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Fuel Demand Elasticities in Pakistan: An Analysis of Households' Expenditure on Fuels using Micro Data

NADEEM A. BURNEY and NAEEM AKHTAR*

This study aims to examine the pattern of households' expenditure on fuel consumption in Pakistan using the data of Household Income and Expenditure Survey (1984-85). Price and income elasticities have been estimated by applying the Extended Linear Expenditure System.

It is found that the expenditure pattern of the rural households is different from the urban households, with the rural households spending proportionately more on fuels. The estimates of the income elasticities imply that all fuels are a necessity for both urban and rural households. The price elasticities of different fuels are found to be extremely low, implying that the consumption of fuels in Pakistan is highly price inelastic.

I. INTRODUCTION

Energy plays a decisive role in the development process of a country. It not only powers nearly every production process, but is also an important and fundamental component of the households' consumption basket.[1] It is now widely recognized that economic growth and energy consumption are inter-dependent and that industrialization is a highly energy-intensive process.[2] The increase in per capita

*The authors are, respectively, Senior Research Economist and Staff Economist at the Pakistan Institute of Development Economics, Islamabad.

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[1]Energy can be obtained from hydro-electricity, fossil fuels, e.g., natural gas, oil, etc., and biomass fuels, e.g., firewood, charcoal, agricultural residue, etc.

[2]Kuz and Smil (1976) have analyzed energy consumption-cum-growth relationship for a large number of countries. On average, the correlation between commercial energy consumption and economic growth is found to be around 0.9. For Pakistan, Riaz (1984) has found that: (i) One percent increase in gross national product (GNP) increase commercial energy consumption by 1.23 percent. (ii) Energy explains more than 80 percent of the variations in GNP. The dynamic analysis of energy consumption and economic growth is usually presented by the energy-output ratio, also referred to as the energy intensity, over time. This ratio is found to rise in the early stages of development, but to decline and stabilize once the economy has gained certain industrial maturity.

energy consumption over time is thus attributed to increasing capital endowment and a rising per capita income.[3] The recognition that, in the modern era, energy is one of man's basic requirements and that its availability is vital for economic progress has led many countries, particularly those in the developing world, to subsidize domestic fuel prices. The sharp increases in the price of oil in 1973-74 and 1978-79 and subsequent problems associated with huge balance-of-payments and budgetary deficits, however, have forced many of them to abandon that policy, at least partially. In Pakistan electricity and natural gas were heavily subsidized until quite recently. The increase in the price of oil further increased the implicit subsidy on both these items. In recent years, however, this subsidy has been substantially reduced.

The rapid increase in the cost of producing energy has led to concern, particularly in the developing countries, about whether energy will be available in adequate supply and at prices which will allow progress to continue. For the developing countries the problems arise from deciding how best to provide energy needs of the different sectors. One of the major issues involves the finding of an economically efficient way to set energy prices, and the negative consequences for individual agents as well as for the whole economy that result from a failure to do so. Attempts are being made to rationalize energy prices which have and will continue to affect the consumers. The impact, however, is likely to vary across different sectors.

In order to quantify the impact of increases in the price of energy on different sectors as well as the whole economy, sector-specific demand elasticities of different fuels are extremely useful. However, no such estimates exist for Pakistan. The objective of the present study is to estimate a complete set of income and price elasticities of households' expenditure on the consumption of different fuels in Pakistan.[4] The study uses a systems approach to analyze households' expenditure on energy consumption, and is based on a cross-section household-level micro data reported in the 1984-85 Household Income and Expenditure Survey (HIES). As the

[3] For more on this, see Leach *et al.* (1986, Chs. 10 and 11). In estimating production functions for the manufacturing sectors Apte (1983); Hyun (1984); Khan (1989) and Lynx (1983) have found strong complementarity between energy and capital. See also Solow (1987).

[4] The household sector uses energy to support its vital basic needs, such as cooking, heating, and lighting. To fulfil these needs, energy is obtained from various sources, e.g., electricity, natural gas, kerosene, firewood, charcoal, agricultural residue, etc. A number of studies have analyzed households' consumption pattern in Pakistan. For a complete list of such studies, see Burney and Khan (1989). In all of those studies, the expenditure on energy has been analyzed under a single broad category 'Fuel and Lighting'. The income and price elasticities thus obtained correspond to total expenditure on energy. Such estimates are of little value for analyzing the impact of change in the price of any specific fuel. Furthermore, they do not help in determining which of the different fuels are complementary to or substitutes of each other. This latter information is particularly useful for policy purpose.

composition of the energy consumed in the urban sector is different from that in the rural sector, the exercise will be carried out separately for the urban and the rural households. The income and price elasticities thus obtained are of direct relevance for energy pricing policy.

