in period $(t - 1)$, and β_i is the marginal expenditure share on the i th fuel. The model assumes that households maximize Equation 1 subject to total energy expenditures as:

$$m_{et} = \sum_{i=1}^n p_{it} q_{it} \quad (2)$$

where m_{et} is the total energy expenditures in period t , and p_{it} is the price of the i th fuel in period t .

The maximization of Equation 1 subject to Equation 2 gives the following demand equation:

$$q_{it} = \gamma_i + \theta_i q_{i(t-1)} + \frac{\beta_i}{p_{it}} [m_{et} - \sum_{i=1}^n p_{it} (\gamma_i + \theta_i q_{i(t-1)})] \quad (3)$$

The expenditure counterpart of Equation 3 is

$$m_{it} = p_{it} (\gamma_i + \theta_i q_{i(t-1)}) + \beta_i [m_{et} - \sum_{i=1}^n p_{it} (\gamma_i + \theta_i q_{i(t-1)})] \quad (4)$$

where m_{it} is the expenditures on the i th fuel in period t .

Energy expenditures can be separated into two component: nondiscretionary and discretionary. The nondiscretionary component is expressed by the first term on the right in Equation 4, and the discretionary component by the second term. Because β_i , must be

nonnegative and less than unity, an increase in nondiscretionary demand will increase expenditures on the i th fuel. On the contrary, an increase in nondiscretionary demand for fuels other than the i th fuel will lower expenditures on the i th fuel and will also lower its own-price demand elasticity.

Together with the nonnegativity prerequisite, the adding-up condition¹ requires that the β_i terms sum to unity. Holding all other things constant, a larger marginal expenditure share implies a larger demand elasticity.

The dynamic adjustment coefficient, which must be between 0 and 1, measures the extent to which fuel consumption and expenditure change over time in response to changes in either fuel prices or total energy household expenditures.² Larger coefficients are associated with larger long-run demand elasticities. Also, fuel demand equations with a larger dynamic adjustment coefficient imply that a larger fraction of a household's consumption of that fuel is nondiscretionary.

Energy expenditures are assumed to be a linear function of a number of exogenously determined variables, as expressed in this equation:

$$m_{et} = \sum_{j=1}^k b_j x_{jt} \quad (5)$$

where b_j is the coefficient of the j th variable. These variables (x_{jt}) include household income, number of household members, weather variables, components and changes in the consumer price index, and metropolitan statistical area location.³

Within the context of the linear expenditure system, the marginal expenditure share parameter and nondiscretionary demand component are critical in determining how price changes affect expenditures for a particular energy fuel source. In particular, relative expenditures on the i th fuel, in the short run, will be **greater** the **smaller** the expenditure share parameter, β_i , and the

¹ The adding-up condition requires that the sum of all individual commodity expenditures equal total commodity expenditures, i.e.

$$m_{et} = \sum_{i=1}^n p_{it} q_{it}.$$

² Demand is homogeneous of degree zero in energy prices and total energy expenditures.

³ In the United States, metropolitan areas with a minimum of 50,000 residents constitute individual Metropolitan Statistical Areas (MSAs). The cost of living in these MSAs varies significantly from location to location on the basis of real estate, labor, and consumer costs.

larger the nondiscretionary parameter, γ_i , and dynamic adjustment parameter, θ_i , with an increase in the price of the i th fuel. In the long run, only the expenditure share and nondiscretionary demand parameters will matter.

The linear expenditure system is associated with an intuitively appealing cost function that provides a rigorous measure of the economic welfare effects of changing prices:

$$c_t = \sum_{i=1}^n p_{it}(\gamma_i + \theta_i q_{i(t-1)}) + u \prod_{i=1}^n p_{it}^{\beta_i}, \quad (6)$$

where u is the benchmark parameter, which can be interpreted as a measure of utility in some base period.

6 EMPIRICAL ANALYSIS OF DATA GENERATED FROM APPLICATION OF THE MODEL

Table 1 lists total and electricity expenditures (constant 1979 dollars) for Latino and non-Latino white and black households for 1981 and 1990. The expenditures are broken down by race, Latin ethnicity and poverty status (using household income as an indicator of poverty). Poverty is defined as 125% of the official U.S. Bureau of the Census poverty figure. These data reveal both similarities and differences in how energy is used and how its use has changed over time for these population groups. In a complex and puzzling way, these data reveal convergence in the total level of expenditures among these groups. However, in some cases, this convergence was accompanied by a divergence in energy expenditure patterns by population group and by variations in rates of change in fuel-type expenditures by poverty status.