The rest of the paper is organized as follows: Section II discusses patterns and trends in energy consumption in Pakistan, with particular emphasis on household energy consumption. Section III outlines the model and the methodology for the estimation of income and price elasticities. Section IV examines the pattern of households' expenditure on the consumption of different fuels in Pakistan using data from the 1984-85 HIES. Section V presents and discusses the results. Finally, Section VI summarizes the major findings.

II. ENERGY CONSUMPTION IN PAKISTAN

Per capita consumption of energy is considered to be one of the indicators of economic development. Currently, Pakistan's per capita energy consumption is one of the lowest among the developing countries. Its energy intensity, defined as the ratio of energy consumed and GDP, however, is comparable to countries with relatively much higher per capita income (sèe Table 1). This can be reconciled by

Table 1

Comparison of Energy Intensity across Countries
(TOE Per $MN of GDP)

Countries	1973	1976	1979	1982	1985
Bangladesh	206	197	221	263	282
India	592	654	682	669	714
Pakistan	498	520	550	592	605
The Philippines	418	374	366	314	317
Thailand	421	393	393	345	372
Korea	581	566	631	614	609
The United States	1120	N.A.	1020	N.A.	773
Japan	690	N.A.	620	N.A.	510

Sources: Energy Indicators ADB Member Countries, 1987.
International Energy Agency, OECD, 1981.
World Development Report, 1987.
TOE = Tonne of Oil Equivalent.
$MN = Million U.S. Dollars.
$ values are taken in constant 1975 prices.

considering the following definitional equation;

$$TOE/GDP = (TOE/Pop)\,(Pop/GDP)$$

While *TOE/Pop* (Tonne of Oil Equivalent of energy consumed per capita) in Pakistan is comparatively low, the ratio *Pop/GDP* (inverse of GDP per capita) is higher compared to that for the other countries. Consequently, the energy intensity in Pakistan is high despite low per capita consumption of energy.

Energy consumption in Pakistan during the eighties increased at an annual compound growth rate of 8.0 percent. In absolute terms, the energy consumption has increased from 12.08 million tonnes of oil equivalent (MTOE) in 1979-80 to 20.75 MTOE in 1986-87, showing an increase of 72 percent.[5] In per capita terms, energy consumption during this period increased at an annual compound growth rate of 4.8 percent from 0.15 TOE to 0.21 TOE. Table 2 indicates that oil and

Table 2

Total Commercial Energy Consumption in Pakistan

	Total Energy Consumption (MTOE)	Per Capita Energy Consumption (TOE)	Percentage Share of Different Sources of Energy			
			Coal	Oil	Natural Gas	Electricity
1979-80	12.08	0.15	5.81	35.32	38.29	20.38
1980-81	13.02	0.15	5.42	34.15	39.62	20.18
1981-82	14.31	0.17	5.47	34.95	38.46	21.11
1982-83	15.27	0.17	4.71	37.17	36.07	22.05
1983-84	16.36	0.18	5.11	38.37	33.64	22.88
1984-85	17.85	0.19	5.61	38.07	32.88	23.44
1985-86	19.04	0.20	5.17	38.37	31.87	24.58
1986-87	20.75	0.21	4.87	38.75	31.49	24.89
1987-88	23.24	0.22				
1979/80–88	151.92	1.63				
	(16.88)	(0.18)				

Source: Government of Pakistan (Various Issues) *Energy Year Book.* Islamabad: Ministry of Petroleum and Natural Resources, Directorate General of New and Renewable Resources.

[5] These figures refer only to commercial energy consumption and do not include energy obtained from biomass fuels, e.g., firewood, agricultural residue, etc. According to rough estimates, energy from these sources accounts for 25 percent of the total energy consumption, which is mainly used in the household sector.

natural gas account for around 70 percent of the total commercial energy consumed. Electricity and coal account for the remaining 30 percent of the total consumption. It is interesting to note that since 1979-80, despite rapid increases in the nominal price of oil and electricity, their share in total energy consumption has increased steadily while that of natural gas and coal has declined.[6]

Table 3 indicates that on average the household sector accounts for a little

Table 3

Households' Commercial Energy Consumption in Pakistan

	Household Energy Consumption		Percentage Share of Different Fuels in Total Household Energy Consumption			
	MTOE	% of Total Energy Consumption	Coal	Oil	Natural Gas	Electricity
1979-80	1.58	13.10	0.75	42.70	21.11	35.44
1980-81	1.63	12.48	0.21	34.76	25.54	39.48
1981-82	1.94	13.54	0.52	30.89	29.01	39.58
1982-83	2.22	14.52	0.45	29.32	29.94	40.29
1983-84	2.60	15.88	0.37	29.04	29.04	41.55
1984-85	2.92	16.35	0.25	28.39	29.96	41.40
1985-86	3.27	17.20	0.20	26.94	30.38	42.48
1986-87	3.66	17.65	0.07	26.45	29.24	44.24
1987-88	3.99	17.17	0.40	21.50	26.80	51.30
1979-80 to 1987-88	22.66 (2.52)	138.11 (15.35)				

Source: Energy Year Book (Various Issues).

[6]It may be pointed out that in Pakistan prices of major fuels, e.g., electricity, natural gas, and oil, are controlled by the government. The price of electricity has been increased more frequently and sharply compared to that of the natural gas.

over 15 percent of the total energy consumption in Pakistan. Between 1979-80 and 1986-87, the household energy consumption in Pakistan increased at an annual compound growth rate of 12.7 percent, from 1.58 MTOE to 3.66 MTOE. The household sector obtains the largest proportion of its energy requirements from electricity, followed by natural gas, oil, and coal. The share of electricity and natural gas in total household energy consumption has increased steadily over time despite increases in their nominal prices.[7] This increment can partly be attributed to the facts that:

(i) The electricity and the natural gas are considered to be relatively convenient sources of energy compared to oil or coal; and
(ii) Most of the rural areas in Pakistan do not have access to electricity and natural gas, giving people few alternatives. Consequently, an extension of the supply of these fuels to new areas over time results in an increase in their consumption because of new availability and added efficiency.

Under the impact of change in the relative prices of different fuels over time, as well as structural adjustment by the using sectors induced by the Government policy, substitution has occurred in the use of fuel by various sectors. Table 4 shows

Table 4

Inter-fuel Substitution in Pakistan by Consuming Sectors (Percentage Share)

Sectors	1979-80				1987-88			
	Coal	Oil	Natural Gas	Electricity	Coal	Oil	Natural Gas	Electricity
Household	0.74	42.70	21.11	35.45	0.40	21.50	26.80	51.30
Commercial	–	2.70	41.00	56.30	–	–	34.50	65.50
Industrial	17.99	5.98	50.03	26.00	17.10	18.40	30.90	33.60
Agriculture	–	–	–	65.42	–	23.90	–	76.10
Transport	–	100.00	–	–	–	99.60	–	0.40
Fertilizer	–	–	100.00	–	–	–	100.00	–
Power	0.40	2.61	96.95	–	0.20	33.10	66.70	–
Other Govt.	0.70	71.85	–	27.45	0.10	43.00	–	56.90

Source: Pakistan Economic Survey, 1987-88.

[7] Between 1979-80 and 1987-88, the average sale price of electricity for the household sector increased from 34 paisa/kwh to 45 paisa/kwh. It may be pointed out that real prices of electricity and natural gas have decreased almost continuously since at least 1970. See Leach (1988).

that the household sector, which was relatively more intensive in the use of oil in 1979-80 (oil accounted for around 43 percent of the total energy consumed) has now shifted to electricity, whose share has increased from 35.5 percent in 1979-80 to 51.3 in 1987-88. As the demand for electricity is a derived demand, this increase in the share of electricity can also be attributed to a change in the households' consumption pattern whereby the use of electricity-intensive products has increased. Similarly, the industrial sector, which was intensive in the use of natural gas, has moved towards greater use of oil and electricity. In general, all the sectors have become relatively more electricity-intensive.

III. THE MODEL AND ESTIMATION METHODOLOGY

In order to estimate income and price elasticities of households' expenditure on the consumption of different fuels, we estimate an Extended Linear Expenditure System (ELES), first developed by Lluch (1973) and subsequently used, among others, by Powell (1973, 1973a), Lluch and William (1975) and Lluch *et al.* (1977), to analyze household consumption behaviour. The ELES is preferred to the commonly used Linear Expenditure System (LES), first suggested by Stone (1954), because it yields better estimates of the price elasticities.[8] In addition, by endogenizing the total household consumption expenditure, the ELES allows one to measure the impact of changes in relative prices on households' savings. The ELES, like other demand systems, is based on the standard utility maximization behaviour of the households, where the problem is how much to spend on various commodities, given a spendable amount per unit of time.

Assuming that households' decisions are made on a per capita basis, and that except for income and prices, other factors like age, education, and occupation do not affect consumption, the expenditure behaviour can be described by the following relationship:[9]

$$e_i = p_i x_i = p_i \gamma_i + \beta_i (y - \Sigma p_j \gamma_j) \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where $i = 1, 2, \ldots\ldots n$ goods, e_i is households' per capita expenditure on good i, p_i is the price of good i, x_i is households' per capita quantity consumed of good i, y is households' per capita income, and (γ_i, β_i) are the parameters to be estimated. The

[8] For details see Lluch *et al.* (1977, p. 15).