In general, energy expenditures for non-Latino whites and blacks were about the same, but the composition of those expenditures was different. Typically, non-Latino whites spent relatively more on electricity, even though a larger fraction of the black population lives in the south, where electricity is more extensively used. On the other hand, Latino households spent substantially less on energy than non-Latino whites, but the relative expenditures for electricity were about the same for both groups.

In both periods (i.e., 1981, 1990), electricity expenditures for non-Latino white households were larger than those for Latino and non-Latino black households. As mentioned, total energy expenditures by non-Latino white and black households were virtually the same for the period; however, expenditures declined at a faster rate for non-Latino blacks. The faster decline in energy expenditures by black households was mostly caused by a dramatic decline in total expenditures by nonpoor blacks. Together with the convergence in overall energy expenditures, the composition of energy expenditures between non-Latino white and black households became more similar, with the share of expenditures for electricity rising faster for black households.

For Latino households, the decline in total energy expenditures was not as large as for non-Latino whites. Unlike for non-Latino blacks, the decline in energy expenditure by nonpoor Latinos was relatively small. For both poor and nonpoor Latinos, electricity expenditures increased between 1981 and 1990. As in the case of non-Latinos, the share of expenditures for electricity increased dramatically for Latinos between 1981 and 1990.

Figures 1 through 3 show the relative importance of various residential energy sources by population group and region (DOE 1993a). In these figures, energy consumption fractions are shown for five residential energy sources: natural gas, electricity, LPG, fuel oil, and kerosene.

TABLE 1 Total Energy and Electricity Expenditures (constant 1979\$/household)

Household	1981 ^a		1990 ^a		Change (%)	
	Electricity	Total	Electricity	Total	Electricity	Total
Non-Latino white						
Non-poor	470 (8)	852 (13)	459 (7)	697 (10)	-2.3	-18.2
Poor	352 (12)	667 (19)	341 (13)	537 (17)	-3.1	-19.5
Total	452 (7)	824 (12)	440 (6)	672 (9)	-2.7	-18.4
Non-Latino black						
Non-poor	446 (21)	940 (35)	417 (21)	692 (29)	-6.5	-26.4
Poor	339 (18)	724 (30)	332 (22)	595 (32)	-2.1	-17.8
Total	400 (15)	848 (26)	385 (15)	656 (22)	-3.8	-22.6
Latino						
Non-poor	398 (22)	727 (32)	437 (27)	628 (32)	9.8	-13.6
Poor	260 (22)	604 (38)	283 (27)	472 (35)	8.8	-21.9
Total	361 (18)	693 (27)	389 (20)	580 (25)	7.8	-16.3

^a Standard deviations are shown in parentheses.

Source: DOE (1983a, 1993a).

The composition of energy consumption is shown by census region⁴ and nationally⁵ for each population group (Latino and non-Latino black and white) in Figures 1 through 3. Natural gas and electricity are the major energy sources used by all households. However, the regional compositions of natural gas and electricity use vary. Most salient is the large electricity share of total energy consumption in the south census region and the large natural gas share in the Midwest census region.

⁴ The Southwest is included because of the extraordinary concentration of Latinos in Texas, New Mexico, Arizona, and California.

⁵ No allowances for electricity production losses are made. Electricity consumption is measured at the point of end use.

FIGURE 1 1990 Composition of Fuel Use: Non-Latino White Households (fuels shown from top to bottom in chart)

FIGURE 2 1990 Composition of Fuel Use: Latino Households
(fuels shown from top to bottom in chart)

FIGURE 3 1990 Composition of Fuel Use: Non-Latino Black Households (fuels shown from top to bottom in chart)

For non-Latino whites, natural gas is the major residential fuel consumed at the point of end use.⁶ The consumption of natural gas by non-Latino white households was most prominent in the Midwest census region. In each census region, more natural gas was consumed as a proportion of total residential energy consumption than any other fuel type, except in the south census region. In that region, electricity was the dominant residential energy source in 1990.

For Latino households, interregional changes in the composition of natural gas and electricity consumption were qualitatively similar to those for non-Latino whites. However, at both the regional and national levels, the fraction of natural gas consumption was typically larger. At the national level, natural gas represented slightly under 60% of total residential energy consumption for Latino households and slightly over 50% of total residential energy consumption for non-Latino white households.