[9] The ELES can be derived from the utility maximization behaviour. The underlying utility function is Stone-Geary type where the preferences are directly additive, i.e.,

$$U(x) = f_i(x_i) = \beta_i \log (x_i - \gamma_i)$$

with $x_i > \gamma_i$, $\beta_i > 0$, and $\Sigma \beta_i = \mu$.

β_is represent marginal propensity to consume of good i such that $\Sigma\beta_i = \mu$ is the aggregate marginal propensity to consume. The γ_i parameter can be interpreted as representing the basic needs or subsistence quantity of good i if it is positive and $\Sigma p_j\gamma_j$ is total subsistence expenditure. The expression $(y - \Sigma p_j\gamma_j)$ represents supernumerary income. The relationship described by Equation (1) is referred to as the ELES.[10] Adding all the expenditure equations gives an aggregate consumption function of the following form:

$$E = (1 - \mu)\Sigma p_i\gamma_i + \mu y \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

where E is the total household consumption expenditure. An additional advantage of using ELES is that Equation (2) enables identification of $\Sigma p_i\gamma_i$ in the absence of price data which helps in obtaining price elasticities from the cross-section data.

As γ_i appears in all the equations, the system of equations described by (1) needs to be estimated simultaneously. This imposes cross-equation restrictions which, in general, require maximization of the likelihood function. In the case of cross-section data, however, since each household faces identical commodity prices, the term $p_i\gamma_i$ is independent of the unit of observations. Thus it can be replaced by γ_i^*. This stochastic specification of the ELES can then be written as:

$$e_{ih} = \alpha_i + \beta_i y_h + \epsilon_{ih} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

where $h = 1, 2, \ldots H$ households, $\alpha_i = \gamma_i^* - \beta_i\Sigma\gamma_i^*$, and ϵ_{ih} is the error term with usual classical properties.

The system of equations described by relation (3) is one of identical regressors in which every left-hand side variable is regressed upon the same set of exogenous variables. Estimation of each of its equations separately for different commodities, by the Ordinary Least Squares (OLS) method, is equivalent to the system's maximum likelihood estimation.[11] The maximum likelihood estimates of μ, $\gamma_i^*$and $\Sigma\gamma_i^*$ can be estimated from the OLS estimates of α_i and β_i using the following relationship:

[10]A LES differs from an ELES in the sense that instead of y total household expenditure (E) appears in the equation. Thus instead of supernumerary income, there is an expression $(E - \Sigma p_j\gamma_j)$ referred to as supernumerary expenditure. The coefficient of $(E - \Sigma p_j\gamma_j)$ denoted say as β_i^* is interpreted as marginal budget shares, i.e., marginal propensity to consume out of total expenditure, such that $\Sigma\beta_i^* = 1$. The β_i^* can be obtained from β_i^* as $\beta_i^* = \beta_i/\mu$.

[11]See, for example, Goldberger [(1964), pp. 207–212] and Dhrymes [(1970), pp. 153–161].

$$\mu = \Sigma\beta_i$$

$$\Sigma\gamma_i^* = \Sigma\alpha_i/(1-\mu)$$

$$\gamma_i^* = \alpha_i + \beta_i\Sigma\gamma_i^*$$

The relevant demand elasticities can then be computed as follows:

(i) Income Elasticity of Good *i*: $\eta_{iy} = \beta_i(y/e_i)$

(ii) Expenditure Elasticity of Good *i*: $\eta_{ie} = (\beta_i/\mu)(E/e_i)$

(iii) Own-price Elasticity of Good *i*: $\eta_{ii} = (1-\beta_i)(\gamma_i^*/e_i) - 1$

(iv) Cross-price Elasticity of Good *i*: $\eta_{ij} = -\beta_i(\gamma_j^*/e_i)$

(v) Income Elasticity of Total Expenditure: $\eta_{Ey} = \mu(y/E)$

(vi) Price Elasticity of Total Expenditure: $\eta_{Ei} = (1-\mu)(\gamma_i^*/E)$

The formula for the cross-price elasticity indicates that for a cross-price elasticity to be positive either β_i^* must be negative, i.e., good *i* be inferior, or γ_j^* must be negative, i.e., good *j* be a luxury. This implies that in ELES the uncompensated cross-price elasticities, under normal circumstances, can assume only negative values. Thus no conclusions can be derived from negativity of these elasticities. This, it may be pointed out, is true for the LES as well.[12]

IV. THE DATA

This study is based on the micro level data of Household Income and Expenditure Survey (HIES) for the year 1984-85, compiled by the Statistics Division of the Government of Pakistan. This survey, based on a national sample, covered 16580 households and reports households' expenditure on a detailed and comprehensive list of commodities.

Since the purpose of this present study is to examine the pattern of households' expenditure on fuels, total household expenditure has been categorized into

[12] For more information on the limitations of price elasticities obtained by using LES, see Deaton and Muellbauer [(1980), Ch. 3].

two broad groups, namely 'expenditure on fuels' and 'expenditure on non-fuels'.[13] The expenditure on fuels has been further disaggregated into the expenditure on firewood, kerosene oil, natural gas, electricity, and other-fuels. The last category includes expenditure on coal, dung cakes, and crop residue, which are important sources of biomass energy, particularly for the rural households.

In general, the households' expenditure on fuel is influenced by a number of factors, including culture, tradition, climate, season, availability and price of fuels, household income, household size, and place of residence, i.e., whether urban or rural. Because of these factors, large differences are observed in the households' expenditure on fuels. These differences can be seen clearly in the following tables.

The evidence given in Table 5 indicates that a large proportion of the rural households are reported to have zero expenditure on natural gas and electricity. This is due to the fact that most of the rural areas in Pakistan do not have access to these fuels. The average monthly expenditure and expenditure shares of different fuels reported in the table show that the rural households spend proportionately more on fuels compared to the urban households. This difference can partly be attributed to the fact that the oil equivalent of firewood and other-fuels, which are the major source of energy for the rural households as revealed by the table, is substantially lower than that of electricity or natural gas. Thus, for a given amount of oil equivalent of energy, the expenditure of the rural households on fuels is higher than that of the urban households.[14] For the urban households, however, electricity and fossil fuels, e.g., kerosene oil and natural gas, are the major source. Among the different types of fuel, the rural households spend most on firewood whereas the urban households mostly purchase electricity.

[13] In most household studies it is implicitly assumed that preferences provide a natural structuring of the commodities to define commodity groups. The first idea in this context is that of separability of preferences. If this holds, the commodities can be partitioned into groups so that preferences within the groups can be described independently of the quantities in other groups. The second idea is that of two-stage budgeting. This occurs when households can allocate expenditure in two stages. At the first stage, expenditure is allocated to broad commodity groups, e.g., Food, Fuel and Lighting, Entertainment, etc. At the second stage, group expenditures are allocated to the individual commodities. This implies that allocation of expenditure to ith commodity in jth group is independent of expenditure on commodities in other groups. For details, see Deaton and Muellbauer [(1980), Ch. 5]. In our case, this implies that a change in the price of, say, cereals can only affect the demand for electricity or natural gas through the same channels and in the same way as will a change in the price of any other commodity in the non-fuel group.

[14] It has been found that in the developing countries most of the biomass fuels are consumed by the households, so that the energy use in this sector is particularly inefficient (in the technical sense). See Leach *et al.* [(1986), Ch. 10].

Table 5

Households' Expenditure on Different Fuels

	Households with Zero Reported Expenditure (% of Total Households)		Average Household Expenditure (% of Total Household Expenditure)		Average Household Expenditure (Rupees per Month)		Average Household Expenditure Per Capita (Rupees per Month)	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Firewood	47	19	1.35	2.95	29.24	42.50	4.83	7.99
Kerosene Oil	50	17	0.65	0.76	14.09	11.00	2.76	2.21
Natural Gas	67	98	0.83	–	18.00	–	2.93	–
Electricity	17	70	1.59	0.48	34.50	6.88	6.06	1.27
Other Fuels	5	3	0.51	1.74	10.96	25.13	1.94	4.69
Total Fuel			4.93	5.93	106.79	85.50	18.51	16.15
Non-fuel			95.07	94.07	2057.81	1357.1	359.81	247.3

Table 6 indicates that within the urban and the rural sectors, households' per capita expenditure on fuel increases with the level of income. Table 7, however, reveals that for both the urban and the rural households, the share of energy in total household expenditure declines with income. Furthermore, the rural households allocate a larger proportion of their total expenditure to fuel consumption compared to their urban counterparts, irrespective of the level of income. This shows that although there is a relationship between the income and the expenditure on fuels, the pattern is different between the urban and the rural sectors. It is generally believed that since biomass fuels are an inefficient source of energy, their consumption falls as income increases, and that of electricity and fossil fuels rises. This is supported by the shares of different fuels in total household expenditure given in Table 7. The per capita expenditure on different fuels reported in Table 6, however, shows that, in absolute terms, the expenditure on biomass fuels increases with the level of income. On a per capita basis, to fulfil their energy needs, the rural households allocate close to 50 percent of their fuel expenditure to firewood and around 30 percent to the other-fuels, irrespective of the level of income. In the urban