For non-Latino black households, the changes in the composition of natural gas and electricity consumption were qualitatively the same as for non-Latino white households. However, the magnitude of the relative difference in consumption of natural gas and electricity in non-Latino black households was dramatic. In the Midwest, natural gas represented almost 90% of total residential energy consumption in non-Latino black households, compared with 65% in non-Latino white households. Nationally, natural gas consumption constitutes about 65% of total residential energy consumption by non-Latino black households (compared with the 50% of total consumption for non-Latino white households).

To provide a theoretical context for explaining changes in energy consumption, the energy demand model, described earlier, was estimated for Latino, black and non-Latino, nonblack households, and all households.⁷ The results are shown in Tables 2 through 5. The log-likelihood function values for each of the models are listed in Tables 2 and 3. Results for each group are described below.

6.1 LATINO ENERGY DEMAND

The parametric estimates for the Latino and non-Latino energy demand models are shown in Tables 2 and 4. The null hypothesis that two demand systems are equivalent is overwhelmingly rejected. The estimated natural gas demand model for Latinos suggests that,

⁶ Clearly, electricity was the most important fuel because of its predominant share of total residential energy expenditures in 1990. For each population group, more than 50% of total residential energy expenditures were for electricity.

⁷ The Latino and black population categories are not mutually exclusive. Latino can be any race.

TABLE 2 Dynamic Energy Demand Model Estimates: Latino and Non-Latino Households

Parameter	Household ^a		
	All	Latino	Non-Latino
Natural gas			
Marginal share	0.24	0.32	0.23
(β_{ng})	(0.006)	(0.029)	(0.006)
Nondiscretionary	-10.46	-9.94	-10.44
(γ_{ng})	(1.15)	(5.90)	(1.15)
Dynamic coefficient	0.83	0.65	0.84
(θ_{ng})	(0.007)	(0.029)	(0.007)
Electricity			
Marginal share	0.56	0.55	0.57
(β_{el})	(0.006)	(0.026)	(0.006)
Nondiscretionary	-6.04	-3.72	-6.41
(γ_{el})	(0.60)	(2.03)	(0.65)
Dynamic coefficient	0.79	0.72	0.80
(θ_{el})	(0.011)	(0.044)	(0.012)
Fuel oil/kerosene			
Marginal share	0.13	0.09	0.13
(β_{fo})	(0.005)	(0.022)	(0.005)
Nondiscretionary	-6.58	-3.82	-6.81
(γ_{fo})	(0.62)	(2.15)	(0.66)
Dynamic coefficient	0.74	0.73	0.74
(θ_{fo})	(0.006)	(0.029)	(0.007)
Liquid petroleum gas			
Marginal share	0.07	0.04	0.07
(β_{lp})	(0.003)	(0.007)	(0.003)
Nondiscretionary	-1.96	-0.76	-2.04
(γ_{lp})	(0.20)	(0.33)	(0.21)
Dynamic coefficient	0.77	0.89	0.76
(θ_{lp})	(0.007)	(0.021)	(0.007)
Log-likelihood function	-208,071	-11,698	-196,071

^a Standard errors are shown in parentheses.

TABLE 3 Dynamic Energy Demand Model Estimates: Black and Non-Black Households

Parameter	Household ^a		
	All	Black	Non-Black
Natural gas			
Marginal share	0.24	0.39	0.21
(β_{ng})	(0.006)	(0.023)	(0.006)
Nondiscretionary	-10.46	-22.01	-8.98
(γ_{ng})	(1.15)	(6.51)	(1.08)
Dynamic coefficient	0.83	0.77	0.84
(θ_{ng})	(0.007)	(0.031)	(0.007)
Electricity			
Marginal share	0.56	0.45	0.58
(β_{el})	(0.006)	(0.020)	(0.007)
Nondiscretionary	-6.04	-6.60	-5.87
(γ_{el})	(0.60)	(1.39)	(0.66)
Dynamic coefficient	0.79	0.77	0.79
(θ_{el})	(0.011)	(0.032)	(0.012)
Fuel oil/kerosene			
Marginal share	0.13	0.13	0.13
(β_{fo})	(0.005)	(0.014)	(0.005)
Nondiscretionary	-6.58	-10.63	-6.35
(γ_{fo})	(0.62)	(2.18)	(0.63)
Dynamic coefficient	0.74	0.63	0.75
(θ_{fo})	(0.006)	(0.020)	(0.007)
Liquid petroleum gas			
Marginal share	0.07	0.03	0.08
(β_{lp})	(0.003)	(0.008)	(0.004)
Nondiscretionary	-1.96	-0.87	-2.09
(γ_{lp})	(0.20)	(0.49)	(0.22)
Dynamic coefficient	0.77	0.82	0.76
(θ_{lp})	(0.007)	(0.021)	(0.008)
Log-likelihood function	-208,071	-23,566	-184,118

^a Standard errors are shown in parentheses.