Table 6

Average per Capita Household Expenditure on Energy by Type of Fuel and Income Groups

Income Groups (Rupees per Month)	Average per Capita Household Monthly Income		Average per Capita Monthly Household Monthly Expenditure on Energy		Average per Capita Monthly Household Monthly Expenditure on fossil Fuel*		Average per Capita Monthly Household Monthly Expenditure on Biomass Fuel		Average per Capita Monthly Household Expenditure by Type of Fuel									
									Firewood		Kerosene Oil		Natural Gas		Electricity		Other Fuels	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
0–1000	181.60	165.53	13.67	12.40	5.63	2.45	8.04	9.95	6.03	6.13	2.03	1.74	0.63	–	2.97	0.71	2.00	3.82
1001–1500	218.54	206.19	14.00	13.26	6.71	2.76	7.29	10.51	5.51	6.61	2.25	1.83	1.05	–	3.41	0.93	1.78	3.90
1501–2000	254.75	244.70	14.42	14.10	8.30	2.98	6.12	11.12	4.60	6.93	2.21	1.86	1.90	–	4.19	1.12	1.52	4.18
2001–3000	315.04	295.22	15.54	14.98	9.81	3.17	5.73	11.81	4.09	7.62	2.31	1.81	2.65	–	4.84	1.36	1.64	4.20
3001–5000	443.06	411.18	17.65	17.59	12.90	3.71	4.75	13.89	3.35	8.86	2.02	1.76	4.28	–	6.59	1.95	1.40	5.03
5001–15000	899.65	808.07	25.12	22.27	21.64	5.40	3.48	16.87	1.95	10.69	1.40	1.77	8.05	–	12.19	3.62	1.54	6.18

Source: HIES 1984-85.

*Include expenditure on electricity.

Table 7

Pattern of Household Expenditure on Energy by Type of Fuel and Income Groups

Income Groups (Rupees per Month)	Average Monthly Income		Share of Energy in Total Household Expenditure		Share of Fossil fuel in Total Household Expenditure*		Share of Biomass Fuel in Total Household Expenditure		Share of Different Fuel Item in Total Household Expenditure									
									Firewood		Kerosene Oil		Natural Gas		Electricity		Other Fuels	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
0–1000	785.73	723.84	7.08	7.08	2.92	1.40	4.16	5.68	3.12	3.50	1.05	1.00	0.32	–	1.54	0.40	1.04	2.18
1001–1500	1257.63	1236.13	6.40	6.42	3.07	1.34	3.34	5.08	2.52	3.20	1.03	0.88	0.48	–	1.56	0.45	0.81	1.89
1501–2000	1754.48	1721.27	5.74	6.05	3.30	1.28	2.43	4.77	1.83	2.98	0.88	0.80	0.76	–	1.67	0.48	0.60	1.80
2001–3000	2440.37	2393.86	5.16	5.53	3.26	1.17	1.90	4.36	1.36	2.80	0.77	0.67	0.88	–	1.61	0.50	0.55	1.55
3001–5000	3789.52	3727.06	4.26	4.91	3.12	1.04	1.15	3.87	0.81	2.47	0.49	0.49	1.03	–	1.59	0.54	0.34	1.40
5001–15000	7504.80	7151.95	3.26	3.79	2.81	0.92	0.45	2.87	0.25	1.82	0.18	0.30	1.04	–	1.58	0.62	0.20	1.05

Source: HIES 1984-85.

*Include expenditure on electricity.

sector, on the other hand, the poorest households allocate 40 percent and 25 percent of their fuel expenditure to firewood and electricity, respectively, while the richest urban households allocate 30 percent and 50 percent of their fuel expenditure to natural gas and electricity, respectively.

According to Engel's law, as income increases the share of expenditure on the necessities falls and that on luxuries rises.[15] The information given in Table 7 shows that for both the urban and the rural households in Pakistan, the share of fuels in total household expenditure declines as income increases. The breakdown of total fuel expenditure by expenditure on fossil and biomass fuels, however, indicates that for the urban households the share of fossil fuels in total household expenditure first rises with the level of income, and then declines. In the case of the rural households, the share of biomass fuels declines as income increases. The breakdown of total fuel expenditure by different fuels further reveals that for the urban households the share of natural gas in total household expenditure, and for the rural households the share of electricity in total household expenditure, increases continuously with the level of income. For the urban households the share of electricity first increases, and then declines. In all other cases, the share falls as income increases.