TABLE 4 Energy Expenditure Model Estimates: Latino and Non-Latino Households

Parameter	Household ^a		
	All	Latino	Non-Latino
Household income	0.0066 (0.00026)	0.0092 (0.0026)	0.0063 (0.00025)
Household members	105.72 (3.72)	64.42 (12.65)	113.03 (3.95)
Cooling degree days (CDD) (65°F base)	0.080 (0.011)	0.1017 (0.031)	0.075 (0.012)
Heating degree days (HDD) (65°F base)	0.054 (0.004)	0.087 (0.0134)	0.048 (0.004)
CDD × HDD	3.44×10^{-5} (3.64×10^{-6})	1.68×10^{-5} (1.41×10^{-5})	3.40×10^{-5} (3.70×10^{-6})
Consumer price index urban (1979 = 1)	164.22 (17.37)	42.17 (58.08)	184.09 (18.33)
Central city location	-67.18 (13.40)	-14.71 (49.21)	-63.04 (13.96)
Non-metropolitan location	-106.92 (14.44)	-88.80 (73.61)	-109.96 (14.76)

^a Standard errors are shown in parentheses.

under a regime of higher natural gas prices, Latinos natural gas expenditures are likely to increase at a slower rate than those for non-Latinos. The larger expenditure-share parameter and the smaller dynamic-adjustment parameter reinforce this finding.⁸

The electricity demand model reveals that the nondiscretionary demand parameter in Latino households is more than one and half times greater than in non-Latino households.

⁸ The nondiscretionary demand for natural gas will play little or no role because of the closeness of its value for both Latinos and non-Latinos. Also, the value of the lagged consumption of natural gas is important. For different population groups, if the values are very different, historical patterns of natural gas expenditures could be very different.

Consequently, electricity expenditures (certainly in the long run) are expected to increase at a faster rate in Latino households than in non-Latino white households.

under a regime of higher natural gas prices, Latinos natural gas expenditures are likely to increase at a slower rate than those for non-Latinos. The larger expenditure-share parameter and the smaller dynamic-adjustment parameter reinforce this finding.⁹

The electricity demand model reveals that the nondiscretionary demand parameter in Latino households is more than one and half times greater than in non-Latino households. Consequently, electricity expenditures (certainly in the long run) are expected to increase at a faster rate in Latino households than in non-Latino white households.

The relative changes in expenditures associated with electricity and natural gas implied by the model seem to be confirmed by the expenditure data reviewed earlier. These data indicate that real electricity expenditures in relation to nonelectric energy expenditures increase at a faster rate in Latino households than in non-Latino households.¹⁰

6.2 BLACK ENERGY DEMAND

The parametric estimates for the black and nonblack energy demand models are shown in Tables 3 and 5. Once again, the null hypothesis is overwhelmingly rejected.

As in the case of Latinos, the estimated natural gas demand model for black households implies that, under a regime of higher natural gas prices, expenditures by black households for natural gas are likely to increase at a slower rate than those for nonblack households. The larger expenditure-share parameter in black households and the smaller nondiscretionary natural-gas-demand parameter are likely to reinforce this result.

For the electricity model, the smaller marginal expenditure-share parameter in black households implies that electricity expenditures in black households are likely to increase at a relatively faster rate, whereas the historically lower level of electricity consumption in black households will prevent a substantial overall increase.

⁹ The nondiscretionary demand for natural gas will play little or no role because of the closeness of its value for both Latinos and non-Latinos. Also, the value of the lagged consumption of natural gas is important. For different population groups, if the values are very different, historical patterns of natural gas expenditures could be very different.

¹⁰ This finding, of course, assumes that electricity and natural gas prices are increasing at about the same rate and that nondiscretionary energy expenditures remain about the same, leaving only price changes to influence expenditures.

TABLE 5 Energy Expenditure Model Estimates: Black and Non-Black Households

Parameter	Household ^a		
	All	Black	Non-Black
Household income	0.0066 (0.00026)	0.0070 (0.0011)	0.0067 (0.00027)
Household members	105.72 (3.72)	115.09 (9.58)	102.50 (4.18)
Cooling degree days (CDD) (65°F base)	0.080 (0.011)	0.057 (0.035)	0.087 (0.012)
Heating degree days (HDD) (65°F base)	0.054 (0.004)	0.087 (0.0155)	0.053 (0.004)
CDD × HDD	3.44×10^{-5} (3.64×10^{-6})	2.86×10^{-5} (1.30×10^{-5})	3.24×10^{-5} (3.80×10^{-6})
Consumer price index urban (1979 = 1)	164.22 (17.37)	138.00 (55.48)	166.02 (17.97)
Central city location	-67.18 (13.40)	-26.92 (49.21)	-92.22 (14.28)
Non-metropolitan location	-106.92 (14.44)	-159.22 (53.36)	-96.99 (14.71)

^a Standard errors are shown in parentheses.