V. THE RESULTS AND ANALYSIS

This section presents and discusses the estimates of income and price elasticities of household expenditure on different fuels. For both the urban and the rural households the regression results corresponding to Equation (3) are reported in Table 8. The coefficients, except for firewood in the case of the urban households, have anticipated signs, and are highly significant. The negative coefficient of income for firewood suggests that, in the urban sector, firewood is considered to be an inferior source of energy. The intercept term for each fuel is positive but the numerical value is small, implying that all the fuels are a necessity and that their existing consumption levels are low. This is also supported by positive γ_i^*s reported in Table 9.

It may be noted that β_i, the marginal propensity to consume different fuels, is very low in both the urban and the rural sectors. Except for electricity, however, the β_is are relatively larger for the rural households compared to the urban households. This could be because, among other things, the average income of the rural households is lower compared to the urban households (see Table 6). The marginal budget shares reported in Table 9 indicate that if households' per capita expenditure is increased by one rupee, then the urban and the rural households will allocate 2.4

[15] See Stigler (1954). In general, it is argued that the share of expenditure on 'Fuel and Lighting' remains constant.

Table 8

*Ordinary Least Square Estimates**

$(e_{ih} = \alpha_i + \beta_i y_h + \epsilon_{ih})$

	Urban		Rural	
	α_i	β_i	α_i	β_i
Fuel and Lighting	14.74	0.009	11.07	0.017
	(18.06)	(37.81)	(69.57)	(47.57)
Firewood	5.21	−0.001	5.70	0.008
	(54.45)	(−6.77)	(44.08)	(26.41)
Kerosene Oil	2.43	0.001	1.53	0.002
	(27.25)	(6.40)	(31.82)	(21.38)
Natural Gas	1.52	0.003	–	–
	(19.24)	(30.97)		
Electricity	3.81	0.005	0.46	0.003
	(39.27)	(40.09)	(11.60)	(30.05)
Other Fuels	1.77	0.001	3.39	0.004
	(27.78)	(4.57)	(38.81)	(22.16)
Non-fuels	207.42	0.359	77.98	0.563
	(58.23)	(74.25)	(42.05)	(136.02)

*The expenditure and income used refer to per capita expenditure and income. Figures in the parenthesis are *t*-ratios.

percent and 2.9 percent of it, respectively, to fuel consumption.[16] The urban households allocate more to electricity (1.4 percent), and the rural households to firewood (1.3 percent).

The income and expenditure elasticities, obtained for different fuels, are reported in Table 10.[17] All the income elasticities given in the table are less than unity, implying that the different types of fuels are a necessity for both the urban and the rural households.[18] However, the expenditure elasticity of natural gas

[16]Implicit in the Ali (1985) estimates, obtained by using grouped data from the HIES for the year 1979, is that households allocate 1.6 percent of their increased per capita expenditure on 'Fuel and Lighting'. The relatively lower estimates of Ali can partly be attributed to the use of grouped data which limits within the groups variations.

[17] In most household studies, total households' expenditure is taken as a proxy for permanent income. Thus, expenditure elasticities can also be interpreted as demand elasticities with respect to permanent income.

[18] Ali (1985) found income and expenditure elasticities for 'Fuel and Lighting' to be 0.25 and 0.35, respectively.

Table 9

Minimum Required Expenditure and Marginal Expenditure Shares of Different Fuels

	Marginal Expenditure Share		Minimum Required Expenditure	
	Urban	Rural	Urban	Rural
Firewood	–0.003	0.014	4.90	7.31
Kerosene Oil	0.003	0.003	2.71	2.01
Natural Gas	0.008	–	2.68	–
Electricity	0.014	0.005	5.68	1.04
Other Fuels	0.003	0.007	1.91	4.30
Fuel and Lighting	0.025	0.029	17.86	14.66
Non-fuels	0.976	0.971	333.42	197.48

Table 10

Demand Elasticities for Different Fuels in Pakistan

	Income Elasticity		Expenditure Elasticity		Elasticity of Total Expenditure w.r.t.p_i	
	Urban	Rural	Urban	Rural	Urban	Rural
Firewood	–0.088	0.301	–0.211	0.455	0.008	0.012
Kerosene Oil	0.154	0.272	0.370	0.405	0.005	0.003
Natural Gas	0.436	–	1.034	–	0.005	–
Electricity	0.351	0.712	0.850	1.081	0.010	0.002
Other Fuels	0.220	0.257	0.528	0.388	0.003	0.007
Fuel and Lighting	0.207	0.316	0.500	0.478	0.030	0.023

(electricity) in the case of urban (rural) households is greater than unity. The elasticities with respect to total expenditure are higher compared to income elasticities. Also the rural households have higher demand elasticities relative to the urban households.