7 POLICY IMPLICATIONS OF DIFFERENCES IN LATINO AND NON-LATINO ENERGY DEMAND

The effects of energy policies and programs on the relative prices of residential fuel sources will affect the economic welfare of Latino, non-Latino white, and non-Latino black groups differently. Whether price changes occur in response to macroeconomic or market-driven dynamics, or to federal price or state public utility policies, the economic welfare implications of policies and programs that affect the service price of residential energy sources can be estimated by the cost function given in Equation (6). Specifically, the relative impact of energy policies and programs at the household level are determined by the relative magnitudes of the marginal share, nondiscretionary demand, dynamic adjustment coefficient parameters, and levels of fuel consumption evident among these diverse households.

For Latino and non-Latino population groups, the comparative economic welfare impacts of changing energy prices are not clear-cut. The economic welfare changes implied by the estimated marginal share parameters are often offset by the implied changes associated with the estimated nondiscretionary demand parameter and differences in the patterns of energy use.

Each policy scenario will have to be evaluated on its own merits, using the parameters in the model as a frame of reference. Both the magnitude and the timing of energy price changes will have an effect on the comparative economic consequences of energy policy. It is clear, however, that the intragroup distribution of a policy's impact for Latino households will differ from that for non-Latino black and non-Latino white households. The impact of these differences has consequences not only for such compensatory energy policies as the national Low-Income Household Energy Assistance Program (LIHEAP) and such state utility rate schemes as lifeline and declining block rate structures, but also for a variety of income transfer programs designed to sustain and expand the economic welfare of these households. Low income and subsidized housing programs, Aid to Families with Dependent Children, Supplemental Security Income Programs under the Social Security Administration, and other income maintenance programs are designed to address poverty caused by a combination of household income stresses, including energy price increases.

The next step is to apply the model to household energy data to simulate how potential policy scenarios are likely to affect different population groups in terms of both overall economic impact and distributive consequences. The work of Cook and Scioli (1971) on policy impact assessment is potentially strengthened by the application of the household energy demand-consumption-expenditure model. They recommend a reciprocal approach to impact assessment: groups and institutions are affected by events; those events mobilize groups and institutions to develop new policies or alter existing policies; resultant policy development and implementation stimulate more economic, social, and political events; these events generate more impacts for groups and institutions. Thus, the energy demand model, combined with policy assessment models, can provide higher levels of validity and reliability in assessing energy policy impacts. Once these impacts are evaluated, the results can help policymakers to anticipate how various

demographic and socioeconomic groups, affected differently by energy events and policies, are likely to alter their behavior in terms of household energy consumption and expenditure. The result is an approach to impact assessment that is both highly empirical in the inputs it generates from data sources and analyses and anticipatory of economic and socioeconomic impacts, the assessment of which helps policymakers to anticipate and respond creatively to all groups affected by such events and policies.

8 CONCLUSIONS

This report discusses energy demand and expenditure patterns for Latino and non-Latino households in the United States as a case study of residential energy consumption across different population groups in a country.

As expected, the data analyzed indicated that the patterns of energy use and expenditures among Latino, non-Latino black, and non-Latino white households in the United States generally differ. The analyzed energy sources included electricity, natural gas, fuel oil, and LPG. The literature search confirmed that residential energy demand by fuel type for Latinos has not been explained by economic and noneconomic factors in any statistical model in the public domain.

The linear expenditure system model developed by Stone and Geary was selected as the basis to explain the fuel consumption of and expenditures for Latino and other population groups (including non-Latino black, non-Latino white, and all households) in the United States. This model estimates energy consumption of and expenditures for electricity, natural gas, fuel oil, and LPG by various households at the national level. Significant variations in the consumption patterns of these fuels by Latino and non-Latino households were noted, and the policy implications of the differential energy demand of Latino and non-Latino households were discussed.

As in the United States, residential energy cost is an important part of the household budget in many countries and could vary significantly across different population groups.

The model methodology and results of this research should be useful to energy policymakers in government and industry, researchers, and academicians who are concerned with economic and energy issues related to various population groups.

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