The uncompensated own- and cross-price elasticities of different fuels extimated from the regression results for both the urban and the rural households are presented in Table 11. Except for firewood in the case of the urban households, the signs of all the other price elasticities, including both own- and cross-price elasticities, are negative.[19] It is to be noted that the numerical values of the estimated price elasticities, although non-zero, are rather small, implying that the households' consumption of fuels is price inelastic.[20] This suggests that, for analyzing households' fuel expenditure, price elasticities are not all that important. In other words, fuel prices have little effect on households' fuel consumption. This can partly be attributed to the fact that the average expenditure on different fuels is close to the minimum requirement. The estimated price elasticities, in general, are higher for the rural households compared to their urban counterparts, implying that, relatively speaking, the response of the rural households to price changes is higher.

The elasticity of total households' expenditure with respect to the prices of different fuels reported in Table 10 indicates that if prices of all the fuels increase by 100 percent, then, while holding household income constant, the total expenditure of the urban households will increase by 3 percent and that of the rural households by 2.3 percent. At the given households' income, this will amount to a decline in households' savings. The savings of the urban households will decline by 24 percent, and those of the rural households by 17 percent.[21] For the urban households, the largest increase in total expenditure comes from the increase in the price of electricity; and for the rural households, from the increase in the price of firewood.[22]

VI. CONCLUSION

This study has examined the pattern of households' expenditure on fuel con-

[19]See discussion in Section III for negativity of cross-price elasticities.

[20]For the broad category 'Fuel and Lighting', the own-price elasticity obtained by Ali (1985) is –0.101. For comparison we estimated the own-price elasticity for 'Fuel and Lighting' using micro data from the 1984-85 HIES, and found that for the urban households the said elasticity was –0.044, and for the rural households it was –0.108.

[21]The households' saving elasticity has been estimated using the formula $E_{si} = -\gamma_i^* (1 - \mu)/(y - E)$, where E_{si} is elasticity of savings with respect to the price of good i. See Lluch *et al.* (1977).

[22]A 100 percent increase in the price of electricity will lower savings of the urban households by 7.7 percent, and those of the rural households by 1.2 percent. A similar increase in the price of natural gas will lower savings of the urban households by 3.6 percent.

Table 11

Uncompensated Price Elasticities of Different Fuels for Urban and Rural Households in Pakistan: 1984-85

	Urban					Rural				
	Fire-wood	Kero-sene Oil	Natural Gas	Electric-ity	Other Fuels	Fire-wood	Kero-sene Oil	Natural Gas	Electric-ity	Other Fuels
Firewood	0.0142	0.0006	0.0006	0.0012	0.0004	–0.0922	–0.0020	–	–0.0010	–0.0043
Kerosene Oil	–0.0018	–0.0210	–0.0010	–0.0021	–0.0007	–0.0066	–0.0922	–	–0.0010	–0.0039
Natural Gas	–0.0050	–0.0028	–0.0877	–0.0058	–0.0020	–	–	–	–	–
Electricity	–0.0040	–0.0022	–0.0022	–0.0676	–0.0016	–0.0173	–0.0048	–	–0.1853	–0.0102
Other Fuels	–0.0025	–0.0014	–0.0014	–0.0029	–0.0167	–0.0062	–0.0017	–	–0.0010	–0.0860

Note: Figures along the diagonal are own-price elasticities, and those off the diagonal are cross-price elasticities.

sumption in Pakistan. In particular, households' responsiveness to changes in income and fuel prices, i.e., income and price elasticities, has been estimated. The major findings of the study are as follows: (1) the expenditure pattern of the rural households is different from that of their urban counterparts, with rural households spending proportionately more on energy; (2) for both the urban and the rural households all the fuels are necessities; (3) the expenditure on fuels is fairly inelastic with respect to changes in income; (4) for the urban households firewood is an inferior source of energy; (5) the marginal propensity to consume fuels is low in Pakistan; (6) out of a one-rupee increase in the per capita expenditure, 2.4 percent is allocated to fuel consumption by the rural households; (7) the price elasticities of different fuels are found to be extremely low, implying that the consumption of fuels in Pakistan is highly price-inelastic; (8) the rural households' response to the changes in prices is higher compared to their urban counterparts; (9) all fuels are gross complements in the technical sense; (10) a 100 percent increase in the prices of all the fuels will increase the expenditure of the urban households by 3 percent, and that of the rural households by 2.3 percent; and (11) at the given households' income, a 100 percent increase in the prices of all the fuels will decrease savings of the urban households by 24 percent, and those of the rural households by 17 percent.

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